FLORIDA DEPARTMENT OF TRANSPORTATION

SURVEYING AND MAPPING HANDBOOK

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ABBREVIATIONS

- 2D – 2 Dimensional
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- ASCII – American Standard Code for Information Interchange
- ASPRS – American Society of Photogrammetry and Remote Sensing
- AT – Aerial Triangulation or Aerotriangulation
- BM – Bench Mark
- BSM – Bureau of Survey and Mapping
- CADD – Computer Aided Design and Drafting
- CORS – Continuously Operating Reference Station
- CSDGM – Content Standard for Digital Geospatial Metadata
- CSMO –Central Surveying and Mapping Office
- DEM – Digital Elevation Model
- Department – Florida Department of Transportation
- DMI – Distance Measuring Instrument
- DSMO – District Surveying and Mapping Office
- DTM – Digital Terrain Model
- EFB – Electronic Field Book
- EOR – Engineer of Record
- F.A.C. – Florida Administrative Code

- FDEP – Florida Department of Environmental Protection
- FDOT – Florida Department of Transportation
- FGDC - Federal Geographic Data Committee
- FHWA – Federal Highway Administration
- FKP - Flächen Korrektur Parameter
- FPRN – Florida Permanent Reference Network
- F.S. – Florida Statutes
- GDOP – Geometric Dilution of Precision
- GLONASS – Global Orbiting Navigation Satellite System
- GNSS – Global Navigation Satellite System
- GPS – Global Positioning System
- GSD – Ground Sample Distance
- iMAC – Individualized Master Auxiliary Concept (iMAX)
- IMU – Inertial Measurement Unit
- INS – Inertial Navigation System
- LiDAR – Light Detection and Ranging
- MOT – Maintenance of Traffic
- MAC – Master Auxiliary Concept (MAX)
- MHWL – Mean High Water Line
- MSTS – Mobile Survey Tracking System
- NAD – North American Datum
- NAVD – North American Vertical Datum

- NDP – Network Design Plan
- NGS – National Geodetic Survey
- NGVD – National Geodetic Vertical Datum
- NSRS – National Spatial Reference System
- NSSDA – National Standard for Spatial Data Accuracy
- OHWL – Ordinary High Water Line
- OPUS – Online Positioning User Service (NGS Web-based Software)
- OPUS-P – Online Positioning User Service Projects (NGS Web-based Software)
- OPUS-RS – Online Positioning User Service Rapid Static (NGS Web-based Software)
- PC – Point of Curvature
- PDOP – Positional Dilution of Precision
- PI – Point of Intersection
- PNC – Project Network Control
- POC – Point on Curve
- POT – Point on Tangent
- PT – Point of Tangency
- PSM – Professional Surveyor and Mapper
- QA/QC – Quality Assurance/Quality Control
- RGNSS – Real-Time GNSS
- RINEX – Receiver Independent Exchange Format
- RMS – Root Mean Square

- RMSE – Root Mean Square Error
- RS – Rapid Static
- RSGNSS – Rapid Static GNSS
- RT – Real-Time Positioning
- RTK – Real-Time Kinematic
- RTN – Real-Time Network
- R/W – Right of Way
- Scope – Project Scope of Services
- SGNSS – Static GNSS
- SMO – Surveying and Mapping Office
- SRD – State Road Department
- SUEL – Safe Upland Elevation Line
- TBM – Temporary Bench Mark
- TIITF – Trustees of the Internal Improvement Trust Fund
- TRB – Transportation Research Board
- USGS – United States Geological Survey
- VRS – Virtual Reference System
- X,Y,Z – Cartesian Coordinates

DEFINITIONS

- **Accuracy** – Degree of conformity with a standard or accepted value. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

- **Artifacts** – Erroneous data points that do not correctly depict the scanned area. Objects moving through the scanner's field of view, temporary obstructions, highly reflective surfaces, and erroneous measurements at edges of artifacts (also known as "edge effects") can cause artifacts.

- **Axis Test** – Method of calibration in which multiple direct and reverse angular readings are used to correct systematic errors in a total station.

- **Bathymetry** – The art or science of determining ocean depths.

- **Image** - A pattern formed by electromagnetic radiation that approximately duplicates the pattern formed by a real object or a physical field detectable by the radiation. This definition is more general than the usual definition because many instruments used for detection operate at other than light frequencies but in ways similar or analogous to those used for forming optical images. The kind of radiation forming an image is usually specified by adding a word that identifies the part of the spectrum involved, e.g., radio image, infrared image, optical image, and X-ray image. However, the terms "radar image" and "X-ray image" are used to refer to optical images of the images formed by radar or X-ray. *Source: National Geodetic Survey: Geodetic Glossary. Library of Congress Catalogue Card Number 86-61105. 1986.* http://www.ngs.noaa.gov/CORS-Proxy/Glossary/xml/NGS_Glossary.xml

- **LAS** – A binary file standard supported by the American Society of Photogrammetry and Remote Sensing (ASPRS) for storing point location and attribute information primarily used for LiDAR data.

- **LiDAR** – An active optical remote sensing technology which measures the return properties of scattered light to determine range, direction, and other information of a distant line-of-sight object

- **Localization** – A coordinate transformation from the GNSS reference system to the project specified system as defined by Department approved control.

- **Mean High Water (MHW)** – The average height of the high waters over a 19 year period.

- **Mean High Water Line (MHWL)** – The intersection of the tidal plane of mean high water with the shore.
- **Ordinary High Water (OHW)** – The highest reach of a navigable, nontidal waterbody as it usually exists when in its ordinary condition.
- **Ordinary High Water Line (OHWL)** – The intersection of the plane of ordinary high water with the shore in areas without tidal influence.
- **Orthophotograph** - A photographic copy, prepared from a perspective photograph, in which the displacements of images due to tilt and relief have been removed. *(Source: American Congress on Surveying and Mapping and the American Society of Civil Engineers. Definitions of Surveying and Associated Terms. Library of Congress Catalogue Card Number 72-76807. Washington 1972, 1978.)*
- **Point Cloud** - A relatively precise group of three dimensional point data collected by a laser scanner from a single observation session. A point cloud may be merged with other point clouds to form a larger composite point cloud.
- **Point Density** - The number of points per unit area; can also be expressed as the average distance between points in a point cloud. National Cooperative Highway Research Program (NCHRP) : Report 748. (2013). *Guidelines for the Use of Mobile LIDAR in Transportation Applications.* Washington D.C.: Transportation Research Board of the National Academy of Sciences.
- **Positional Accuracy** – A statistical estimate of how close the measured position of a point or object is to its true location in a defined spatial system or datum.
- **Precision** – A measure of the uniformity or reproducibility of the result. Precision relates to the quality of the operation by which the result is obtained and is distinguished from accuracy which relates to the quality of the result.
- **Project Specific Datum** – Datum/Realization used for project monumentation (date specific) or specified by the Scope of Services.

PURPOSE

This handbook sets forth basic guidelines for performing surveying and mapping activities, developing products, and quality assurance/quality control for the Department. It is not intended to be a comprehensive technical manual but is to act as a directive for requirements, guidelines, and best practices. For specific project instructions, see the DSMO.

AUTHORITY

Sections 20.23(4)(a), F.S. and 334.048(3), F.S.

SCOPE

This handbook applies to anyone performing surveying and mapping services for the Department under the Surveying and Mapping Workgroup or referenced or as directed in other guidelines, specifications, or contract requirements.

REFERENCES

Chapter 20, F.S. – Organizational Structure
Chapter 177, F.S. – Land Boundaries
Chapter 287, F.S. – Procurement of Personal Property and Services
Chapter 334, F.S. – Transportation Administration
Chapter 337, F.S. – Contracting; Acquisition; Disposal; and Use of Property
Chapter 472, F.S. – Land Surveying and Mapping
Rule Chapter 5J-17, F.A.C. – Board of Professional Surveyors and Mappers
Rule Chapter 14-75, F.A.C. – Qualification, Selection and Performance Evaluation Requirements for Professional Consultants to Perform Work for DOT
Surveying and Mapping Procedures, Topic No. 550-030-101-c
CADD Manual, Topic No. 625-050-001
EFB User's Handbook
Survey Safety Handbook

GENERAL

This handbook supersedes the previous ***Surveying Handbook*** dated 10/31/2003 and the ***Right of Way Mapping Handbook*** dated January 2003.

REQUIREMENTS FOR SURVEYS

All surveys done for the Department will be conducted in accordance with the ***Standards of Practice*** set forth in ***Rule Chapter 5J-17, F.A.C.***, pursuant to ***Section 472.027, F.S.***

There may be requirements set forth by the Department that are more stringent than those defined in the ***Standards of Practice*** that must be adhered to as well.

DISTRIBUTION

This handbook will be made available by the CSMO. The Department will consider input from all users concerning the regular upkeep of this handbook. Appropriate contact information will be included in the handbook for users to submit suggestions for revisions to the handbook. Items warranting immediate revision, or revisions mandated by state or federal law, will be made to the handbook after review by the State Surveyor, in the form of revisions to this handbook or ***Surveying and Mapping Bulletins***. These revisions may be temporary in nature or may carry over until the next handbook revision.

TRAINING

See ***Maintenance of Traffic Training, Topic No. 625-010-010*** for information on Maintenance of Traffic training and certification.

FORMS

See the DSMO for applicable forms.

SURVEYING AND MAPPING

1. CONTROL

1.1. HORIZONTAL PROJECT CONTROL (27.1)

Horizontal positions are referenced to the Florida State Plane Coordinate System, NAD 83, 1990 or later readjustment or realizations. Some existing projects may be referred to NAD 27. 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 assumed datum. A local or assumed datum will only be used with written authorization from the DSMO. Exercise caution when using a local or assumed datum.

Since there is no direct mathematical method to accurately transform coordinates from one system to the other, the use of data conversion programs, such as NADCON and CORPSCON, is discouraged. However, they could be used for specific projects where a general accuracy of ±0.5 ft. is acceptable. This will require written authorization from the DSMO.

Project Network Control Data Sheets will be filled out for all primary control set for a project. See the DSMO for data sheets and instructions.

Note: The Department strongly encourages its consultants to report to NGS and the DSMO any destroyed monuments that are recorded in the published data.

See ***Appendix C*** for horizontal control accuracy requirements.

1.2. VERTICAL PROJECT CONTROL (27.2)

Elevations are referenced to NAVD 88. Some existing projects may be referred to NGVD 29. 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 assumed local datum. A local or assumed datum will only be used with written authorization from the DSMO. Exercise caution when using a local or assumed datum.

Since there is no direct mathematical method to accurately transform elevations from one system to the other, the use of data conversion programs, such as VERTCON, is discouraged. However, they could be used for specific projects where the required project accuracy could be met using this method. This will require written authorization from the DSMO.

Note: The Department strongly encourages its consultants to report to NGS and the DSMO any destroyed monuments that are recorded in the published data.

See ***Appendix C*** for vertical control accuracy requirements.

1.3. AERIAL NETWORK CONTROL (27.4)

Place, locate, and maintain aerial targets and/or photo identifiable points. This includes analysis and processing of all field collected data, existing maps, and/or reports. Placement of these targets will be at the direction of the aerial firm.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

2. ALIGNMENT

2.1. RETRACEMENT

The suggested order of importance is:

1. Alignment monumentation as shown on previous Department surveys or right of way maps
2. Alignment reference points from previous projects
3. SRD and FDOT right of way monuments
4. Subdivision monuments and land lines shown on previous Department surveys
5. Significant improvements shown on the existing construction plans
6. Evidence along the right of way not shown on previous Department surveys
7. State plane coordinates from previous right of way documents

2.2. MONUMENTATION (27.3) AND REFERENCE POINTS (27.5)

Set suitable marks at PC's, PT's, PI's, and POT's and POC's at ±1000 foot intervals; reference these points as required. Reference points should be set at right angles or radial to the baseline whenever possible.

2.3. STATIONING (27.3)

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

If the survey begins on an existing route, then the existing stationing is normally used.

2.4. DEFINITION OF CURVATURE

Arc definition curves are the standard used on current Department projects. On older projects, chord defined curves may have been used. Where chord defined curves are encountered on existing maps, it is necessary to convert the curve data to the arc definition. The most practical method is to compute new curve data, holding the central angle and tangents.

2.5. ALIGNMENT SUBMITTAL/APPROVAL

The deliverable includes:

- a description of all points found.
- a comparison of the field data to the record data.
- a report or narrative describing the process by which the alignment was retraced.
- a sketch or map of the preliminary alignment, including the alignment geometry which consists of stationing, bearings, distances, complete curve data, and coordinates.

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

3. TOPOGRAPHY

3.1. FIELD DESCRIPTIONS

All surfaces should be identified, e.g., sod, pavement type, rock, and soil. Be specific in the description.

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 (including overhangs where pertinent) 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.

Wood lines, changes in types of cultivation, and breaks in terrain should all 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 their diameter. Measure tree diameter at breast height (4 ½ feet above the 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.

All above ground utility features should be located and identified.

When measuring to any improvement which is circular, e.g., poles, manholes, tanks, fire hydrants, ties should be made to the center.

3.2. DIGITAL TERRAIN MODEL – 3D (27.6)

DTM's are used when both horizontal and vertical data are required to fix known drainage or slope issues, to redesign or adjust slope/drainage conditions, and for new design. DTM's are derived from points and breaklines, and are developed from data collected by ground or aerial survey. All pertinent features and improvements should be located with a density sufficient enough to produce an accurate DTM.

Check cross-sections or profiles should be performed to verify the accuracy of the DTM.

See ***Section 3.3*** for more information on cross-sections

3.3. ROADWAY CROSS-SECTIONS (27.8)

Cross-sections are an organized field data collection technique used for obtaining 3D data along linear features such as roadways, ditches, and embankments.

Cross-sections provide information for:

- surface model creation or verification
- cross-slope inspection
- sign placement
- comparison to proposed typical sections
- specific point elevations
- side street returns
- contour generation
- earthwork calculation
- bathymetry
- drainage structures

See ***Appendix C*** for horizontal and vertical accuracy requirements.

3.4. PLANIMETRIC – 2D (27.7)

Planimetric surveys are used when no vertical data is required for design. This is sufficient when existing slope/drainage data is available and only minor changes are being performed to a road section, such as resurfacing. In these instances, all above ground features and improvements are located horizontally.

See ***Appendix C*** for horizontal accuracy requirements.

3.5. SIDE STREET SURVEYS (27.9)

Side street surveys are necessary when design will continue beyond the project specific corridor width. In these instances data is collected per the requirements in either ***Section 3.2*** or ***Section 3.4***, depending on the application.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

3.6. UNDERGROUND/SUBSURFACE UTILITIES (27.10)

Subsurface utility locations are needed on most projects, in support of design criteria decisions that reduce construction delays and financial risks as well as enhance jobsite safety. For subsurface utilities, the research information, locating tools, and methods used dictate the accuracy of the utility data. Subsurface utilities within the project limits should be identified, and/or located, and properly depicted with their proper "quality levels" so that the engineer can make informed decisions through all phases of a project by having confident knowledge of the utility data accuracy. Only subsurface utilities are referenced to quality levels. The project engineer should depict in the scope what and where differentiating quality level data is needed for the project. Additional underground/subsurface utilities may be located in advance of geotechnical operations.

See ***Section 5.3*** for geotechnical support.

3.6.1. SUBSURFACE UTILITY QUALITY LEVELS

QL 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 underground systems that are not shown on any records. Level D may be appropriately used in the early development of a project to determine the presence of utilities.

QL 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 level C and D locates.

QL B Information obtained through the use of designating technologies, e.g., geophysical prospecting technologies. This is a field activity using remote sensing geophysical scanning technologies, most of which have very specific capabilities and offer various strengths and weaknesses. 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 as these tools may react differently to the type of utility conductor, soil conditions, and adjacent utilities or surrounding environments that impact accuracy and disrupt electromagnetic radio frequencies. Designating technologies are capable of providing marginal to good horizontal information but provide limited vertical information and therefore vertical accuracy is not suitable to address potential conflicts in vertical design.

QL A Provides the highest level of accuracy of utility locations in three dimensions. This level may apply to manual, mechanical, or nondestructive, e.g., vacuum excavation, methods to physically expose utilities for measurement and data recording. Levels B, C, and D are incorporated into level A locates. The designer should obtain level A locates at highway and utility conflict points where verified information is needed to make confident design decisions.

3.7. DESIGN SURVEYS

3.7.1. OUTFALL SURVEYS (27.11)

Outfall surveys are conducted to measure the size, shape, flow, capacity and locate the destination of an above ground storm drainage system. This may be required for an existing ditch.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

3.7.2. DRAINAGE SURVEYS (27.12)

Drainage surveys are conducted to determine the description of, location, flow and capacity of storm water structures, within project specific limits. This will require the 3D location of the flowline(s) of the structure, as well as the size, material, and condition. It is most important to show the nominal pipe size, do not give the skew width or the bell diameter.

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

See ***Appendix C*** for horizontal and vertical accuracy requirements.

3.7.3. BRIDGE SURVEYS (27.13)

Bridge surveys are conducted to gather data pertaining to bridge structures within project specific limits. This will require the location of above ground features and improvements for the project limits. Requirements for bridge surveys are project specific.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

It may also be necessary to perform water boundary surveys in conjunction with bridge surveys in order to satisfy project requirements. See ***Section 4.2.1*** for information on water boundary surveys.

3.7.4. CHANNEL SURVEYS (27.14)

Channel surveys are conducted to determine the description, location, and capacity of water features, manmade or natural, to/from or through specific projects limits. This will require the location of features and improvements both above ground and/or below the water's surface for the project limits.

Requirements for channel surveys are project specific.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

It may also be necessary to perform water boundary surveys in conjunction with channel surveys in order to satisfy project requirements. See ***Section 4.2.1*** for information on water boundary surveys.

3.7.5. POND SITE SURVEYS (27.15)

Pond site surveys are used to determine the capacity & capability of a specific storm water retention area. This will require the location of features and improvements, both above ground and/or below the water's surface for the project limits.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

4. BOUNDARY SURVEYS (27.22)

Boundary surveys for the acquisition or disposal of a parcel of land may be required. Specifications for this work will be defined by the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers.

See ***Appendix C*** for horizontal accuracy requirements.

4.1. SECTIONAL/GRANT SURVEYS (27.19)

Sectional/Grant surveys include field location/placement of monumentation for section corners, quarter-section corners, and fractional corners where pertinent, and includes analysis and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal accuracy requirements.

4.2. SUBDIVISION LOCATION SURVEYS (27.20)

Subdivision location surveys include field location/placement of monumentation along existing recorded subdivision/condominium boundaries, tracts, units, phases, blocks, street right of way lines, common areas, etc., and includes analysis and processing of all field data and/or reports. If an unrecorded subdivision is on file in the public records of the subject county, any existing monumentation of its parent tract should be located.

See ***Appendix C*** for horizontal accuracy requirements.

4.2.1. WATER BOUNDARY SURVEYS (27.23)

4.2.1.1. MEAN HIGH WATER LINE SURVEYS

The MHWL establishes the boundary between state sovereignty lands and those of private ownership in areas of tidal influence.

All MHWL surveys must be performed in accordance with ***Chapter 177 Part II, F.S.***; FDOT; and the FDEP, BSM standards. Contact FDEP, BSM for MHWL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

4.2.1.2. ORDINARY HIGH WATER LINE SURVEYS

The OHWL is the point up to which the presence and action of the water is so continuous as to destroy the value of the land for agricultural purposes by preventing the growth of vegetation constituting what may be termed an ordinary agricultural crop. This establishes the boundary between state sovereignty lands and private ownership in areas of navigable waters.

Contact FDEP, BSM for OHWL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

4.2.1.3. SAFE UPLAND ELEVATION LINE SURVEYS

In the course of obtaining an easement over sovereign submerged lands a SUEL survey may be performed rather than a MHWL or OHWL survey, at the direction of FDEP BSM. A SUEL is a line that is landward of the sovereign boundary and is used in the easement legal description to ensure all the interest of the sovereign is obtained.

SUEL are not to be considered a sovereignty submerged land boundary and will not be recognized by FDEP for use in controlling future development or for any other use or purpose unless specifically stated by FDEP. Contact FDEP, BSM for SUEL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

5. SPECIFIC PURPOSE SURVEYS

5.1. MITIGATION SURVEYS (27.16)

Mitigation surveys are conducted to locate areas where any given type of environmental impact must be averted or minimized for its protection or the protection of the public. Design professionals frequently rely on these for planning and site design.

See ***Appendix C*** for horizontal accuracy requirements.

5.2. JURISDICTION LINE SURVEYS (27.17)

Jurisdiction line surveys are conducted to locate limits of wetlands, usually to satisfy the requirements of governmental authorities. Perform 2D field location of jurisdictional limits as defined by respective authorities. This includes field edits, analysis and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal accuracy requirements.

5.3. GEOTECHNICAL SUPPORT (27.18)

Perform 3D field location, or stakeout, of boring sites established by a geotechnical engineer. This includes field edits, analysis, and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

6. RIGHT OF WAY

6.1. MAINTAINED RIGHT OF WAY (27.21)

Perform 2D field location of maintained right of way limits as defined by the maintaining authority. This includes field edits, analysis and processing of all field collected data and/or reports.

See ***Section 26.3*** for information on maintained right of way surveys.

See ***Appendix C*** for horizontal accuracy requirements.

6.2. RIGHT OF WAY STAKING, PARCEL/RIGHT OF WAY LINE (27.24)

Perform field staking and calculations of existing and/or proposed right of way lines for on-site review purposes.

See ***Appendix C*** for horizontal accuracy requirements.

6.3. RIGHT OF WAY MONUMENTATION (27.25)

Set right of way monumentation as depicted on final right of way maps for corridor, water retention areas, and perpetual easements.

See ***Appendix C*** for horizontal accuracy requirements.

7. MISCELLANEOUS SURVEYS (27.28)

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

See ***Appendix C*** for horizontal and vertical accuracy requirements.

8. SUPPLEMENTAL SURVEYS (27.29)

Incidental surveys that cannot be readily anticipated when scoping the project.

See ***Appendix C*** for horizontal and vertical accuracy requirements.

9. SURVEY REPORT

The purpose of a survey report is to adequately communicate the survey methods and results as judged by the surveyor and mapper. To accomplish this, information may be needed such as: data sources, measurement methods, history and lineage of data, limitations pertaining to the information presented, and a list of all included deliverables.

Reports should give a clear description of the methodology used as it relates to both field and office procedures. There should be no doubt in the reader's mind as to the intent of the survey and how it was accomplished.

All survey reports should contain standard content that satisfies the requirements of the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers and those of the Department. Nothing precludes the Department from requiring more stringent standards than those set forth in the ***Standards of Practice***. See ***Appendix E*** for the survey report format.

Report items are information, as required by other parts of this rule, such as: abbreviations, legends, accuracy statements, feature lists, datums used, and things done or not done as part of the surveying and mapping process. Text report items shall be

displayed either through notes on the map, report, or in a text report delivered with the map.

When the report is produced as a text document and a map is attached, the report shall be signed and sealed. When the map is delivered in digital form only, then a report is required. For digital map deliveries all notes formerly shown on paper maps should be included in the report. Each surveying entity submitting electronic data to the Department must prepare a survey report.

When a survey project involves multiple surveyors or firms, a lead surveyor will be identified. A comprehensive survey report will be prepared by the lead surveyor and should detail the total survey, describing the roles and responsibilities of each surveying entity and will reference and include as attachments, all survey reports prepared by the other surveyors involved in the project.

10. OFFICE PROCEDURES

10.1. DOCUMENT RESEARCH (27.30)

Perform research of documentation to support field and office efforts involving surveying and mapping.

10.2. TECHNICAL MEETINGS (27.32)

Attend meetings as required and negotiated by the DSMO.

10.3. QUALITY ASSURANCE/QUALITY CONTROL (27.33)

A QA/QC plan is required from the consultant for each project prior to the commencement of work. This details the proposed methods of providing quality control for all work products. This plan will be kept current with the work requirements.

The main objective of QA/QC is to provide a mechanism by which all products for the DSMO can be subject to a systematic and consistent review. The QA/QC review minimizes errors and creates a quality survey.

A secondary objective is to provide for a well-documented trail of the survey process. A properly documented project file should be a by-product of the QA/QC plan. The Department should be able to substantiate its position from properly documented project files if any legal, social or procedural issues arise regarding the project.

10.3.1. QUALITY CONTROL REVIEWS

Every product will undergo a QA/QC review by the consultant as part of the QA/QC plan. The reviewer should be experienced in QA/QC review. Procedures for these quality control reviews are discussed in the sections below.

10.3.1.1. CHECKING SURVEY REPORTS

Once the report writing has progressed to an appropriate stage of development, a draft is sent to the reviewer. Review comments and corrections are marked on the review draft in red. Upon completion of the review, the reviewer signs and dates the cover page of the draft and returns the draft to its originator. The originator then confirms or revises the corrections and comments, adds their own corrections and comments, and makes the corrections to the text. The marked-up draft is placed in the project file after the document is finalized. This marked-up draft is submitted to the Department as part of the final project deliverables.

10.3.1.2. CHECKING DRAWINGS

Drawings are developed progressively by an interactive process using sources of information such as survey data, reports, record data, preliminary sketches, samples, official maps, etc., in conformance with the requirements, survey criteria, and standards and guidelines required by the Department. Before a drawing is considered final, it will be independently checked for:

- Conformance with the mapping criteria and project requirements, including CADD standards
- Completeness and clarity
- Coordination with other aspects of the project
- Compatibility standards and good mapping practice

10.3.1.3. CHECKING SURVEY DATABASES

The project surveyor and survey technician will develop a checklist pertaining to the survey database. The checklist will be updated using comments from Department reviewers throughout the life of the project.

10.3.1.4. CHECKING CORRESPONDENCE

All correspondence will include the financial project number as well as a local name when referring to a project. Any correspondence that is prepared for external customers should be reviewed by another employee for spelling and grammar mistakes.

10.3.2. PROPOSED METHODS OF DOCUMENTATION

10.3.2.1. DOCUMENTATION OF COMMENTS AND RESPONSES

All comments made by external reviewers will be recorded either by copy of memos, e-mail, letters or marked drawings. In the event that comments are received through meetings, there will be minutes prepared that summarize the comments received. All comments will be responded to in writing in a format that identifies the document review

date, reviewer's comments and responses to the comments. All comment/response drafts will be added to the project file.

10.3.2.2. QA/QC RECORDS

The project surveyor will be responsible for maintaining the QA/QC records. At any point in the surveying process, the project surveyor will make records available to the DSMO for a QA/QC review. All submittals may be subject to QA/QC audits by the Department.

When any review by the Department is performed, consultants must not rely on the Department as a part of their QA/QC plan either formally or informally. Survey consultants are expected to follow their own QA/QC plan.

Strong emphasis will be placed on coordination with all of the sub-consultants throughout the project. Particular attention will be placed on critical path activities and on the sub-consultant's needs for information required for participating in these and other activities in a timely manner. Regular meetings will take place in order to facilitate this coordination. All sub-consultants will be required to conform to the QA/QC plan and provide their supplement to the plan if they are performing a specialized service that is not adequately addressed in the plan. Problem areas will be discussed with the sub-consultant and agreed upon remedial actions will be taken by the sub-consultant.

10.4. SUPERVISION (27.34)

Perform all activities required to supervise and coordinate project. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

10.5. COORDINATION (27.35)

Coordinate survey activities with other disciplines. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

11. FIELD PROCEDURES

11.1. FIELD REVIEW (27.31)

Perform verification of the field conditions as related to the collected survey data.

11.2. LINE CUTTING (27.26)

Perform all efforts required to clear vegetation from the line of sight.

See the ***Survey Safety Handbook*** for line cutting safety procedures.

11.3. WORK ZONE SAFETY (27.27)

Work zone safety is the first consideration. Project location and scope dictate the measures needed to maintain a safe workplace. Work should not begin at the site until proper traffic control devices, e.g., signs and cones, have been placed and other safety

precautions taken. Please refer to the ***Manual on Uniform Traffic Control Devices (MUTCD), Part VI*** for information on traffic control devices.

Appropriate MOT certification should be maintained. See ***Maintenance of Traffic Training, Topic No. 625-010-010***.

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 the public.

The ***Survey Safety Handbook*** outlines the Department's survey safety program, and is available through the ***FDOT SMO website***. Specific attention should be paid to the placement of control to ensure that consultants, DOT employees, and the public are protected to the greatest extent possible. The historic placement of control on or near the pavement in high traffic areas is discouraged.

AERIAL PHOTOGRAMMETRY

12. OVERVIEW

Photogrammetry is one of many valuable remote sensing methods available to today's surveying and mapping professionals, and has a long history of use on transportation projects. This section sets forth basic guidelines for performing manned aerial photogrammetric surveys for the Department.

The requirements herein are at the discretion of the Department and may be waived under certain circumstances such as but not limited to: post disaster mapping, research and development, and equipment testing / calibration. Any deviation from these requirements must be addressed in the scope of services.

This document is organized into sections related to the typical tasks and deliverables associated with a transportation project employing Aerial Photogrammetric technologies.

"Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting photographic images and patterns of electromagnetic radiant energy and other phenomenon." (Slama, 1980)

With the advent of digital cameras and digital photography/softcopy image processing we are moving away from film based products and the traditional photo scale requirements. Since we can easily view and work with digital imagery in differing scales, the film and paper based criteria have little meaning. The productivity and accuracy improvements of current digital sensor systems over film based systems especially in the support of 3D design methods are also moving the survey industry away from traditional imagery collection.

Much of the following accuracy standards are based on the ASPRS Positional Accuracy Standards for Digital Geospatial Data, *"This standard defines accuracy classes based on RMSE thresholds for digital orthoimagery, digital planimetric data, and digital elevation data."* (American Society for Photogrammetry and Remote Sensing, 2014). See tables below.

12.1. ASPRS HORIZONTAL ACCURACY STANDARDS FOR GEOSPATIAL DATA

Horizontal Accuracy Class	Absolute Accuracy			Orthoimagery Mosaic Seamline Mismatch (cm)
	RMSEx and RMSEy (cm)	RMSEr (cm)	Horizontal Accuracy at 95% Confidence Level (cm)	
X-cm	≤ *X*	≤ 1.414**X*	≤ 2.448**X*	≤ 2**X*

12.2. ASPRS VERTICAL ACCURACY STANDARDS FOR DIGITAL ELEVATION DATA

Vertical Accuracy Class	Absolute Accuracy			Relative Accuracy (where applicable)		
	RMSEz Non-Vegetated (cm)	NVA[1] at 95% Confidence Level (cm)	VVA[2] at 95th Percentile (cm)	Within-Swath Hard Surface Repeatability (Max Diff) (cm)	Swath-to-Swath Non-Vegetated Terrain (RMSDz) (cm)	Swath-to-Swath Non-Vegetated Terrain (Max Diff) (cm)
X-cm	≤ *X*	≤ 1.96**X*	≤ 3.00**X*	≤ 0.60**X*	≤ 0.80**X*	≤ 1.60**X*

The focus in the following pages will be on three key elements; image resolution or GSD, measurement RMSE, and finally the resulting estimate of positional error of the final photogrammetry product based on the National Standard for Spatial Data Accuracy (Federal Geographic Data Committee, 1998).

12.3. FDOT PROJECT HORIZONTAL ACCURACY STANDARDS FOR PHOTOGRAMMETRY

(Orthophotography and Planimetric)

Horizontal Accuracy Class	Project Horizontal Accuracy			Orthoimagery Mosaic Seamline Mismatch (ft)
	RMSEx and RMSEy (ft)	RMSEr (ft)	Horizontal Accuracy at 95% Confidence Level (ft)	
X-feet	≤ *X*	≤ 1.414**X*	≤ 2.448**X*	≤ 2**X*

12.4. FDOT PROJECT VERTICAL ACCURACY STANDARDS FOR PHOTOGRAMMETRY

Vertical Accuracy Class	Project Vertical Accuracy	
	RMSEz Non-Vegetated (ft)	Vertical Accuracy at 95% Confidence Level (ft)
Z-feet	≤ ***Z***	≤ 1.96**Z*

13. GENERAL REQUIREMENTS

Unless otherwise stated, this section identifies the general requirements common to all aerial photogrammetric products and services performed for the Department.

All photogrammetric products submitted shall be supported by a survey report containing at a minimum all information necessary to support the precision and accuracy of measurements and products, and meets the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers. To this end the survey report shall include but is not limited to the documentation and references to digital reports, products and media, identified in this document.

13.1. DIGITAL CAMERA SYSTEM SPECIFICATIONS

- A digital metric camera system with forward motion compensation and a gyro-stabilized camera mount, capable of producing raw source imagery resolutions with horizontal and vertical accuracies necessary to meet project scope.
- Geometric distortions induced by the camera's optical system shall be corrected during post processing using valid calibration data obtained from the camera manufacturer or a facility authorized by the camera manufacturer to provide such data.

13.2. DIGITAL EXPOSURE DOCUMENTATION

- Flight lines shall be numbered from south to north and west to east with the highest numbers ending on the north and east.

- All digital photographic image files shall be saved to final media using the following file naming convention: AAAABB_CCCC (A=MSTS number, B=Flight Line number, C=Exposure number). Example: 492201_0010.tif Digital data shall be provided to the Department in a format which is immediately readable by the Surveying and Mapping Office and the Department.

- Meta Data – All final image files provided to the Department shall have a corresponding named metadata file in Extensible Markup Language (xml) format that meets the CSDGM.

- Example: 492201_0010.xml

13.3. AIRBORNE GNSS PROCESSING (28.5)

Airborne GNSS a.k.a. INS based camera orientation is vital to today's softcopy photogrammetry where typically less ground control is used. Solving for the trajectory of the sensor using post processing technique provides position and orientation of the camera at the time of each exposure.

The required INS accuracies vary depending on the photogrammetric product and are detailed in the appropriate sections. The INS shall be performed such that the resulting accuracy of the mapping meets ASPRS standards from ***Section 7.7 of the "Accuracy***

Requirements for Aerial Triangulation and INS-based Sensor Orientation of Digital Imagery" (American Society for Photogrammetry and Remote Sensing, 2014).

13.4. POST MISSION REPORTING

Post mission reporting shall, at a minimum, consist of:

- A graphical representation of the vehicle trajectory. Sufficient documentation to verify positional accuracy of camera at exposure events.
- A text file with final post processed exposure events with camera position and orientation (Omega Phi, Kappa and associated accuracies) sufficient for inclusion into an AT adjustment.

13.5. AERIAL TRIANGULATION/AEROTRIANGULATION (28.9)

The required AT accuracies vary depending on the photogrammetric product and are detailed in the appropriate sections. The AT shall be performed such that the resulting accuracy of the mapping meets ASPRS standards from ***Section 7.7 of the "Accuracy Requirements for Aerial Triangulation and INS-based Sensor Orientation of Digital Imagery"*** (American Society for Photogrammetry and Remote Sensing, 2014).

> *"Accuracy of aerial triangulation designed for digital planimetric data (orthoimagery and/or digital planimetric map) only:*
>
> *RMSEx (AT) or RMSEy (AT) = ½ * RMSEx (Map) or RMSEy (Map)*
>
> *RMSEz (AT) = RMSEx (Map) or RMSEy (Map) of orthoimagery*
>
> *Note: The exact contribution of aerial triangulation errors in z to the overall horizontal error budget for the products depends on ground point location in the image and other factors. The relationship stated here for an RMSEz (AT) of twice the allowable RMSE in x or y is a conservative estimate that accommodates the typical range of common camera geometries and provides allowance for many other factors that impact the horizontal error budget.*
>
> *Accuracy of aerial triangulation designed for elevation data, or planimetric data (orthoimagery and/or digital planimetric map) and elevation data production:*
>
> *RMSEx (AT), RMSEy (AT) or RMSEz (AT) = ½ * RMSEx (Map), RMSEy (Map) or RMSEz (DEM)."*

Aerotriangulation adjustment reporting shall consist of a text file containing sufficient information to independently process raw imagery to verify accuracies achieved.

13.6. BEFORE WORK BEGINS

When a contract is awarded and before any work begins, the consultant will contact the DSMO to request the MSTS number. The MSTS number shall be included in all image file names to facilitate inclusion in the CSMO image library without modifications. The MSTS number should be referenced in all correspondence and project deliverables.

13.6.1. QUALITY ASSURANCE AND QUALITY CONTROL PLAN (28.23)

All survey projects must have a detailed QA/QC plan developed by the consultant and provided to the DSMO for approval before work begins. See ***Section 10.3*** for additional details and requirements.

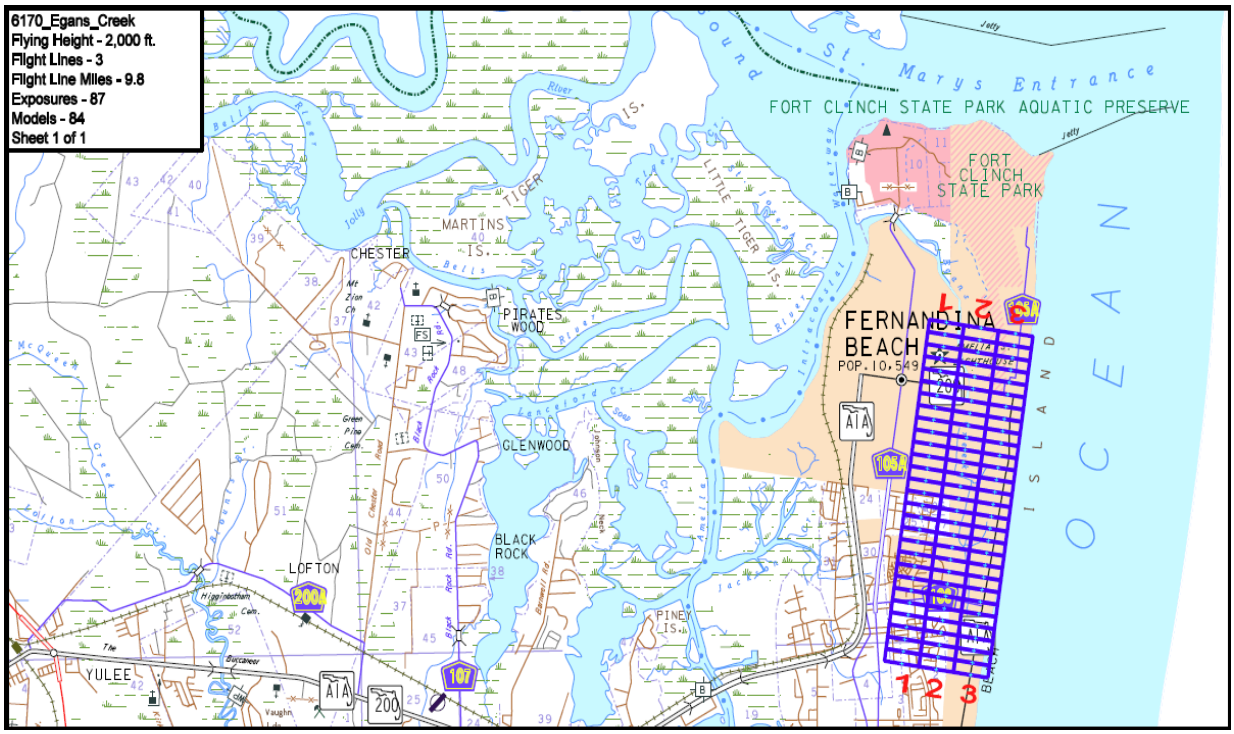
13.7. PLANNING (28.1)

Planning is critical to the success of any survey project. The planning activities should begin with reviewing the project scope and location to develop the detailed aerial survey approach. The approach activities will vary based on project requirements; however there are important elements common to all aerial survey approaches that are worth noting here.

13.7.1. AERIAL PHOTOGRAPHY MISSION PLAN (28.1)

A graphic aerial mission plan (see below) based on the location and scope of the project should be developed. The mission plan should show proper stereo image model coverage of the project area, as well as other pertinent information supporting the flight mission with the understanding that properly executed, the flight will provide results necessary to achieve the desired survey products.

13.7.1.1. AERIAL PHOTOGRAPHY MISSION PLAN EXAMPLE



13.8. GROUND CONTROL RECONNAISSANCE (28.2)

Suitable locations for the ground control and validation point locations should be chosen by the photogrammetrist and identified on a control reconnaissance map for later use by survey crews in the field. The allowable tolerance for moving the control point locations without loss of model adjustment accuracy should be provided.

Targeting of control points should be performed for most large scale mapping projects especially those requiring accurate surface compilation. Photo identifiable (Photo ID) points may be used on small scale mapping projects, or when targeting is not possible.

14. GROUND CONTROL SURVEY (28.2)

Project ground control should be used to establish horizontal and vertical positions on targeted and/or well-defined photo identifiable points. These values will be used as control or check points for aerial photogrammetric mapping.

The activity of establishing ground control falls under Work Type 8.2 and Tab 27, while the coordination of the size, type, and placement of the ground control by the photogrammetrist is covered in Work Type 8.3 Tab 28. The following requirements apply specifically to ground control for aerial mapping purposes. The appropriate surveying & mapping methods referenced in ***Appendix C*** shall be performed such that the resulting accuracy of the ground control meets ***Section 7.8 of the "Accuracy Requirements for***

Ground Control Used for Aerotriangulation" (American Society for Photogrammetry and Remote Sensing, 2014)***.***

> *"Ground control points used for aerial triangulation should have higher accuracy than the expected accuracy of derived products according to the following two categories:*
>
> *Accuracy of ground control designed for planimetric data (orthoimagery and/or digital planimetric map) production* ***only****: RMSEx or RMSEy = 1/4 * RMSEx (Map) or RMSEy (Map), RMSEz = 1/2 * RMSEx (Map) or RMSEy (Map)*
>
> *Accuracy of ground control designed for elevation data, or planimetric data* ***and*** *elevation data production: RMSEx, RMSEy or RMSEz= 1/4 * RMSEx (Map), RMSEy (Map) or RMSEz (DEM)"*

New photo control point positions shall be identified in the field by a survey mark. When aerial panels are used, the vertical offset from top of mark to the panel surface shall be measured and recorded. In rare circumstances where the photo identifiable control point cannot be occupied directly, a horizontal offset from the occupied survey mark may be computed for orthophotography or planimetric mapping only. Field survey measurements of sufficient precision must be collected and recorded to allow accurate coordinate computation of the photo identifiable point from the offset mark. The higher accuracy orthophotography required for many transportation projects may preclude the use of offset control points and post identified control.

14.1. GROUND CONTROL TABLE EXAMPLE

(Portion of County Orthophoto Control)

FINAL ADJUSTED HORIZONTAL AND ORTHOMETRIC HEIGHT VALUES FOR MARION COUNTY (PD6027) POST FLIGHT PHOTO POINT
UNITS ARE US Survey Feet (USft)
HORIZONTAL DATUM IS NAD 83 (2011)
STATE PLANE ZONE IS FLORIDA WEST ZONE 0902
ORTHOMETRIC HEIGHT DATUM IS NAVD 88
ALL CONTROL STATION VALUES ARE DERIVED BY STATIC GPS OBSERVATIONS FROM PUBLISHED NGS CONTROL

	GPS Control Station - Geographic			GPS Control Station - USft			Offset from GPS Station to Photo ID Point - USft			FINAL Photo ID Control - USft		
PHOTO_ID	LATITUDE	LONGITUDE	ELLIP_HGT (meters)	NORTHING	EASTING	ORTHO_HGT	Offset North	Offset East	Offset Vertical	NORTHING	EASTING	ORTHO_HGT
D510S010	29 29 44.73172	-82 24 24.26473	1.757	1876786.20	526773.97	97.18	0	0.5	0	1876786.20	526774.47	97.18
D510S011	29 28 42.07552	-82 3 20.32535	-4.497	1870232.35	638460.51	77.18	-0.5	-0.75	0	1870231.85	638459.76	77.18
D510S012	29 30 29.98811	-81 51 49.10517	10.530	1881156.88	699540.72	127.11	0	0	0	1881156.88	699540.72	127.11
D510S013	29 19 32.46883	-81 58 11.18511	-5.832	1814716.87	665798.44	72.96	0	0	1	1814716.87	665798.44	73.96
D510S014	29 21 52.50874	-81 44 25.40237	-16.367	1828952.74	738861.52	39.27	0	0	0	1828952.74	738861.52	39.27
D510S015	29 17 40.65095	-81 39 9.97229	-27.655	1803585.22	766847.02	2.34	0.5	0.3	0.5	1803585.72	766847.32	2.84

Note: *In this example the horizontal accuracy required for the orthophotography was 5.06 feet. The higher accuracy orthophotography required for many transportation projects may preclude the use of offset control points and post identified control.*

All established control shall be referenced to the FDOT FPRN and/or the project control network through redundant survey measurements.

Proposed control point locations may be moved up to the allowable tolerance provided by the photogrammetrist to insure safety. If the proposed point is ambiguous or no longer exists, it shall be documented as moved.

A field sketch with information necessary to properly identify and recover the aerial mapping control point, along with the date and weather conditions at the time of survey measurement collection must be provided. Digital photo(s) shall also be taken when establishing post aerial mapping photo identifiable control points. Photos should show the exact location of the control point, preferably while the point is being measured to avoid misidentification. Digital photo filenames shall include the control point name.

14.2. CONTROL SURVEY DELIVERABLES

The Professional Surveyor and Mapper in responsible charge of the control survey will prepare a certified survey report identifying the level of accuracy (see ***Appendix C***) met by the control survey. In addition to these requirements the survey report shall also include the following:

- Project title, Financial Management Number, and MSTS number
- Name and address of corporation including certificate of authorization number
- Statement cross referencing digital media as part of the report by referencing media drive label items. See ***Section 15.3***.
- An index of files on digital media listed by filename, file location (path), and brief description.
- Accuracy reporting will be according to ***Appendix C*** of this handbook.
- Describe and list the geodetic control (existing and newly-established), displaying the horizontal and vertical coordinates and Datum referenced.
- Describe monumentation recovered and set
- Map displaying the following:
    - Existing horizontal and vertical geodetic control
    - New control established for photogrammetric mapping

14.3. DIGITAL MEDIA (CONTROL SURVEY)

The ground control data shall be submitted to the Department on digital media format agreed upon in project scope. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT. The digital media shall be labeled in such a way as not to impede its use, and shall display the following information:

- Statement cross referencing digital media as part of the survey report by including survey report title, Financial Management Number, MSTS number, and date of survey information from the survey report.
- Digital media make, model, and serial number
- Consultant name and contact information.

The digital media shall contain at a minimum:

- Digitally signed copy of the control survey report
- Existing geodetic control recovery/to-reach descriptions, sketches, field notes, photographs, etc.
- Sketches of photo control point sites identifying measured point location and type of mark including target size and material if applicable.
- Digital pictures if post mapping photo identifiable control established.
- A Microsoft EXCEL spreadsheet file list of final control with datum header information along with point name, geographic (Latitude, Longitude), grid (State Plane Zone Northing and Easting), and elevation values for control points. Grid coordinates and elevations shall be in units of US survey feet. Any horizontal and vertical mark offsets measured shall be identified and applied to the aerial panel or photo identifiable feature surface. Offset measurements shall be included to verify computations. See ***Section 15.1***.

15. ORTHOPHOTOGRAPHY (28.11)

Modern digital orthophotography is often described in terms of resolution using the GSD of the final orthophoto product. GSD is the ground distance represented by a single pixel on the final orthophoto product and the original source imagery that was used to create it. The raw camera GSD or “source imagery” GSD is governed by the camera focal length, the flying height, and the size of a pixel in the camera CCD (Charged Coupled Device).

$$\frac{f}{H} = \frac{Ps}{GSD}$$

f = Focal Length

H = Height above ground,

Ps = Camera Pixel Size

GSD = Ground Sample Distance (source imagery)

The acceptable range of the final orthophoto product GSD a.k.a. product Ground Pixel Resolution (GPR) that should be derived from a specific source imagery GSD a.k.a. Original Image Resolution, can be seen in the USGS table on the right (Rufe, 2014). It is generally accepted that the source imagery may be re-sampled to produce an orthophotography product with a larger GSD thus resulting in a product with less

resolution than the source imagery. However the reverse is not prudent i.e. an orthophotography product should not be re-sampled to have a smaller GSD (higher resolution) than the original source imagery. There can be some exceptions to this due to site conditions. Occasionally the altitude necessary for a camera to achieve the desired source GSD is compromised either by terrain or airspace restrictions. The USGS table allows for this by up to 10 percent. This 10 percent over sampling may be allowed on certain FDOT orthophotography products with written approval from the FDOT project manager as long as it does not violate the accuracy requirements. Now that we have discussed the imagery resolution, let us go back and look at our accuracy definitions again. Unlike measurement RMSE and positional accuracy which can be directly related, orthophoto resolution is often desired for sharpness of imagery rather than for a specific accuracy. For this reason orthophotography resolution and accuracy often need to be defined separately. For example the positional accuracy for the orthophotography might be 3 feet while the GSD resolution desired is 1.0 feet. This is not to say the image resolution does not affect accuracy. It is accepted that the image resolution GSD may be smaller than or equal to the desired RMSE, however it cannot be larger. Thus, when the accuracy requirements are dictating the resolution to be acquired, oversampling is not permitted.

Table 1. Product ground pixel resolution and image resolution.

[m, meter; ft, foot]

Ground pixel resolution (GPR)	Original image resolution (maximum)	Original image resolution (minimum)
1.0 m	0.5 m	1.1 m
3.28 ft	1.64 ft	3.6 ft
0.3 m	0.15 m	0.35 m
1 ft	0.5 ft	1.1 ft
0.15 m	0.08 m	0.17 m
0.5 ft	0.25 ft	0.55 ft
0.08 m	0.04 m	0.1 m
0.25 ft	0.125 ft	0.275 ft

> *"Given current sensor and processing technologies for large and medium format metric cameras, an orthoimagery accuracy of 1-pixel RMSEx and RMSEy is considered achievable, assuming proper project design and best practices implementation."* (American Society for Photogrammetry and Remote Sensing, 2014)

Section 16.1 shows the horizontal accuracies of orthophotography in terms of final image pixels. The highest accuracy orthophotography has a one to one or smaller ratio of orthophoto GSD to RMSE.

15.1. HORIZONTAL ACCURACY CLASSES FOR VARYING DIGITAL ORTHOPHOTOGRAPHY RESOLUTIONS

Orthoimage RMSEx and RMSEy in terms of Pixels	Maximum Orthoimage Mosaic Seamline Mismatch (2 x Pixel*)	Allowable Aerotriangulation (AT) or INS-based (Pixels)		Allowable Ground Control RMSE (pixels)		NSSDA Horizontal Accuracy at the 95% Confidence Level (Pixels) (2.4477 x Pixel*)
		RMSEx and RMSEy (0.5 x Pixel*)	RMSEz (1 x Pixel*)	Horizontal x and y (0.25 x Pixel*)	Vertical z (0.5 x Pixel*)	
1	2	0.5	1	0.25	0.5	2.448
2	4	1.0	2	0.50	1.0	4.895
3	6	1.5	3	0.75	1.5	7.343
4	8	2.0	4	1.00	2.0	9.791

Pixel* = Orthoimage RMSEx and RMSEy in terms of pixels

Orthophotography produced for the Department shall meet the appropriate "Orthophoto Horizontal Accuracy Class" necessary to fulfill project requirements. See ***Section 25*** for typical horizontal accuracy and quality standards associated with Digital Orthophotography produced for a sample of GSD pixel sizes.

In addition to meeting the accuracy requirements for INS processing in ***Section 14.3*** and the adjustment accuracy requirements in ***Section 14.5***, the final quality control verification shall be a comparison of the horizontal positions of a sample subset (minimum twenty-five) clearly photo-identifiable features with ground positions for these features independently collected to a higher horizontal accuracy. The resulting check point comparisons shall meet the check point distribution and positional accuracy requirements for the map at the 95% confidence level based on the NSSDA (Federal Geographic Data Committee, 1998) and shall be included in the survey report.

A metadata file must be delivered for each image file and each surface file used in orthophotography production.

16. PLANIMETRIC (28.16)

The project horizontal accuracy of photography must meet or surpass the required project horizontal accuracy class of the planimetric data compiled from the imagery. The imagery GSD resolution shall be equal to or smaller than the required project horizontal accuracy, AND must be of sufficient resolution to clearly define the features to be mapped.

In addition to meeting the accuracy requirements for INS processing in ***Section 14.3*** and the adjustment accuracy requirements in ***Section 14.5***, the final quality control verification shall be a comparison of the horizontal positions of a sample subset (minimum twenty-five) of features with ground positions for these features independently collected to a

higher horizontal accuracy. The resulting check point comparisons shall meet the check point distribution and horizontal positional accuracy requirements for the map at the 95% confidence level (Accuracy r = 1.7308 * RMSEr) based on the NSSDA_(Federal Geographic Data Committee, 1998), and shall be included in the survey report.

17. VERTICAL (28.10)

The vertical accuracies of data compiled from aerial imagery shall meet the Department project scope requirements. When the vertical accuracy is of primary importance, the horizontal accuracy will equate to that which results from using the same AT/INS solution.

> *"For elevation data derived using stereo photogrammetry, the horizontal accuracy equates to the horizontal accuracy class that would apply to planimetric data or digital orthoimagery produced from the same source imagery, using the same aerial triangulation/INS solution."* (American Society for Photogrammetry and Remote Sensing, 2014)

In addition to meeting the accuracy requirements for INS processing in ***Section 14.3*** and the adjustment accuracy requirements in ***Section 14.5***, the final quality control verification shall be a comparison of the vertical positions of a sample subset (minimum twenty-five) of features with ground positions for these features independently collected to a higher vertical accuracy. The resulting check point comparisons shall meet the check point distribution and vertical positional accuracy requirements for the map at the 95% confidence level (Accuracy z = 1.9600 * RMSEz) based on the NSSDA (Federal Geographic Data Committee, 1998), and shall be included in the survey report.

When verifying corridor surfaces cross-section measurements may be used with or instead of check points, as long as cross sections cover the surface and are spaced appropriately.

18. TOPOGRAPHIC MAPPING (28.15)

When performing topographic mapping from aerial photography where both horizontal and vertical accuracy is important, the more stringent aerial accuracy requirements shall be followed. Requirements of topographic map products are addressed in ***Section 3*** and in the ***CADD Manual, Topic No. 625-050-001***.

19. DRAINAGE BASIN (28.17)

Usually this is specific topographic mapping of additional storm water retention areas outside of the main mapping corridor. Often the surface model accuracies are less stringent than those required within the corridor. As with other topographic surveys the mapping methods used must meet the accuracy requirements for the model.

20. CADD EDIT (28.18)

Cartographicedits are performed after the field reviews. The aerial mapper receives information from the field review and updates the map database. The optimal method is for surveyor to update the map directly during the field review, or place a waypoint where features exist that need to be searched for in the imagery or possibly statically surveyed.

21. DATA MERGING (28.19)

When merging files from photogrammetry, field survey, and data from other sources to develop a complete survey project database, it is critical for the all the project surveyors to coordinate data exchange to create deliverables. This effort can be reduced significantly if all consultants use the standard Department feature codes listed in the ***CADD Manual, Topic No. 625-050-001*** before merging data.

22. FIELD REVIEW (28.21)

This review of field conditions by the surveyor allows for identifying object attributes such a traffic sign type and wording, which cannot be discerned from the aerial imagery, or in some cases identify a feature that should have been collected but was missed by the aerial mapping operator. Traditionally this was performed by marking up map sheets to be transcribed in the office by the mapper. Today this process can be performed much more efficiently using an electronic field device which allows the field reviewer to make edits directly to the map using Department feature codes. This eliminates the need to transcribe information reducing time and errors.

23. AERIAL SURVEY DELIVERABLES

The PSM in responsible charge will prepare a certified survey report that shall at a minimum include the following items:

- Project title, Financial Management Number, and MSTS number
- Name and address of corporation including certificate of authorization number
- Name and address of the surveyor in responsible charge
- Abbreviations; data sources; etc.
- Description and scope of work
- Describe equipment, software; specifications, calibration, etc.
- Statement cross referencing digital media as part of the report by referencing media drive label items. See ***Section 24.1*** for information on digital media.

- A reference citing ground control survey accuracies. If ground control survey performed by others a reference to the control survey report as well as a certified copy of the report is needed.

- An index of files on digital media listed by filename, file location (path), and brief description. The imagery and metadata files need only be referenced by directory, and not individually.

- Describe the planning, collection, processing, adjustment, and quality control methodology used to produce aerial surveying and mapping product(s)

- Appropriate horizontal and/or vertical NSSDA accuracy reporting.

- List the field and office personnel who worked on project, and their responsibilities.

- Field date of aerial survey (First and last imagery acquisition flight date(s)).

- Map displaying the project location

23.1. DIGITAL MEDIA

The project data shall be submitted to the Department on digital media format agreed upon in project scope. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT.

The digital media shall be labeled in such a way as not to impede its use, and shall display the following information:

- Statement cross referencing digital media as part of the survey report by including survey report title, Financial Management Number, MSTS number, and date of survey information from the survey report.

- Digital media make, model, and serial number

- Consultant name and contact information.

The digital media shall contain at a minimum:

- Final photogrammetric product(s); survey scope items, i.e., orthophotography, planimetric map, topographic map, surface, etc.
- Digitally signed copy of the control survey report
- All raw imagery
- Sketches and digital pictures of base station sites identifying measured point location and identification of mark.
- Copies of field notes or GNSS data logs/static occupations.
- All airborne system (GNSS/INS) data observed including the raw observation data and processed sensor trajectory information including reports.

24. REFERENCES

American Society for Photogrammetry and Remote Sensing. (2014, November). ASPRS Positional Accuracy Standards for Digital Geospatial Data. *Photogrammetric Engineering & Remote Sensing*, Vol. 81, No. 3, pp. A1–A26. Retrieved from http://www.asprs.org: http://www.asprs.org/PAD-Division/ASPRS-POSITIONAL-ACCURACY-STANDARDS-FOR-DIGITAL-GEOSPATIAL-DATA.html

Federal Geographic Data Committee. (1998). Part 3: National Standard for Spatial Data Accuracy. *Geospatial Positioning Accuracy Standards*. Retrieved from http://fgdc.er.usgs.gov/fgdc.html.

Rufe, P. P. (2014). Digital orthoimagery base specification V1.0. In U. S. Survey, *Chapter 5 of Section B, U.S. Geological Survey Standards Book 11, Collection and Delineation of Spatial Data* (p. 13). Reston, Virginia: USGS; http://dx.doi.org/10.3133/tm11B5.

Slama, C. (Ed.). (1980). *Manual of Photogrammetry* (Fourth ed.). Falls Church, Virginia, USA: American Society of Photogrammetry.

25. EXAMPLE ACCURACIES FOR ORTHOPHOTOGRAPHY

Final Ortho Image Pixel Size (ft)	Horizontal Accuracy Class RMSEx and RMSEy (ft)	Ortho Image RMSEx and RMSEy in terms of pixels	Horizontal Accuracy RMSEr (ft)	Maximum Ortho Image Mosaic Seamline Mismatch (Pixels)	Maximum Ortho Image Mosaic Seamline Mismatch (ft)	Allowable AT or INS-based (ft)		Allowable Ground Control RMSE (ft)		NSSDA Horizontal Accuracy at the 95% Confidence Level (ft)
						RMS Ex and RMS Ey	RMS Ez	Horizontal x and y	Vertical z	
0.05	0.05	≤1-pixel	0.071	2	0.10	0.025	0.05	0.013	0.025	0.12
	0.10	2-pixels	0.141	4	0.20	0.050	0.10	0.025	0.050	0.24
	0.15	3-pixels	0.212	6	0.30	0.075	0.15	0.038	0.075	0.37
	0.20	4-pixels	0.283	8	0.40	0.100	0.20	0.050	0.100	0.49
0.10	0.10	≤1-pixel	0.141	2	0.20	0.050	0.10	0.025	0.050	0.24
	0.20	2-pixels	0.283	4	0.40	0.100	0.20	0.050	0.100	0.49
	0.30	3-pixels	0.424	6	0.60	0.150	0.30	0.075	0.150	0.73
	0.40	4-pixels	0.566	8	0.80	0.200	0.40	0.100	0.200	0.98
0.25	0.25	≤1-pixel	0.354	2	0.50	0.125	0.25	0.063	0.125	0.61
	0.50	2-pixels	0.707	4	1.00	0.250	0.50	0.125	0.250	1.22
	0.75	3-pixels	1.061	6	1.50	0.375	0.75	0.188	0.375	1.84
	1.00	4-pixels	1.414	8	2.00	0.500	1.00	0.250	0.500	2.45
0.35	0.35	≤1-pixel	0.495	2	0.70	0.175	0.35	0.088	0.175	0.86
	0.70	2-pixels	0.990	4	1.40	0.350	0.70	0.175	0.350	1.71
	1.05	3-pixels	1.485	6	2.10	0.525	1.05	0.263	0.525	2.57
	1.40	4-pixels	1.980	8	2.80	0.700	1.40	0.350	0.700	3.43
0.50	0.5	≤1-pixel	0.707	2	1.0	0.250	0.50	0.125	0.250	1.22
	1.0	2-pixels	1.414	4	2.0	0.500	1.00	0.250	0.500	2.45
	1.5	3-pixels	2.121	6	3.0	0.750	1.50	0.375	0.750	3.67
	2.0	4-pixels	2.828	8	4.0	1.000	2.00	0.500	1.000	4.90
1.00	1.0	≤1-pixel	1.414	2	2.0	0.5	1.00	0.250	0.500	2.45
	2.0	2-pixels	2.828	4	4.0	1.0	2.00	0.500	1.000	4.90
	3.0	3-pixels	4.243	6	6.0	1.5	3.00	0.750	1.500	7.34
	4.0	4-pixels	5.657	8	8.0	2.0	4.00	1.000	2.000	9.79
2.00	2.0	≤1-pixel	2.828	2	4.0	1.0	2.0	0.50	1.0	4.90
	4.0	2-pixels	5.657	4	8.0	2.0	4.0	1.00	2.0	9.79
	6.0	3-pixels	8.485	6	12.0	3.0	6.0	1.50	3.0	14.69
3.00	3.0	≤1-pixel	4.243	2	6.0	1.5	3.0	0.75	1.5	7.34
	6.0	2-pixels	8.485	4	12.0	3.0	6.0	1.50	3.0	14.69
	9.0	3-pixels	12.728	6	18.0	4.5	9.0	2.25	4.5	22.03
5.00	5.0	≤1-pixel	7.071	2	10.0	2.5	5.0	1.25	2.5	12.24
	10.0	2-pixels	14.142	4	20.0	5.0	10.0	2.50	5.0	24.48
	15.0	3-pixels	21.213	6	30.0	7.5	15.0	3.75	7.5	36.72

RIGHT OF WAY MAPPING

26. MASTER CADD FILE

A master CADD file will be created for all right of way related maps prepared for the Department. Files will be delivered in a format that adheres to the ***CADD Manual, Topic No. 625-050-001***.

Master CADD files may contain any number of the following elements as directed by the DSMO:

26.1. ALIGNMENT (29.1)

The line work along with all required data will be placed in this file. Required data includes bearings on tangent lines, stationing, all curve elements and points of intersection station value with deflection angle left or right.

26.2. SECTION AND QUARTER-SECTION LINES (29.2)

The line work along with all required data will be placed in this file. Required data includes labeling of bearings/distances and ties by station/distance to the survey alignment. Closure reports, if required, will be calculated from this file.

26.3. SUBDIVISIONS (29.3)

The line work along with all required data will be placed in this file. Required data includes name, recording data, boundaries (with arrow indicators), lot/block lines, lot/block numbers, street names, alleys, and platted easements. Subdivisions will be tied to the survey alignment with station values. The DSMO will determine the method of ties, whether by 90 degree offsets or by straight-line extension. Closure reports for each block, if required, will be calculated from this file.

26.4. EXISTING RIGHT OF WAY (29.4)

The line work for existing right of way by deed, maintenance or dedication for mainline corridor and/or side streets will be determined, verified and placed in this file. Required data includes name of the street, width (or varies) and source of creation, i.e., plat, deed, maintenance map.

26.5. TOPOGRAPHY (29.5)

The topographic elements will be referenced to this file at the desired scale. Elements will be adjusted and modified as necessary. Required elements include, but are not limited to, buildings, canopies, signs, fences, groves, parking/pavement, above ground utilities,

and bodies of water. Dimensional data required by the ***Survey and Mapping Procedures, Topic No. 550-030-101*** will be shown on the Right of Way Map Detail Sheets.

26.6. PARENT TRACT PROPERTIES AND EXISTING EASEMENTS (29.6)

A title search analysis will be performed to determine the location of parent tract boundaries and existing easements. The line work will be shown and identified by the appropriate symbology, e.g., cell/block, and be placed in this file. A parcel identification number depicted in a parcel bubble will be placed and assigned in accordance with the ***Right of Way Manual, Topic No. 575-000-000***.

26.7. PROPOSED RIGHT OF WAY REQUIREMENTS (29.7)

The Roadway Designer or EOR will provide right of way requirements to the PSM. The EOR, in coordination with the DSMO and the Right of Way Acquisition Manager, will determine the type of interest required, i.e., fee, permanent or temporary easement, or license agreement. The line work will be placed in this file. All takes and remainders will be calculated, labeled and dimensioned with station and offsets designated at each change in direction of the right of way. Closure reports will be prepared for each take and remainder area.

26.8. LIMITS OF CONSTRUCTION (29.8)

The line work will be provided by the Roadway Designer or EOR and placed in this file. Coordination with the Roadway Designer or EOR will be required to resolve problem areas. The line work will be labeled “L.O.C.”. Care will be taken to ensure the limits of construction do not extend beyond the existing or proposed right of way as well as insuring the proposed right of way is supported by necessity in the construction plans. Limits of construction will be shown, at minimum, on all Federal Aid Right of Way projects.

26.9. JURISDICTIONAL/AGENCY LINES (29.9)

The line work for jurisdictional wetlands, water boundaries and city/county limit lines will be placed in this file. The DSMO will determine how and when these lines or areas will be depicted on the actual right of way maps.

See ***Sections 4 and 5*** for information on water boundary and jurisdictional surveys.

27. SHEET FILES

Sheet files will be created to form the actual control survey, right of way map, or maintenance map, in the following designations:

27.1. CONTROL SURVEY

A control survey is prepared to provide horizontal position data for the support of right of way related maps.

27.1.1. GENERAL MAP REQUIREMENTS

The map will depict, at a minimum, the following:

- The survey alignment with reference points
- Sufficient land line ties
- Recorded subdivisions, condominiums and cooperatives along with recording data
- A north arrow and scale of map
- County and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- State, county, or municipal roads intersecting the survey alignment
- The bearing basis
- The source of dimensions: Field (F), Plat (P), Deed (D), Calculated (C)
- Sufficient general notes on sheet 1
- The Department standard title block
- A legend of abbreviations and symbols
- Found monumentation

27.1.2. CONTROL SURVEY COVER SHEET (29.10)

The Department's approved sheet cell/block will be used in preparation of this cover sheet. The legend, general notes, location map and certifications will be placed on this sheet.

The following certification by the PSM will be placed on the cover sheet:

I hereby certify this control survey was made for the purpose of surveying, referencing, describing and mapping the survey alignment, and providing horizontal position data for the support or control of right of way related maps for the transportation facility shown and depicted hereon. I further certify said survey was done under my responsible charge and is in compliance with the Standards of Practice as set forth by the Board of Professional Surveyors and Mappers in Chapter 5J-17, Florida Administrative Code pursuant to section 472.027, Florida Statutes.

This drawing, consisting of sheets _____ through _____, is a true, accurate and complete depiction of a field survey performed under my direction and completed on _____.

_____
Name
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RASIED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

27.1.3. CONTROL SURVEY KEY SHEET (29.11)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), with reference points; section line ties; subdivisions, condominiums and cooperatives with recording data; and other elements, including monumentation identified as to size, type, set or found, as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.1.4. CONTROL SURVEY DETAIL SHEET (29.12)

This sheet(s) is derived from the master CADD file at an appropriate scale to depict the field right of way survey data. The line work, text, etc. will be added/modified to fit the detail sheet scale. The DSMO will determine if detail sheets will be prepared for the entire project or if only recorded subdivisions will be shown on the detail sheets. All subdivision block lines will be tied by station and offset to the survey alignment. The DSMO will determine the method of ties, whether by 90 degree offsets or by straight-line extension.

27.2. RIGHT OF WAY MAP

A right of way map is prepared when real property rights are to be acquired for a transportation facility. It will be designed to provide a high degree of uniformity and maximum readability.

At the discretion of the DSMO, a boundary survey or sketch of description, as defined in ***Rule Chapter 5J-17, F.A.C.***, may be used for situations such as advance acquisition, hardship acquisition, donations, etc., in lieu of preparing a right of way map.

27.2.1. GENERAL MAP REQUIREMENTS

The map will depict, at minimum, the following:

- If a control survey was not produced, all control survey elements will be a requirement of the right of way map.

  See ***Section 27.1*** for information on control surveys.

- The survey alignment with reference points
- Sufficient land line ties
- Recorded subdivisions, condominiums, and cooperatives, along with the recording data
- A north arrow and scale of the map
- County lines and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- State, county, or municipal roads intersecting the survey alignment
- The existing right of way
- Existing easements with recording data.
- Right of way requirements with all data necessary to describe the parcel
- The bearing basis
- The source of dimensions: Field (F), Plat (P), Deed (D), Calculated (C)
- Sufficient general notes on sheet 1
- The Department standard title block
- The date of photography on projects using aerial photography
- Parent tracts with required geometry and boundaries labeled
- The parcel identification number shown in a parcel bubble for each acquisition. The parcel number assigned will be in accordance with the ***Right of Way Manual, Topic No. 575-000-000***.
- Buildings, improvements and key topographic features, e.g., groves, fences, signs, bodies of water, etc. within the proposed right of way. Buildings, canopies/overhangs, and signs, etc. severed by the acquisition will be dimensioned accordingly. Buildings and improvements located within 50 feet for urban projects, or 100 feet for rural projects, outside of the proposed right of way

line will be shown graphically only, unless otherwise instructed by DSMO. Buildings within 25 feet of the proposed right of way will show a distance from the nearest corner of the building to the proposed right of way line. Buildings will be labeled to show use if apparent, e.g., residential, commercial.

- Encroachments within existing right of way
- A legend of abbreviations and symbols
- A table of ownerships
- The statement: *THIS MAP IS NOT A SURVEY* on each sheet
- The statement: See sheet 1 for legend and general notes on each subsequent sheet
- Additional data required by FHWA on projects that have federal funding, e.g., limits of construction

27.2.2. RIGHT OF WAY MAP COVER SHEET (29.13)

The Department's approved sheet cell/block will be used in preparation of this cover sheet. The legend, general notes, and location map will be placed on this sheet. On projects that do not require a cover sheet, the foregoing information may be shown on the key or detail sheet(s) as directed by the DSMO.

27.2.3. RIGHT OF WAY MAP KEY SHEET (29.14)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), section ties, subdivisions, condominiums and cooperatives with recording data, large parent tracts and other elements as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.2.4. RIGHT OF WAY MAP DETAIL SHEET (29.15)

This sheet(s) is derived from the master CADD file at an appropriate scale. The line work, text, etc. will be added/modified to fit the detail sheet scale. These detail sheets may also be copied from the existing detail sheets of the control survey. Detail sheets will include parcel numbering by use of bubbles, complete geometry for all takes and geometry for remainders as directed by the DSMO, topography, limits of construction, if required and jurisdictional or agency lines, if required.

27.2.5. MAP PROCESSING

Processing will be as follows:

- The designated District authority will approve and date each map sheet.

27.2.6. MAP REVISIONS

Prior to making revisions to approved right of way maps, documentation will be provided to the project file to identify:

- the person(s) requesting the change.
- the person(s) authorizing the change.
- a detailed description of necessary change(s).
- an explanation of why the changes are necessary.

27.3. MAINTENANCE MAP

A maintenance map is prepared and filed with the Clerk of the Circuit Court when the DSMO has determined that there has been no formal conveyance of right of way or accepted dedication or there is notification/evidence that a formal conveyance was ineffectual to pass title to the Department.

27.3.1. GENERAL MAP REQUIREMENTS

The map will depict, at minimum, the following:

- The survey alignment with reference points
- Sufficient land line ties
- A north arrow and scale of map
- County and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- A State, county, or municipal roads intersecting the survey alignment
- The existing right of way
- The maintained right of way lines with station and offset to the survey alignment
- Key topographic features
- The bearing basis
- The source of dimensions

- Sufficient general notes on sheet 1
- The Department standard title block
- The date of photography on projects using aerial photography
- A legend of abbreviations and symbols

27.3.2. MAINTENANCE MAP COVER SHEET (29.16)

The Department's approved sheet cell will be used in preparation of this cover sheet. The legend, general notes, location map and certifications will be placed on this sheet. On projects that do not require a cover sheet, the foregoing information may be shown on the key or detail sheet(s) as directed by the DSMO.

The following certifications will be placed on the cover sheet:

1. The Department certification

THIS IS TO CERTIFY that sheets numbered _____ to _____, inclusive, constitute a true copy of the State of Florida Department of Transportation Maintenance Map for a portion of State Road _____, designated as _____ in _____ County, Florida.

THE PROPERTY labeled _____ on said sheets has been vested in the State of Florida Department of Transportation pursuant to the provision of Section 95.361, Florida Statutes

IN WITNESS WHEREOF, we have hereunto set our hands and affixed the seal of the State of Florida Department of Transportation, at _____, Florida, this _____ day of _____, A.D. 20__.

_____ _____

District Secretary *(Witness)*
Department of Transportation
State of Florida

2. The recording certificate

Filed for record in the office of the Clerk of the Circuit Court for the County of _____, State of Florida, in Road Plat Book _____, Page _____, on the _____ day of _____, A.D. 20__.

3. The PSM's certification

This survey was performed for the specific purpose of establishing a survey alignment and locating the limits of maintained right of way as identified by the Maintenance Engineer for the transportation facility shown and depicted hereon. I hereby certify to the best of my knowledge and belief this is a true, accurate and complete depiction of a field survey performed under my direction and completed on _____. I further certify that said drawing is in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers, in Chapter 5J-17, Florida Administrative Code pursuant to Section 472.027, Florida Statutes.

_____

Name
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RASIED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

4. If the responsible maintenance engineer or authority has not signed an affidavit, he or she must certify as follows:

This is to certify that the limits of maintained right of way as shown on this map were identified by myself as having been maintained continuously for four (4) years without interruption.

_____

Name and Title
Date

27.3.3. MAINTENANCE MAP KEY SHEET (29.17)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), section line ties, subdivisions, condominiums and cooperatives with recording data, and other elements as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.3.4. MAINTENANCE MAP DETAIL SHEET (29.18)

This sheet(s) is derived from the master CADD file at an appropriate scale. The line work, text, etc. will be added/modified to fit the detail sheet scale. These detail sheets may also be copied from the existing detail sheets from the right of way control survey. All maintained right of way along the mainline corridor will be supported by certified field notes. At the direction of the DSMO, reference to the appropriate field books will be made either in the general notes on the cover sheet or by reference on the detail sheet. Station and offsets will be shown at each change in direction of the right of way.

27.3.5. MAP PROCESSING

Processing will be as follows:

- After the map has been accepted by the DSMO, the original and 1 set of prints will be submitted to the appropriate authorities for certification and witnessing.
- After the map has been certified and witnessed, the DSMO will obtain 1 film copy and file the original map with the Clerk of the Circuit Court. The Clerk will affix the recording information on the set of prints for DSMO records and the recording data will be placed on the film copy retained by the DSMO.

27.4. REFERENCE POINT SHEET SET (29.19)

This information as derived from field book data or electronic files will be plotted into a CADD file. The line work, text, etc. will be added/modified to fit the sheet scale, if applicable. There will be a maximum number of 15 reference points per sheet. Reference point sheets will be prepared at the direction of the DSMO as appropriate to the project. This sheet(s) will be included with the control survey, right of way map, and maintenance map.

27.5. PROJECT NETWORK CONTROL SHEET (29.20)

This information as derived from field book data or electronic files will be plotted into a CADD file. The line work, text, etc. will be added/modified to fit the sheet scale, if applicable. Project network control sheet(s) will be prepared at the direction of the DSMO as appropriate to the project.

This sheet depicts the baseline, benchmarks, primary and secondary control points and their reference points including the type of material used for each point, their X,Y,Z coordinates, scale factors and convergence angles. This sheet(s) may be included with the control survey map, right of way map, and maintenance map.

27.6. TABLE OF OWNERSHIPS SHEET (29.21)

The Department's approved sheet cell will be used in preparation of the ownerships sheet. Required data will include parcel number, sheet numbers on which the parcel appears, name of property owner(s), the area in square feet or acres of the part to be acquired and the remainder (when there is no remainder show 0), any necessary comments, and the recording data of the executed or condemned parcel when completed.

28. MISCELLANEOUS SURVEYS AND SKETCHES

28.1. PARCEL SKETCHES (29.22)

Parcel sketches may be prepared for various purposes at the direction of the DSMO. Purpose, format, scale, etc. are designated in the scope as required.

28.2. TIITF SKETCHES (29.23)

Sketches are prepared for the Department to obtain rights over sovereignty submerged lands or state owned uplands. Specific requirements, e.g., purpose, format, scale, are designated in the scope or by the requirements of FDEP, BSM.

28.3. OTHER SPECIFIC PURPOSE SURVEYS (29.24)

These may include preparation of maps for mitigation surveys or jurisdiction line surveys. Specific requirements, e.g., purpose, format, scale, are designated in the scope.

28.4. BOUNDARY SURVEY MAP (29.25)

This survey may be prepared for any specific need at the direction of the DSMO. Specific requirements, e.g., purpose, format, scale, are designated in the scope.

28.5. RIGHT OF WAY MONUMENTATION MAP (29.26)

This survey is prepared for the depiction of the field-monumented right of way. The right of way map set is the basis for this map with minimal adjustments to the cover sheet, including adding the proper certification. The recording data is shown on the table of ownerships sheet. It is prepared and filed after the right of way has been monumented.

28.5.1. ADDITIONS TO THE RIGHT OF WAY MAP

The following will be added to the original right of way map:

- The appropriate symbol where each right of way monument was set
- A note on each map sheet describing the symbol indicating the right of way monument

- The recording data for each parcel acquisition or condemnation in the table of ownerships

28.5.2. CERTIFICATIONS

A reproducible copy of the original right of way map that meets the requirements of the appropriate Clerk of Circuit Court will be made after the above is completed and the title blocks will be revised to show *RIGHT OF WAY MONUMENTATION MAP.* The note *THIS MAP IS NOT A SURVEY* will be removed from all sheets of the reproducible copy and the following will be added.

The certificate of the PSM in responsible charge on sheet 1 as follows:

This certification is made exclusively to the Florida Department of Transportation.

This survey was performed for the specific purpose of monumenting the existing right of way only for the transportation facility shown hereon. I hereby certify that to the best of my knowledge and belief, the right of way monumentation as shown by the symbol for Permanent Right of Way Markers (P.R/W M.) and depicted on this drawing, consisting of sheets _____, is a true, accurate, and complete depiction of a field survey performed under my direction and completed on _____. I further certify that said drawing is in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers, in Chapter 5J-17, Florida Administrative Code pursuant to Section 472.027, Florida Statutes.

_____
Name of Surveyor
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RASIED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

The recording certificate on sheet 1 as follows:

Filed for record in the office of the Clerk of the Circuit Court for the County of _____, State of Florida, in Road Plat Book _____, Page _____, on the _____ day of _____, A.D. 20__.

29. MAP PREPARATION

29.1. SIZE & FORMAT

All final right of way related map sheets will be a size which is determined by the DSMO to be acceptable to the Clerk of the Circuit Court for recording.

All sheet formats will have a standard title block with provision for a federal project number.

All final right of way maps prepared for the Department are to be delivered in hard copy and/or electronic format that adheres to the ***CADD Manual, Topic No. 625-050-001***.

29.2. MATERIAL

The map material for all final right of way related map sheets delivered in hard copy will be submitted on a reproducible material that meets the requirements of both the DSMO and the Clerk of the Circuit Court.

30. TITLE SEARCH AND DOCUMENT PREPARATION (29.28)

The procurement of lands for transportation facilities requires a current report of the present ownership and all encumbrances on each parcel to be acquired. This includes, within the report, a list of all conveyances of the subject land made during the most recent five year period together with the consideration paid based on documentary stamps. Title search reports are prepared in accordance with the ***Right of Way Manual, Topic No. 575-000-000*** and based upon a thorough search of the public records, which may require searching back to the earliest public records. The services of a qualified title company or title examiner are usually obtained for this purpose. In Districts where the Department has qualified personnel experienced in title examination, the DSMO may elect to obtain its own updates and to do some or all original title searches.

Information received from title searches is analyzed by surveying and mapping personnel in order to make property boundary determinations necessary for adequate map and document preparation. Specifically, the descriptions of the various ownerships are plotted to scale for inclusion on the maps. In addition, a determination of the various encumbrances such as mortgages, liens, easements, etc., of record against each parcel are identified based upon the report of title search. In some instances the assistance of the District general counsel and/or the Department's general counsel may be required for specific interpretations.

Documents of conveyance are prepared in accordance with the ***Right of Way Manual, Topic No. 575-000-000***.

30.1. TITLE SEARCH MAP (29.27)

This map is prepared utilizing property appraiser maps or preliminary right of way maps. The purpose of this map is to depict the properties affected by the proposed project requirements. This map is used to obtain title search reports necessary to develop the right of way maps. The DSMO directs the schedule of preparation.

30.2. RIGHT OF WAY MAPPING RESPONSIBILITIES

Obtaining, analyzing and processing current title search and updates is the responsibility of the DSMO under direction of the District General Counsel until delivery of the right of way project to the Office of Right of Way. Title search reports/updates are certified to within six months of delivery of the project to the Office of Right of Way. After the project is delivered the responsibility for updating title is determined by the District.

Title search reports reflect all documents that create, or purport to create, an interest, lien or encumbrance in the parcel. Title searches should cover a sufficient period of time to include any existing easements or reservations. A description of all conveyances that occurred in the five years immediately preceding the completion date of the title search is also included.

On all title search contracts for the Department, the DSMO serves as contract manager and has the following responsibilities:

- Enforcement of performance of all contract terms and conditions
- Liaison between the Department and the title examiner

30.3. ORDERING A TITLE SEARCH

The contract manager furnishes the title company or title examiner with a copy of the title search map. Occasionally, the title examiner may find a reference to plats and subdivisions that have not been depicted on the preliminary maps or property appraiser maps. In such cases, he includes a copy of the plats with the title search so that the maps can be corrected. When the maps are submitted to the title company or title examiner, the contract manager may include an estimate on time of completion and an authorized expenditure with the letter of authorization for the title examiner or title company to commence work on the project.

The letter of authorization to the title company or title examiner may also provide the following:

- Reference to the title search agreement under which the search is being ordered, and the amounts quoted for the various types of search under the agreement
- The number of copies of the search to be furnished as required by the contract manager

- A tentative due date for the search

30.4. CERTIFICATION OF UPDATE

The title examiner, under the provisions of the title search contract agreement, is required to certify any update of the original search. The update shows the owner's name and mailing address. The title examiner also provides specific data as to outstanding encumbrances not already listed in previous title searches, such as mortgages (with book and page reference) and satisfaction of mortgages (with book and page reference).

31. LEGAL DESCRIPTIONS (29.29)

31.1. MINIMUM REQUIREMENTS

All points of commencement, where practical, should be outside of the required right of way. Descriptions must also be prepared and certified in accordance with the ***Surveying and Mapping Procedures, Topic No. 550-030-101***. The format will be determined by the DSMO.

31.2. INFORMATION FOR WRITING LEGAL DESCRIPTIONS

- A set of right of way maps that show the required right of way with all necessary geometry.
- Title information from the most recent title search, including any updates. This information should include the current record owner, the legal description of the property, and a list of all encumbrances on the property. Easement locations must be plotted to determine whether they will affect the right of way taking. Determination may then be made to ascertain if the taking will be subject to an existing easement, subordinated or fully cleared. Private easements may be brought to the attention of the DSMO by title examiners, surveyors, appraisers, and others. This information must also be included on the right of way maps.
- Other information may be obtained from additional field survey, local surveyors, or other sources to clarify the property boundary location and title data. On consultant prepared projects, the consultant will coordinate this effort with the DSMO.

31.3. EARLY INVOLVMENT IN MAP PREPARATION

- Includes analyzing the title search to define parent tracts and ownerships affected by the proposed right of way acquisition.
- Includes reviewing the title search for errors in the legal description or omissions in the title evidence. Items requiring clarification must be referred promptly to the title examiner or Title Company to complete the title work before the preparation

of legal descriptions. Title updates may indicate revisions for which the maps should be adjusted.

- The record parent tract legal description for each right of way parcel and the proposed right of way requirements will be depicted as required on the right of way map and assigned a numbered parcel bubble in accordance with ***Section 31.4***.

31.4. ASSIGNMENT OF PARCEL NUMBERS

Parcel numbers are assigned conforming to the numbering convention as follows:

- Series 1 – 99 is reserved
- Series 100 – 699 is used for all parcels to be acquired in fee
- Series 700 – 799 is used for temporary easements
- Series 800 – 899 is used for perpetual easements, including TIITF parcels
- Series 900 – 999 is used for all license agreements

In the event any series exceeds the above range on a project, the series is extended by beginning with the first number of that series and adding 1000. For example, 100 – 699 would become 1100 – 1699, etc.

Once a parcel number is assigned and transmitted to the Office of Right of Way it may not be reused or reactivated if voided.

31.5. VESTING OF TITLE TO ROADS

When a state road intersects a street or dedicated right of way owned by a local governmental agency, that portion of the right of way that is required for maintenance of the state road after construction should be clearly depicted on the right of way map. If legal descriptions are required, they are prepared at the direction of the DSMO in accordance with local agency requirements. If necessary, a parcel number(s) may be assigned.

31.6. PREPARATION OF LEGAL DESCRIPTIONS

Having completed the analysis of the title evidence, plotting of ownerships, reconciling conflicting information, and showing the information on the right of way map, including right of way requirements, the legal descriptions can be prepared. The DSMO will determine the description format.

All data, distances and bearings used in a legal description should be readily discernible from the right of way map, with all data between the map and the legal description in complete agreement.

Computations and closure reports are prepared to support the description and provide additional data that may be required on the right of way map.

31.6.1. BASIC METHODS

The basic methods to be used for the description of real property are:

- Metes and bounds
- Survey alignment description
- Sections, lots, blocks or specific parts thereof

31.6.2. AREA

Areas are shown in all legal descriptions in square feet or acres, usually not both. The areas agree with the table of ownership sheet and depicted as follows:

- Areas of a half-acre or more should be shown in acres, to 3 decimal places. Areas less than a half-acre should be shown in square feet, to the nearest foot, or as directed by the DSMO. Areas, both acres and square feet, should be followed by *more or less.*
- For legal descriptions with multiple parts where some of the parts are less than or equal to 1/2 acre but the total amounts to more than 1/2 acre, the parts may be shown to the nearest square foot following each part of the legal description and the total in acres at the end of the legal descriptions. Parts should be clearly tied together by "*AND"* or "*ALSO"* to clearly show the intent. Care should be taken to ensure that the "part" areas add up to the total area with no rounding differences, and there are no discrepancies with the table of ownership sheet. The DSMO directs the method of depiction on the table of ownership sheet, i.e., total area only or parts shown.

31.6.3. METES AND BOUNDS DESCRIPTIONS

This type of description is one which requires adequate field survey information to identify the point of beginning and list the bearings and distances that define the limits of the parcel. This is the preferred method if a simpler description is not suitable.

Each metes and bounds description should adequately identify the land described and make the title certain with regard to adjoining ownerships by the use of proper qualifying language.

31.6.3.1. PARENT TRACT

In some instances minor flaws may be detected in the parent tract description that would not materially affect the right of way. In such instances, the parent tract should be placed

in direct quotes to indicate the description of the parent tract is being used exactly as the conveyance was made to the current owner.

However, when major discrepancies are detected such as improper sections, townships or ranges that would place the property a considerable distance from the actual location on the ground, the property owner should be advised of the discrepancy and should file a corrective deed before the Department takes title. In the event this cannot be accomplished, an alternate method for describing the right of way should be pursued such as by direct metes and bounds or survey alignment description.

31.6.3.2. EXCEPTIONS TO THE PARENT TRACT

Occasionally, a parent tract description contains one or more areas that are excepted from it. These may be described by copying the parent tract description and following it by the description of the exception, clearly denoting it as an exception.

31.6.4. SURVEY ALIGNMENT DESCRIPTION

Where partial takings of a generally constant width are involved throughout a considerable length of the project, the survey alignment description is often the most practical type of description. This description is based upon right of way taking of a portion of land out of a given parent tract that lies within a specific distance of a survey alignment.

31.6.4.1. SURVEY ALIGNMENT TIES

This line may be a survey alignment or a construction centerline tied at both ends to known land corners such as a section corner, quarter section corner, subdivision block corner or permanent reference monument. The distance between ties should not normally exceed one mile except through large acreage tracts where it is permissible to cover the entire tract without intermediate ties. When crossing large acreage tracts, a beginning tie to a substantial corner prior to reaching the large tract is required. List the sections that are being crossed and tie to a substantial corner or just past the ending boundary line for the tract.

31.6.4.2. SURVEY ALIGNMENT CURVES

Describe by curve data, tangent lengths, and bearings, the survey alignment used in the description.

The description of the curve should contain the following information:

- concave direction
- direction of curve
- central angle

- length
- radius

If the curve is non-tangent, additional information to define the curve will be included.

A survey alignment beginning on a curve will have the tangent bearing or chord bearing at the beginning indicated and the curve data should define only that part of the curve included in the description.

31.6.4.3. SURVEY ALIGNMENT IDENTIFICATION

The survey alignment, centerline, and construction centerline may or may not be common lines, so it is important that the line on which the right of way is based be clearly identified in the description and on the right of way map. Survey alignments should be described as beginning and ending on a land line, with a bearing and distance to the nearest land corner. It is most important the bearing of the land line be shown in order to have complete ties.

Many variations of the survey alignment description are used, but the principle remains the same. Each line is identified by name such as baseline, centerline, survey alignment, etc. as shown on the maps.

In most cases, especially where the width of the right of way varies, direct metes and bounds is the best method to describe real property.

31.6.4.4. RIGHT OF WAY WIDTH

After defining the survey alignment, then define the width of the taking. The right of way map indicates the required width.

Where there is existing right of way, it should be clearly stated in the description, e.g., *excepting 25 feet of existing right of way on each side of the survey alignment…*, and the area for the taking should also exclude the area of the existing right of way.

31.6.4.5. VARIABLE WIDTH RIGHT OF WAY

Occasionally, a description requires a change of right of way width within the parcel. This change may be defined by station and offset located in the description of the survey alignment that follows.

Breaks can be located on property lines, instead of station numbers. Occasionally, a transition in the right of way may be needed.

31.6.4.6. DESCRIPTIONS FOR FEDERAL LAND TRANSFERS

Where survey alignment descriptions are utilized to describe parcels for federal land transfers where the taking is uniform throughout, recite the beginning and ending stations where the survey alignment enters and leaves the federal lands.

In most cases, especially where the width of the right of way varies, direct metes and bounds is the best method to describe federal lands.

31.6.5. WHOLE AND PARTIAL TAKINGS

31.6.5.1. WHOLE TAKING

An entire ownership as described in the title evidence may be used if all the land is acquired and the description is correct in all respects.

31.6.5.2. PARTIAL TAKING

Partial takings may be defined in various ways; however, the intent should be clear.

These various ways are:

- By recited dimension in a designated direction, sometimes called a strip description
- By area, specified or proportionate
- By exception of portion not conveyed
- By division line between parcels

Care should be exercised in describing partial takings, especially with parcels that do not lie in cardinal directions, and those with irregular shapes.

31.6.5.3. SECTIONAL DESCRIPTIONS

Surveyors should follow best practices for referencing lands defined by the Public Land Survey System as defined by the ***Manual of Survey Instructions for the Survey of the Public Lands of the United States, 2009***.

31.7. MULTIPLE DESCRIPTIONS, LIMITED ACCESS & FREE ACCESS

A description may consist of more than one area of land to be included in the parcel. It is most important the descriptions of these parts be tied together by *"AND*" or "*ALSO*" in order to clearly show the intent. Care should be exercised to ensure the separate parts do not overlap as this can cause confusion as to the intent and possible duplication of acreage.

Locations where access rights are acquired must be defined and clearly separated from free access and other interest included in the same document. Limited access takings must include the following language: "Together with all rights of ingress, egress, light, air and view between the above described property and the Grantor's remaining property.

31.8. EASEMENTS

31.8.1. TEMPORARY EASEMENTS

A time limit is used on temporary easements for stockpiles, detours, construction easements, and other easements required during the period of construction. These time limits run from the date of execution of the instrument unless otherwise noted.

31.8.2. PERPETUAL EASEMENTS

Perpetual easements are generally used for drainage outfalls, drainage inlets, slopes, wall maintenance, ingress/egress and other easements that need to be permanent.

31.9. VERIFICATION

Verification of all descriptions, original or revised, will be included as part of the QA/QC plan.

31.10. CERTIFICATION

The description for each parcel must be certified, i.e., signed, sealed, and dated, by a professional surveyor and mapper as meeting the ***Standards of Practice*** pursuant to ***Section 472.027, F.S.***, and must also be prepared in accordance with the ***Surveying and Mapping Procedures, Topic No. 550-030-101***.

Unless each description is certified individually, the professional surveyor and mapper will prepare a certification letter as follows:

I hereby certify that, to the best of my knowledge and belief, the attached legal descriptions of parcels _____as shown on the right of way maps designated as _____ are true, accurate, and were prepared under my direction.

I further certify that said legal descriptions are in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 5J-17, F.A.C., pursuant to Section 472.027, F.S.

_____

Name of Surveyor
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RASIED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

32. MISCELLANEOUS

32.1. ROAD TRANSFERS

After notice has been given, pursuant to ***Transportation System Jurisdiction and Numbering, Topic No. 525-020-010***, that a state road has changed jurisdictional classification, the orderly transfer of rights of way by deed or the filing of a right of way map must be initiated. The use of right of way maps is the preferred method. Below is the certificate to be used.

This right of way map, when recorded, is an instrument of conveyance, transferring in accordance with Section 337.29(3), F.S., all right, title and interest of the Florida Department of Transportation in the road, street, highway, set forth on this map to_____ County.

Recorded in Public Records of _____County, Florida, this_____day of _____, A.D. 20___, in Road Plat Book_____, Page _____.

_____

Clerk of the Circuit Court
_____ County, Florida

33. OFFICE PROCEDURES

33.1. TECHNICAL MEETINGS (29.32)

Attend meetings as required and negotiated by the DSMO.

33.2. QUALITY ASSURANCE/QUALITY CONTROL (29.33)

See ***Section 10.3*** for information on the QA/QC Plan.

33.3. SUPERVISION (29.34)

Perform all activities required to supervise and coordinate project. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

33.4. COORDINATION (29.35)

Coordinate survey activities with other disciplines. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

33.5. SUPPLEMENTAL MAPPING (29.36)

This task is to cover efforts resulting from major design and/or development changes after 60% map development that affect the right of way requirements/parent tract property lines and may include any number of tasks. Request and approval to utilize the supplemental mapping hours will be in writing and approved by the DSMO prior to any work being done under this task.

33.6. FINAL MAP/PLANS COMPARISON (29.30)

The PSM will perform a comparison of the final right of way maps, with the available construction plans, to review the correctness of the type of parcel to be acquired and the stations/offsets to the required right of way. The PSM will coordinate with the EOR to resolve any conflicts or discrepancies and provide documentation of the review.

34. FIELD PROCEDURES

34.1. FIELD REVIEWS

Perform verification of the field conditions as related to the survey data.

TERRESTRIAL MOBILE LiDAR

35. INTRODUCTION

The intent of this document is to provide guidelines to help insure proper and efficient use of TML technology in support of Department projects.

This document was adapted from *CALTRANS Surveys Manual 2011.* ***http://www.dot.ca.gov/hq/row/landsurveys/SurveysManual/Manual_TOC.html***

Where possible this document is intended to coincide with the National Cooperative Highway Research Program (NCHRP) : Report 748. (2013). *Guidelines for the Use of Mobile LIDAR in Transportation Applications.* Washington D.C.: Transportation Research Board of the National Academy of Sciences. ***http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_748.pdf***

36. TERRESTRIAL MOBILE LIDAR METHODS

TML uses a laser scanner(s) in combination with GNSS receivers, IMU, and DMI to produce accurate and precise geospatial data from a moving terrestrial platform.

LiDAR sensors use an active (projected) light signal to measure the relative x, y, z, position and reflective properties of a point on an object. In practice this results in a point cloud with image qualities similar to other remote sensing technologies. This allows the value of a point cloud to be extended when it is mined for topographic features and information beyond what was required of the intended survey. However, the origin and accuracy of the point cloud data must be supported by a survey report for it to be used with confidence and to ensure the survey information with any byproducts are not misused.

36.1. TYPES OF TML SURVEYS

The focus in this document is on three major survey categories of TML. The examples given here are not intended to be exhaustive.

Type A – High Accuracy Surveys:

- Design engineering topographic
- As-built
- Structures and bridge clearance

- Deformation surveys

Type B – Medium Accuracy Surveys:

- Design engineering topographic corridor study/planning
- Detailed asset inventory and management surveys
- Environmental
- Earthwork
- Urban mapping and modeling coastal zone erosion analysis

Type C – Lower Accuracy Mapping:

- Preliminary planning
- Transportation statistics
- General asset inventory surveys

37. TML PROJECT SELECTION

The following are some of the key factors to consider when determining if TML is appropriate for a particular survey project:

- Safety
- Project deliverables desired
- Budget
- Project time constraints
- GNSS data collection environment
- Terrain and length/size of project
- Traffic volumes and available observation times

38. TML EQUIPMENT

All of the equipment in the TML system used to collect, process, and adjust data must be of sufficient precision to meet the accuracy requirements of the project and applicable accuracy standards described in this document. This determination can be made from the stated specifications of the equipment by the manufacturers, analysis of the systems performance on projects with similar requirements, and the expert opinion of the Professional Surveyor and Mapper in responsible charge of the project survey data and supporting survey report.

38.1. MINIMUM TML SYSTEM SENSOR COMPONENTS

- LiDAR sensor
  - Follow ***OSHA Regulation 1926.54*** and manufacturers' recommendations when using any laser equipment. Never stare into the laser beam or view laser beams through magnifying optics, such as telescopes or binoculars. Additionally, the eye safety of the traveling public and other people should be considered at all times and the equipment operated in a way to ensure the eye safety of all.
- GNSS receivers
  - One or more onboard (roving) GNSS dual frequency receiver(s) capable of RTK data and kinematic data that can be post processed.
  - One or more static GNSS dual frequency receiver(s) at base station(s) capable of simultaneous collection and storage of RTK data and kinematic data that can be post processed.
- An IMU which typically consists of an electronic gyro within a sealed unit mounted securely on or near the primary sensor.
- A DMI typically mounted near vehicle wheel housing. It is used primarily as a supporting measurement that allows for sensor collection at relative distance intervals and can suspend measurements while the vehicle is motionless due to vehicle traffic stops during collection.

The collection rate (epoch) of the TML system sensors must be sufficient to meet project accuracy and point density requirements.

39. TML PROJECT SPECIFICATIONS AND PROCEDURES

39.1. TML MISSION

When a contract is awarded and before any work begins, the consultant will contact the DSMO to request the MSTS number. The MSTS number shall be included in point cloud data file names so the data can be included in the CSMO image data management system. The MSTS number should be referenced in all correspondence and project deliverables.

To maximize the quality and production of measurements, mission planning should be conducted before the collection of TML project data commences.

During a TML data collection mission, simultaneous GNSS signals from a minimum constellation of 5 satellites should be maintained between at least one GNSS base station receiver, and the GNSS roving receiver(s). The GNSS constellation PDOP should be 5 or less at the base and roving units during data acquisition. The occasional momentary

loss of GNSS signals, also known as cycle slips, may occur. In these cases, the position of the LiDAR sensor is dependent on the IMU, and degrades quickly over time from the last corrected GNSS position. To avoid poor and erroneous measurements the period of lost GNSS corrections should never exceed the IMU's ability to accurately position the sensor over this time interval. The inadvertent scanning of moving targets such as traffic and pedestrians will adversely affect measurements, as well as the texture, shape, and color of the surface being scanned.

The accuracy of a project point cloud is affected by many error factors. Some of these factors can be mitigated while others can be eliminated through proper procedures. Two important factors impacting accuracy related to sensor specifications that can be controlled are; the effective range of sensor and the resulting point density.

LiDAR sensor measurement precision diminishes as the distance from the sensor increases. The effective range of the LiDAR sensor, for purposes of this document, is determined by the sensor manufacturer specifications of precision as they relate to the accuracy requirements of the project or specific areas of the project.

Point density is primarily determined by the measurement distance to object, measurement rate of the sensor and speed of the sensor platform during measurement. The point density must be sufficient to identify and extract physical detail to the accuracy specified for the project while meeting the TML application requirements in ***Section 39.6.2***.

All points with compromised accuracies, especially those collected outside the effective range of the scanner, shall be classified as erroneous.

Projects with difficult TML survey conditions should be reconnoitered first to identify as many of these variables as possible and develop a plan to mitigate their effect on the data. Usually this will require additional control to ensure the TML measurements in these areas meet the project accuracy requirements.

39.2. PROJECT BASE STATION CONTROL ESTABLISHMENT

The project base station control that will be used to post-process the TML GNSS data shall be placed at intervals to ensure that no processed baseline exceeds the survey type requirements listed in ***Section 39.6.2*** Short baselines contribute to the best possible positional accuracy outcome. During TML collection two or more GNSS base station occupations are highly recommended to guard against the possibility of wasted effort and useless data from base station failure due to equipment, accident or human error in station setup, and also allow redundant post-processing. Base stations shall be appropriately spaced along the corridor to meet the baseline length limitations listed in ***Section 39.6.2*** for the project area to be mapped. This limitation does not apply to data collected outside of the project as often happens during vehicle staging at the beginning and ending of each pass. All control set shall be done in accordance with the Department's GNSS Guidelines listed in ***Appendix B***.

39.3. EQUIPMENT MAINTENANCE AND BORE SIGHT CALIBRATION

All of the sensor equipment in the TML system shall have records documenting maintenance to the manufacturer's recommendation, including all repairs and adjustments to the sensors.

Sensor alignment (bore sighting) procedures sufficient to meet project accuracy requirements shall be performed and documented immediately before and after collecting the TML data for a project. This must be performed on site if the system has been disassembled for transport.

39.4. REDUNDANCY

TML data collection shall be conducted in such a manner as to ensure redundancy of the data. This means that more than one scan pass is necessary. The data shall be collected so that there is overlap between scan passes. The minimum amount of overlap along the sides of the scan passes should be 20%. More overlap is often necessary to cover critical areas where high accuracy surfaces are needed. The redundant passes can be made in the same direction or in opposite directions. A minimum of 15 minutes between the end of one pass and the beginning of the next overlapping pass is required. The objective is to ensure sufficient satellite constellation changes have occurred between passes, reducing the opportunity for bias in the GPS measurements.

39.5. MONITORING DATA COLLECTION

Monitoring various component operations during the scan session is an important step in the QA/QC process. The following is a list of minimum items that should be monitored and documented during TML data collection:

- Loss of GNSS reception
- Uncorrected IMU drift both in distance and time
- Proper functioning of the laser scanner
- Vehicle Speed

The system operator should be aware and note when the system encountered the most difficulty and be prepared to take appropriate action in adverse circumstances.

39.6. PROJECT CONTROL AND VALIDATION POINTS

In order to improve the project accuracy of the collected TML point cloud data, a project geometric correction must be applied. The two leading methods currently employed for this process both require targeted project control points visually identifiable in the TML point cloud (see ***Section 39.6.1***), measured independently, and having higher project accuracies than required for the TML data.

The preferred method incorporates simultaneous adjustment (least squares) of the raw navigation trajectory with weighted (constrained) project control points. This establishes the best trajectory and exterior orientation parameters for the LiDAR sensor (and any other sensors such as a camera). The best trajectory method produces improved results over the second method, and allows for sound relationships between multiple sensor data collected from the moving vehicle.

The other method is a least squares adjustment of the horizontal and vertical residuals between established project control points, and the corresponding values from the point clouds to produce the transformation parameters of translation, rotation, and scale for the horizontal values and an inclined plane for the vertical values. These parameters are then applied to the point cloud to produce more accurate final geospatial data within the localized area of control. This method should be used with caution especially in longer projects that may require segmented adjustments.

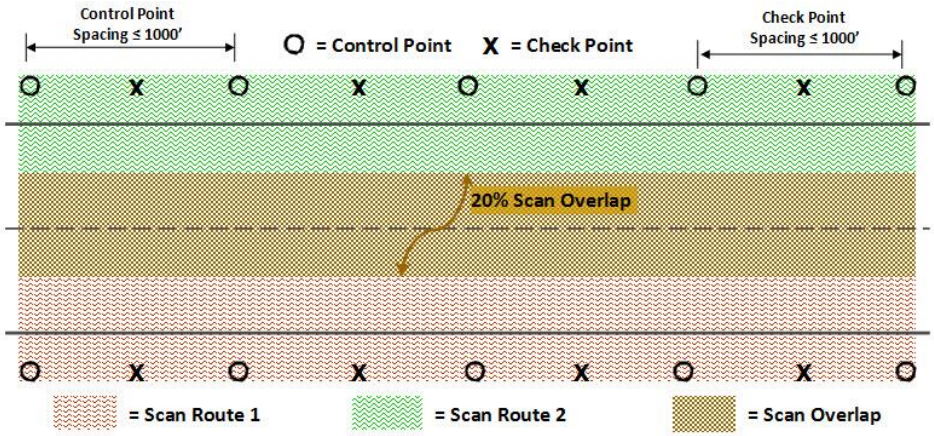
Check points must be established with the same project accuracies as the control. Check points by definition are not constrained in the adjustment of the TML data to project control points. Check points are to be used for statistical accuracy computations validating the adjusted TML point cloud.

Control and check point targets for Type A and Type B TML surveys must be of sufficient size and reflectivity to ensure identification and correct measurement within the point cloud.

The recommended geometry of Primary Project Control pairs should be located at the beginning, end, and evenly spaced throughout the project to ensure that the project TML collection area is bracketed. The recommended maximum distance with respect to route centerline stationing spacing between these points shall be based on the type of survey as defined in ***Section 36.1***. See ***Section 39.6.2*** for TML survey specifications.

Check point pairs are used to check the geospatial data adjustment. Check points should be located at the beginning, end, and evenly spaced throughout the project. The recommended maximum distance with respect to route centerline stationing spacing between these points shall be based on the type of survey as defined in ***Section 36.1*** portion of this handbook. See ***Section 39.6.2*** for TML survey specifications.

39.6.1. TYPICAL TML TYPE "A" PROJECT CONTROL AND VALIDATION POINT LAYOUT



Note: Since all projects are different, these are only recommendations. The Surveyor & Mapper in responsible charge of the TML must choose the appropriate accuracy and geometry of the Project Control Points and Validation Points to insure the TML survey data and products meet or surpass accuracy requirements of the project.

39.6.2. TML SURVEY SPECIFICATIONS

Operation/Specification	TML Survey		
	Type A	Type B	Type C
Bore sight calibration of TML system per manufacturers' specifications before and after project data collection.	Required		
Dual-frequency GNSS	Required; See Note 6		
IMU	Required; See Note 6		
DMI	Required; See Note 6		
GNSS positioning shall be constrained to project control.	Yes		See Note 10
Minimum horizontal (H) and vertical (V) accuracy for GNSS control base stations.	Must be of higher project accuracy than required for TML data.		
Minimum accuracy of Project Control Points and Validation Points	See Note 5		
	H ≤ 0.06 ft	H ≤ 0.10 ft	H and V

Operation/Specification	TML Survey		
	Type A	**Type B**	**Type C**
TML positional accuracy requirements relative to Project Control Points and Validation Points	V ≤ 0.06 ft	V ≤ 0.10 ft	See Note 5
Maximum post-processed baseline length	5 miles		10 miles
Minimum number of common healthy satellites in view for GNSS base stations and mobile scanner	See Notes 1 thru 4		
Maximum PDOP during TML data acquisition	5		
Allow sufficient time between overlapping collection passes to ensure change in satellite constellation. Recommend at least 3 different satellites in view.	Each Overlapping Pass		
Minimum overlapping coverage between adjacent runs	20%		
Minimum orbit ephemeris for kinematic post-processing	Broadcast		
Observations – sufficient point density to model objects	Each pass		
Vehicle speed – limit to maintain required point density	Each pass		
Minimum number of project transformation points required	4		
LiDAR point density requirements (see note 8)	(≥ 20 pts/ft²)	(≥ 10 pts/ft²)	See note 9
Recommended maximum spacing for Project Control Point pairs along the project corridor. Project Control Points should be located on each side of scanned roadway.	1000 ft intervals See Note 5	1500 ft intervals See Note 5	See note 5
Recommended maximum Validation Point spacing along the project corridor for QA purposes as safety conditions permit. (See Note 3)	1000 ft intervals See Note 5	1000-2500 ft intervals See Note 5	See Note 5

Operation/Specification	TML Survey		
	Type A	Type B	Type C
Minimum NSSDA Horizontal and Vertical Check Points	20 points - see note 7		

TML survey specifications notes:

1. Areas in the project that have poor satellite visibility should be identified and a plan to minimize the effect on the data developed.
2. If necessary project area shall be reconnoitered to determine the best time to collect the data to minimize GNSS outages and excessive artifacts in the data collection from surrounding traffic or other factors.
3. If safety conditions permit, additional Validation Points should be added in challenging GNSS environments such as urban canyons.
4. GNSS coverage of less than 5 satellites in view must not exceed the uncorrected position time or distance travelled capabilities of the TML system IMU.
5. Since all projects are different, these are only recommendations. The PSM in responsible charge of the TML must choose the appropriate accuracy and geometry of the Project Control Points and Validation Points to insure the TML survey data and products meet or surpass accuracy requirements of the project.
6. Manufacturer's specifications for precision must be sufficient for TML system to meet or surpass accuracy requirements of the project.
7. Validation Points may also serve as NSSDA check points to meet the requirements of this section. However, if critical areas of the point cloud are to be used outside of the locations of the Validation Points, then additional check points will be needed in those areas to meet this requirement.
8. The PSM in responsible charge must insure the mobile LiDAR collection achieves sufficient point density to support the required detail and accuracy of TML survey data and products. Point density should be verified through sample point spacing analysis using the formula:

$$Sample\ spacing = \sqrt{1/point\ density}$$

National Cooperative Highway Research Program (NCHRP) : Report 748. (2013). *Guidelines for the Use of Mobile LIDAR in Transportation Applications,* Research Board of the National Academy of Sciences.

9. Large surveys requiring less accuracy that do not have designated project control, may use other appropriate published control upon approval by Department.

39.7. ACCURACY ANALYSIS

The accuracy analysis of TML point cloud data shall conform to the NSSDA requirements for geospatial data classification as published by the FGDC in document FGDC-STD-007.3-1998 titled *Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy,* http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part3/chapter3). A minimum of 20 independent horizontal and vertical check points shall be measured and distributed to reflect the geographic area of interest and expected distribution of error in the data sets. The resulting comparisons shall meet or surpass the positional accuracy requirements for the survey at the 95% confidence level based on the NSSDA and shall be included in the survey report.

39.8. QUALITY ASSURANCE/QUALITY CONTROL

Engineering design survey data points collected using TML are checked by various means including comparing scan points to Validation Points, reviewing the digital terrain model, reviewing independent cross section data to scan surfaces, and redundant measurements. Redundant measurements with TML can only be accomplished by multiple scan runs or passes that offer overlapping coverage.

The TML data provider shall provide a Quality Assurance/Quality Control plan that includes descriptions of the proposed quality control and quality assurance plan. The plan shall address the requirements set forth in this document as well as other project specific QA/QC measures.

See ***Section 10.3*** for more information on Quality Assurance/Quality Control.

40. TML DELIVERABLES AND DOCUMENTATION

As stated earlier the origin and accuracy of the point cloud data must be supported by a survey report for it to be used with confidence, and to ensure the survey information and any byproducts are not misused.

Documentation of project TML survey(s) is an essential part of surveying work. The documentation of a scanning project must show a clear data lineage from the published primary control to the final deliverables. All project deliverables and documentation shall be included or clearly identified by reference in the survey report.

40.1. ALL TML TYPE DELIVERABLES

The first product deliverable for all TML Type surveys is an original post-processed geo-referenced point cloud in the latest (unless otherwise directed) ASPRS published LAS binary format file. Supporting documentation required but not limited to:

- Statistical system reports
- PDOP values during the survey
- Separation of forward and reverse solution (difference between forward and reverse post-process roll, pitch, yaw and XYZ positions solution).
- Areas of the project that the data collected exceeded the maximum elapsed time or distance traveled of uncorrected IMU drift due to GNSS signal loss or obstruction.
- Comparison of elevation data from overlapping (side lap) runs
- Comparison of points at the area of overlap (end lap) if more than one GNSS base is used.
- NSSDA report comparison

The most developed TML point cloud data has been adjusted, verified, and classified by subject type. A classified point cloud has the added value of having the individual points within it identified by class. All required classes should be specified in the contract scope as this task can be very time consuming.

40.1.1. LiDAR POINT CLASSES

ASPRS Standard LIDAR Point Classes	
Classification Value	Meaning
0	Created, never classified
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Reserved
9	Water
10	Rail
11	Road Surface
12	Reserved
13	Wire-Guard (Shield)
14	Wire-Conductor (Phase)
15	Transmission Tower
16	Wire-structure Connector (e.g. Insulator)
17	Bridge Deck
18	High Noise
19-63	Reserved
64-255	User definable

Note: The Department continues to review classifications for TML surveys on transportation projects. The DSMO should be consulted before point classification begins.

The only required class at this time is “Erroneous” used for points with compromised accuracies. The ASPRS Classification Value of 64 should be used for this class

64	Erroneous

Whenever possible the current ASPRS classifications should be followed at this time.

The project digital products shall be submitted to the Department on a portable external USB or fire wire computer drive accompanied by an itemized transmittal letter. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT. The digital media drive shall be labeled on the outside with the following information:

- Project title
- Survey report title
- Date of survey

- Financial Management Number
- Consultant name
- Name of PSM in responsible charge
- Central Office Image Tracking Number

The LAS file deliverable for TML Types A and B is the resulting original post processed point cloud from the sensor. The next form of the TML point cloud data is the transformed/adjusted point cloud also saved in an LAS specific binary format.

Supporting documentation required but not limited to:

- Statistical comparison of point cloud data and finished products to Validation Points.
- Statistical comparison of at least 5 cross sections showing differences between the surfaces created from adjusted point cloud data to cross sections collected from independent measurements of equal or higher accuracy.

The point cloud data is now ready to be imported into various software packages for further data analysis and feature extraction as well as fusing with other types of data and analytical tools creating a variety of value-added products.

The following digital products related to TML surveys that are applicable to the project shall be included:

- Binary LAS files of point cloud data from original scans
- Binary LAS files of adjusted and classified point cloud data
- Digital video or photo mosaic files
- FGDC compliant metadata files

Additional digital CADD products as covered in the current ***CADD Manual, Topic No. 625-050-001***.

- Topographic design files
- Surface / TIN files

40.2. TML SURVEY REPORT

The documentation of a mobile scanning project must show a clear data lineage from the published primary control to the final deliverables. The data path of the entire process must be defined, documented, assessable, and allow for identifying adjustment or modification. 3D data without a documented lineage is susceptible to imbedded mistakes, difficult to validate, and offers little or no reliability.

General Survey Report Content:

- Project name & identification: County, Route, Section, etc.
- Survey date, limits, and purpose
- Datum, epoch, and units
- Control found, held, and set for the survey
- Personnel, equipment, and surveying methods used
- Problems encountered
- Declare what TML Type A, B, or C accuracy was achieved
- Project base stations occupied
- Identification of control target points (transformation and validation)
- Results of constrained adjustment of TML data to project transformation control points
- QA/QC reports as described in ***Section 39.8*** portion of this handbook
- NSSDA analysis of Validation Points from ***Section 39.7*** portion of this handbook

All TML Surveying and Mapping products submitted shall be supported by a survey report containing at a minimum all information necessary to support the precision and accuracy of TML measurements and products, and meets the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers. To this end the survey report shall include but is not limited to the documentation and references to digital reports, products and media, identified in this document.

APPENDIX A

NOTES, DATA COLLECTION, AND DATA PROCESSING

1. NOTES AND NOTEKEEPING

Whether recorded electronically or by hand, field notes may be used by persons who are not familiar with the area, 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 this way. After processing and field verification, the database is exported to Department approved design software.

The method of collecting data should be reviewed with the Department before the project is begun to assure compatibility of the digital data with Department approved 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, the following guidelines apply:

- On the front cover of each field book, indicate in ink: the project number, the county in which the survey is made, and the contents of the book, e.g. *Bench Levels and Cross Sections*. On the back edge, in ink, indicate the book number and project number. See ***Figure 1*** below.

- Sample field book certification. See ***Figure 2*** below.

- Pages will not be removed from a field book. Incorrect or obsolete notes should be marked *VOID*, dated, and initialed. Numerical data will 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 pre-stamped 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*** below.

- 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 will be collected, organized and delivered to the DSMO.

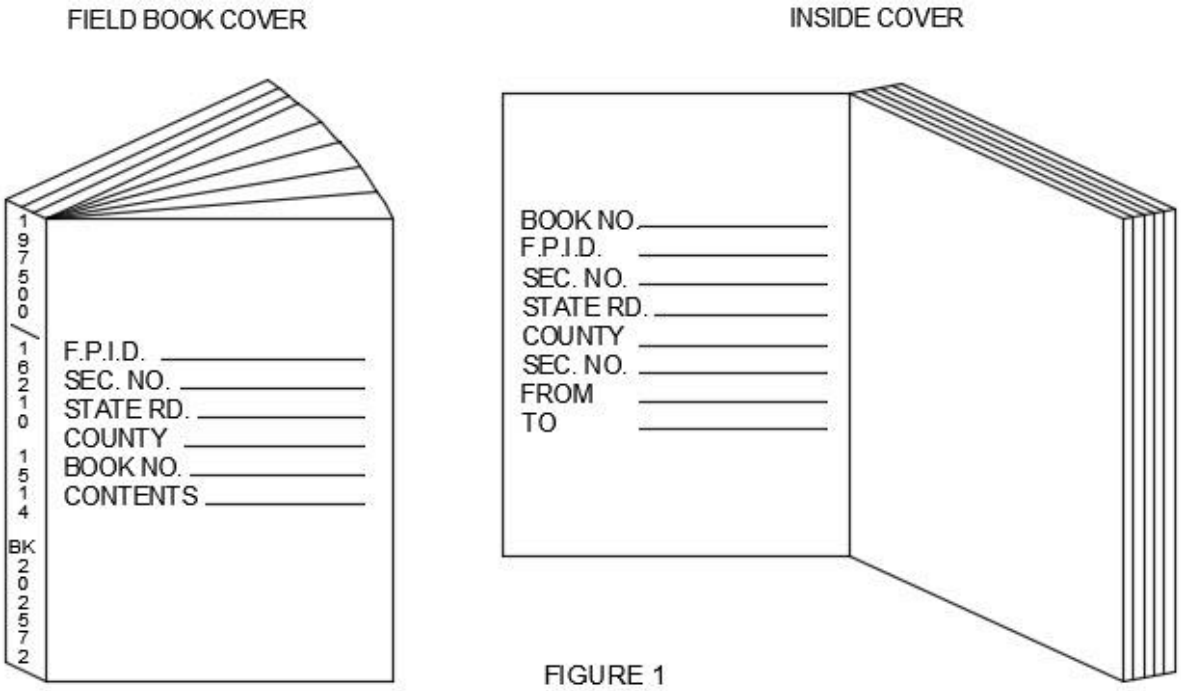


FIGURE 1

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 Standards of Practice adopted by the Florida Department of Agriculture and Consumer Services, Board of Professional Surveyors and Mappers.

CERTIFIED

Sign _____

Print Name _____

Florida Professional Surveyor and Mapper No. _____

Page(s) _____ Date _____

FIGURE 2

1.1. CERTIFIED FIELD BOOK

A certified field book may be kept to record the following information:

- Baseline alignment and references
- Bench levels and bench mark index
- DTM check cross sections

1.2. FIELD WORK BOOK

A segment/project field work book may be kept to record the following information. This information includes but is not limited to the following:

- Project network control, DTM survey, 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 the chain revision during post processing
- Notes to aid in post processing such as modifications to a series of points

2. ELECTRONIC SURVEY DATA COLLECTION

Electronic survey data collection applies to all methods of field survey that utilize electronic means to take 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, MicroStation, and Civil 3D.

2.1. CALIBRATION

Axis tests will be performed when using total stations, as defined in the ***EFB User Handbook***. The ***EFB User Handbook*** is available for download in portable document format (.pdf) within the file *EFB.ZIP* at:

http://www.dot.state.fl.us/surveyingandmapping/doc_pubs.shtm

2.2. CONTROL CHECK-IN

Control should be re-observed in direct and reverse telescope, recording horizontal angle, zenith angle, and slope distance as a check. To ensure that the setup is not disturbed, checking into the control must be done at a minimum of the beginning and end of each setup, but may need to be done more frequently in high risk areas.

2.3. ELECTRONIC MEASUREMENT METHODS

2.3.1. TOPOGRAPHY, DTM, AND R/W CONTROL SURVEY DATA

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

2.3.2. 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 producing 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.

2.3.3. 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 degrees. Height of instrument (HI) and the height of the 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.

2.3.3.1. HVD OBSERAVTIONS

Refer to the ***EFB User's Handbook*** for feature coding and attributing of points and chains.

2.3.4. 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 the 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.

2.3.4.1. SOR OBSERVATIONS

Setup 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.

3. TOPOGRAPHY

All topographic features such as roadbeds, asphalt aprons, curbs and gutters, utility poles, trees, etc. should be observed in HVD mode. All points and chains relating to the ground surface model have a ground (*G*) attribute. Only those points and chains on the ground surface are used in computing the DTM. Topography and DTM surveys should be performed in HVD or SOR mode. Horizontal angle, zenith angle, slope distance (HVD) observations should not be made for distances greater than 500 feet to ensure accurate trigonometric elevations.

3.1. CHAINS

A chain is the ordered connection of points that define the boundary of an object. 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 ***Section 3.2.1. of Appendix A***). Each point along a specific chain is observed, recording the horizontal and vertical position. These points are the horizontal and vertical breaks along the chain and contain point (P) geometry or curve (C) geometry.

3.1.1. GROUND

Ground survey chains are all those break lines, as defined above, that lie on the ground surface. Ground chains are the profiles along the distinct breaks in the ground surface model. Ground chains will contain only ground points.

3.1.2. BREAK LINES

A break line is a profile line 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 roadbeds, curbs and gutters, sidewalks, shoulders, tops of endwalls, tops of slopes, ditch bottoms, etc.

3.2. POINTS

3.2.1. 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.

3.2.2. 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 top of the hydrant. The elevation of this point will not be used when computing the DTM although its elevation is determined during post processing.

3.2.3. 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 judgment of the PSM in responsible charge based on the project requirements of the existing ground surface, and on knowledge of the data collection/DTM system.

3.3. 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's Handbook***. The PSM in responsible charge should meet with the DSMO to set check cross-section requirements.

4. 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 computer in which the segmenting is accomplished directly on the pc. The second method involves seeding the segment forward from the EFB file menu. Now two segments exist on the data collector, the previously collected segment and the newly created segment. By seeding the segment forward, the project names and chain names are copying from the previous segment over to the new segment. This resolves the segmenting issue and activates the data collection program 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 a suitable crew designation, e.g., the party chief's initials, as a prefix to the segment names, point names, and chain names. If a crew is assigned a different project, end the segment by checking into control and downloading and archiving the partial segment. Download each crew's data at least daily.

5. DATA PROCESSING

Processing begins with downloading the segment data files to a computer and backing up the files. The data should be downloaded to a separate directory and archived unedited. Copy the files to the working directory for processing. The EFB field files are as follows:

- *filename.SDF* – Database format observation file containing all the recorded data in the segment.

The binary observation file, *filename.SDF,* is translated to an ASCII file, *filename.OBS.* 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. Revisions are documented in *filename.OBS* by adding remark records at the corresponding revisions. This procedure ensures 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 the SOR observations are stored in the .SDF file. For a more detailed discussion of processing EFB data, see the ***EFB User's Handbook***, the ***EFB Processing System Handbook***, and the ***EFB Processing System Handbook – Technical Reference***.

The *filename.XYZ* file is then imported or merged into a coordinate geometry database imported into the database. The project alignment and other important alignments are computed and/or stored in the database. SOR data is imported into the database after the proper alignments are stored.

6. GRAPHICAL ANALYSIS

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

The data should be viewed in 3D to confirm that the survey chains are oriented correctly in the vertical plane. 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, the DTM triangles should be computed and then verified. The most common method of DTM verification is by comparing the computed cross-sections with the check cross-sections. Discrepancies must be investigated and corrected.

7. QUALITY CONTROL

See ***Section 10.3*** for information on the QA/QC Plan.

8. DELIVERABLES

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

- The raw, unedited field data files

After 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 DSMO.

APPENDIX B

GNSS GUIDELINES

1. TYPES OF GNSS SURVEYS

- **Static GNSS (SGNSS)** - Carrier phase differencing technique where the integer ambiguities are resolved from an extended observation period through a change in satellite geometry.
- **Rapid Static GNSS (RSGNSS)** – Requires shorter occupation times than static positioning and may use a radial baseline technique, network technique, or a combination of the two.
- **Real-Time GNSS (RT)** – Uses measurements of the phase of the signal′s carrier wave, rather than the information content of the signal, and relies on a single reference station to provide real-time corrections.
- **Real-Time Network GNSS (RTN)** – A variation of RT GNSS surveying. Rather than setting up a base station on the project, a number of permanent and continuously operating base stations are set up providing the augmentation to the basic position as determined at the rover.

2. NETWORK DESIGN PLAN

Every project that uses GNSS technology will have an NDP submitted and approved by the Department prior to the commencement of work.

2.1. REQUIREMENTS

- Every NDP will include:
    - the type(s) of GNSS surveys proposed.
    - the layout of the network geometry submitted in .pdf or other Department approved format.
    - the defined RT GNSS survey areas, if any.
    - the control monumentation data sheets for existing control stations to be utilized.
    - the datums for all surveys.
    - the identification, i.e., brand and model of equipment to be used.

3. GNSS EQUIPMENT

Equipment for all GNSS survey activities will be multi-frequency, survey grade, carrier phase, geodetic receivers and antennas unless prior written approval is obtained from the Department.

4. ACCURACY REQUIREMENTS

Accuracy requirements are point type specific.

Use the current Department approved network adjustment for the final adjustment. All vectors used in the adjustment will be independent vectors.

See **Appendix C** for accuracy requirements.

5. POINT TYPES

5.1. STATEWIDE NETWORK CONTROL (FPRN)

The FPRN will serve as the Statewide Network Control for all Department projects. All newly established control will be constrained to the FPRN. Every project using RT methods will use the current correctors broadcast by the FPRN.

5.2. PRIMARY PROJECT CONTROL (PPC)

Raw data file converted to RINEX, open source, or Department approved format and delivered in electronic form for each session.

5.2.1. OBSERVATIONS

A minimum of 2 observations with a 4 hour differential is required for all primary project control.

5.2.2. LOCALIZATION

All transformations should be constrained by a minimum of 3 horizontal and 3 vertical stations (a station can represent both a horizontal and vertical constraint) in the project vicinity with published coordinate values in the project specified system.

5.2.3. DELIVERABLES

Raw data file converted to RINEX, open source, or Department approved format and delivered in electronic form for each session.

5.2.4. ACCURACY REQUIREMENTS

See **Appendix C** for accuracy requirements.

5.2.5. BEST PRACTICES

Primary Project Control should be used for the following:

- Project Control
- Low Altitude Aerial Control
- Benchmarks

5.3. SECONDARY PROJECT CONTROL

5.3.1. OBSERVATIONS

A minimum of 2 observations with a 4 hour differential is required for all secondary control.

5.3.2. LOCALIZATION

All transformations should be constrained by a minimum of 3 horizontal and 3 vertical stations (a station can represent both a horizontal and vertical constraint) in the project vicinity with published coordinate values in the project specified system.

5.3.3. DELIVERABLES

Raw data file converted to RINEX, open source, or Department approved format and delivered in electronic form for each session.

5.3.4. ACCURACY REQUIREMENTS

See ***Appendix C*** for accuracy requirements.

5.3.5. BEST PRACTICES

Secondary Project Control should be used for the following:

- Secondary Project Control
- High Altitude Aerial Control
- Terrestrial Mobile LiDAR Type A Control
- Aerial LiDAR Control
- Alignment Control

5.4. PROJECT VALIDATION CONTROL

5.4.1. ESTABLISHMENT OF VALIDATION POINTS

5.4.1.1. REQUIREMENTS

Validation Points will be established with the following requirements:

5.4.1.2. REDUNDANCY

- Low Altitude Aerial Control, High Altitude Aerial Control, Terrestrial Mobile LiDAR Type A Control, and Aerial LiDAR Control.

    - Validation Points placed at 1000 foot intervals within collection area, on each side of corridor, with a minimum of 20.
- Terrestrial Mobile LiDAR Type B Control
    - Validation Points placed at 1500 foot intervals within collection area, with a minimum of 20.
- Location and Topography
    - Validation Points placed at 1 mile intervals within collection area, with a minimum of 2.

5.4.2. OBSERVATIONS

A minimum of 3 observations with a half hour differential is required for all Project Validation Control.

5.4.3. LOCALIZATION

All transformations should be constrained by a minimum of 3 horizontal and 3 vertical stations (a station can represent both a horizontal and vertical constraint) in the project vicinity with published coordinate values in the project specified system.

5.4.4. DELIVERABLES

Project Validation Control data sets should not exceed 24 hours in length and will be submitted in a Department approved format and delivered in electronic form for each session.

5.4.5. ACCURACY REQUIREMENTS

See ***Appendix C*** for accuracy requirements.

5.4.6. BEST PRACTICES

Project Validation Control should be used for the following:

- Validation Points
- Terrestrial Mobile LiDAR Control
- Monumentation
- Alignment References
- Right of Way Markers

5.5. LOCATION AND TOPOGRAPHY

5.5.1. VALIDATION POINT CHECK-IN

Location and topography data sets will check into validation points before beginning each day’s data collection, at a minimum of every 2 hours thereafter, and at the conclusion of the day’s data collection.

5.5.2. OBSERVATIONS

Typical observations are RT single epoch. This will be the acceptable procedure for both data collection and validation point check-in.

5.5.3. DELIVERABLES

Location and topography data sets should not exceed 24 hours in length and will be submitted in a Department approved format and delivered in electronic form for each session

5.5.4. ACCURACY REQUIREMENTS

See ***Appendix C*** for accuracy requirements.

5.5.5. BEST PRACTICES

Location and topography should be used for the following:

- Validation Point check-in
- Photo Identification Points
- Location
- Topography
- Subsurface Utilities

5.6. SURVEY REPORT

When GNSS is used on a project, the survey report should contain standard content.

- When using OPUS Projects as the final adjustment software, a least squares network solution must be applied.
- When using Vector NT as the final adjustment software, all input, output, and point tolerance ASCII files must be provided.
- If localizing, a transformation report must be provided.

See ***Section 10*** and ***Appendix E*** for information on survey reports.

APPENDIX C

ACCURACY REQUIREMENTS

Point Type	Point Usage (Best Practices)	Horizontal Accuracy		Vertical Accuracy
Statewide Network Control	FPRN	Fixed		Fixed
Primary Project Control	Project Control Low Altitude Aerial Network Control Benchmarks*	0.04'	0.012m	Standards of Practice
Secondary Project Control	Secondary Project Control High Altitude Aerial Network Control TML Type A Control Aerial LiDAR Control Alignment Control (no vertical requirement) Automated Machine Guidance Control	0.06'	0.018m	Standards of Practice
Project Validation Control	Validation Points TML Type B Control Monumentation (no vertical requirement) Alignment References (no vertical requirement) Right-of-way Markers (no vertical requirement)	0.08'	0.024m	Standards of Practice
Location and Topography	Validation Point Check-in Photo Identification Points Subsurface Utilities - Level A Utility Locates Location and Topography	0.10'	0.030m	Standards of Practice

Point Density	Horizontal Density Points / Sq. Ft.	Relative Vertical Position		
Low Density	< 3 points	0.10'		0.030m
Medium Density	3-9 points	0.05'		0.015m
High Density	> 9 points	0.02'		0.006m

APPENDIX D

FORMS

For standardization, this section contains sample forms to be used for survey project submittals. However, there may be other District specific forms that are required in addition to the forms shown in this section. See the DSMO for District specific forms.

Standards of Practice Checklist

Right of Way Requirement Changes Tracking Form

FDOT Project Log

Percentage of Field Work Complete Form

Percentage of Control Map Complete Form

Percentage of Right of Way Map Complete Form

Weekly Report of Survey Activities

Standards of Practice Checklist

5J-17.051 General Survey, Map, and Report Content Requirements

(1) Nothing in these rules shall preclude a surveyor and mapper from entering into a contract with a client which requires more stringent surveying standards than those set forth in this rule.

(2) Survey Data:

(a) REGULATORY OBJECTIVE: The public must be able to rely on the accuracy of measurements and maps produced by a surveyor and mapper.

(b) Surveyors and mappers must achieve the following minimum standards of accuracy, completeness, and quality:

☐1. The accuracy of the survey measurements shall be premised upon the type of survey and the expected use of the survey and map.

☐All measurements must be in accordance with the United States standard, using either feet or meters.

☐2. Records of these measurements shall be maintained for each survey by either the individual surveyor and mapper or the surveying and mapping business entity.

☐3. Measurement and computation records must be dated

☐Measurement and computation records must contain sufficient data to substantiate the survey map

☐Measurement and computation records must support the accuracy statement (closure calculations or redundant measurements, if applicable.)

(3) Surveys, Maps, and/or Survey Products Content.

☐(a) REGULATORY OBJECTIVE: In order to avoid misuse of a survey and map, the surveyor and mapper must adequately communicate the survey results to the public through a map, report, or report with an attached map. Any survey map or report must identify the responsible surveyor and mapper and contain standard content.

(b) Surveyors and mappers must meet the following minimum standards of accuracy, completeness, and quality:

☐1. Each survey map and report shall state the type of survey it depicts consistent with the types of surveys defined in paragraphs 5J-17.050(10)(a)-(k), F.A.C. The purpose of a survey, as set out in paragraphs 5J-17.050(10)(a)-(k), F.A.C., dictates the type of survey to be performed and depicted, and a licensee may not avoid the minimum standards required by rule of a particular survey type merely by changing the name of the survey type to conform with what standards or lack of them the licensee chooses to follow.

Type of Survey stated on map and report

☐As-built

☐Boundary Survey

☐ Condominium Survey

☐Construction Layout Survey

☐Control Survey

☐Hydrographic Survey

☐Mean High Water Line Survey

☐Quantity Survey

☐Record Survey

☐Specific or Special Purpose Survey

☐Topographic Survey

2. All survey maps and reports must:

☐Bear the name, cert. of authorization number, street and mailing address of the business entity on the map and report

☐Display the name and license number of the surveyor and mapper in responsible charge.

☐State the name, license number, and street and mailing address of a surveyor and mapper practicing independent of any business entity on each survey map and report.

☐3. All survey maps must reflect a survey date, which is the date of data acquisition. When the graphics of a map are revised, but the survey date stays the same, the map must list dates for all revisions.

☐4. The survey map and report and the copies of the survey map and report, except those with electronic signature and electronic seal, must contain a statement indicating that the survey map and report or the copies thereof are not valid without the signature and the original raised seal of a Florida licensed surveyor and mapper.

☐5. If either the business entity or the individual licensee does not possess professional liability insurance, then the map, report, and/or survey must contain the following printed statement in

letters at least 1/4" high: The survey depicted here is not covered by professional liability insurance.

☐6. Additions or deletions to survey maps or reports by other than the signing party or parties is prohibited without written consent of the signing party or parties.

☐7. All computed data or plotted features shown on survey maps must be supported by accurate survey measurements unless clearly stated otherwise.

☐8. Bearings, distances, coordinates, and elevations shown on a survey map shall be substantiated by survey measurements unless clearly stated otherwise.

☐9. A reference to all bearings shown on a survey map or report must be clearly stated, i.e., whether to “True North”; “Grid North as established by the NOS”; “Assumed North based on a bearing for a well defined line, such as the center line of a road or right of way, etc.”; “a Deed Call for a particular line”; or “the bearing of a particular line shown upon a plat.” References to Magnetic North should be avoided except in the cases where a comparison is necessitated by a Deed Call. In all cases, the bearings used shall be referenced to some well-established and monumented line.

☐10. A designated “north arrow” is shown prominently upon the survey map.

☐ A stated scale or graphic scale

☐11. Abbreviations generally used by the public or in proper names that do not relate to matters of survey are excluded from the legend requirement.

a. Acceptable abbreviations on the face of survey maps are:

N = North

S = South

E = East

W = West

or any combination such as NE, SW, etc.

º = Degrees

' = Minutes when used in a bearing

" = Seconds when used in a bearing

' = Feet when used in a distance

" = Inches when used in a distance

AC = Acres

+/- = More or less (or Plus or Minus)

metric notation (m = meters, cm = centimeters, km = kilometers, etc.)

☐b. Any other abbreviations relating to survey matters must be clearly shown within a legend or notes appearing on the face of the map or report.

☐12. When special conditions exist that effectively prevent the survey from meeting these minimum standards, the special conditions and any necessary deviation from the standards shall be noted upon the map or report.

13. The map or report must:

☐Clearly state the licensee who is responsible for all mapped features stated on the map or report.

☐Clearly state the individual licensee primarily responsible for the map or report when mapped features have been integrated with others.

14. Report Items:

☐a. Report items are information, such as: abbreviations, legends, accuracy statements, feature lists, datums used, and things done or not done as part of the survey and mapping process.

☐The map or report shall contain other items necessary for an adequate communication of survey methods and results as judged by the surveyor and mapper such as: data sources, measurement methods, history and lineage of data, and limitations pertaining to the information presented.

☐b. Text Report items shall be displayed either through notes on the map, report, or in a text report delivered with the map.

☐When the report is produced as a hardcopy (paper) document and a map is attached, the report shall be signed and sealed.

☐When the map is delivered in digital form only, then a report is required.

☐An attached map must clearly reference the report by title, date and subject; and the report must likewise clearly refer to the map by title, date, and subject.

☐Statements must be made on the map and in the report that neither is full and complete without the other.

15. Map Accuracy.

a. Vertical Feature Accuracy:

☐Vertical Control: Field-measured control for elevation information shown upon survey maps or reports shall be based on a level loop or closure to a second benchmark.

☐Closure in feet must be accurate to a standard of plus or minus .05 ft. times the square root of the distance in miles.

☐All surveys and maps or reports with elevation data shall indicate the datum and a description of the benchmark(s) upon which the survey is based.

☐Minor elevation data may be obtained on an assumed datum provided the base elevation of the datum is obviously different than the established datum.

b. Horizontal Feature Accuracy:

☐i. Horizontal Control: All surveys and maps or reports expressing or displaying features in a publicly published coordinate system shall indicate the coordinate datum and a description of the control points upon which the survey is based.

☐Minor coordinate data may be obtained and used on an assumed datum provided the numerical basis of the datum is obviously different than a publicly published datum.

☐ii. The accuracy of control survey data shall be verified by redundant measurements or traverse closures. All control measurements shall achieve the following closures:

Commercial/High Risk Linear: 1 foot in 10,000 feet;

Suburban: Linear: 1 foot in 7,500 feet;

Rural: Linear: 1 foot in 5,000 feet;

☐iii. When statistical procedures are used to calculate survey accuracies, the maximum acceptable positional tolerance, based on the 95% confidence level, should meet the same equivalent relative distance standards as set forth in sub-paragraphs 5J-17.051(3)(b)15.b.ii., F.A.C.

☐iv. Intended Display Scale: All maps or reports of surveys produced and delivered with digital coordinate files must contain a statement to the effect of: “This map is intended to be displayed at a scale of 1/__ or smaller”.

<u>5J-17.052 Specific Survey, Map, and Report Requirements.</u>

(1) As-Built/Record Survey:

☐(a) When performing as-built or record surveys, the surveyor and mapper shall obtain field measurements of vertical or horizontal dimensions of constructed improvements so that the

constructed facility can be delineated in such a way that the location of the construction may be compared with the construction plans.

☐(b) When the surveyor and mapper prepare as-built maps they will clearly show by symbols, notations, or delineations, those constructed improvements located by the survey.

☐(c) All maps prepared shall meet applicable standards of practice.

☐(d) The vertical and horizontal accuracy of the measurements made shall be such that it may be determined whether the improvements were constructed consistent with planned locations.

(2) Boundary Survey, Map, and Report:

(a) Boundaries of Real Property:

☐1. The surveyor and mapper shall make a determination of the position of the boundary of real property in complete accord with the real property description shown on or attached to the survey map or report.

☐2. All boundary surveys shall result in a map.

☐3. Any discrepancies between the survey map and the real property description must be shown.

☐4. All changes in direction, including curves, shall be shown on the survey map by angles, bearings or azimuths, and will be in the same form as the description or other recorded document referenced on the map.

☐5. Curved lines with circular curves shall show the radii, arc distances and central angles, or radii, arc distances, chord distances and chord bearings.

☐6. When intersecting lines are non-radial to a curve, sufficient angular data shall be shown to relate the line to the curve.

☐7. Surveys of all or part of a lot(s) which is part of a recorded subdivision shall show the following upon the map:

☐a. The lot(s) and block numbers or other designations, including those of adjoining lots.

☐b. A comparison between recorded directions and distances with field measured directions and distances when they vary.

☐c. A comparison between the recorded directions and distances with field measured directions and distances to the nearest street intersection, right of way intersection or other identifiable reference point.

☐d. The dimensioned remaining portion of a lot(s) when part of a lot is included within the description.

8. Surveys of parcels described by metes and bounds shall show the following upon the map:

☐a. The relationship of the parcel(s) to at least one established identifiable real property corner;

☐b. All information called for in the property description, such as point of commencement, course bearings and distances, and point of beginning;

☐c. A comparison between recorded directions and distances and field measured directions and distances on the boundary when they vary;

☐d. The most current abutting recorded instrument or recorded plat either known by the surveyor and mapper or furnished to the surveyor and mapper.

(b) Boundary Monuments:

1. The surveyor and mapper shall:

☐Set monuments as defined herein, unless monuments already exist or cannot be set due to physical obstructions at such corners or unless a water boundary has been located in approximate position.

☐Clearly label all approximate water boundaries with notes and these shall be mapped in a distinctly different graphic fashion from water boundaries located to full survey accuracy.

2. Every boundary monument set shall:

☐a. Be composed of a durable material;

☐b. Have a minimal length of 18 inches;

☐c. Have a minimum cross-section area of material of 0.2 square inches;

☐d. Be identified with a durable marker or cap bearing either the Florida license number of the surveyor and mapper in responsible charge, the certificate of authorization number of the business entity; or name of the business entity;

☐e. Be detectable with conventional instruments for finding ferrous or magnetic objects.

☐f. When a corner falls in a hard surface such as asphalt or concrete, alternate monumentation may be used that is durable and identifiable.

☐3. All monuments, found or placed, must be described on the survey map.

☐The corner descriptions shall state the size, material, and cap identification of the monument as well as whether the monument was found or set.

☐4. When a parcel has an irregular roadway as a boundary, such as a dirt road or a common law road, then a monumented meander or survey line shall be established along or near the feature.

☐5. For other irregular boundaries such as a river, lake, beach, marsh or stream, not identified as in subparagraph 5J-17.052(2)(a)1., F.A.C., a dimensioned meander or survey line may be used.

☐When a meander or survey line is used, monuments shall be set at the meander or survey line's terminus points on real property boundary lines and dimensions shall be shown between a meander or survey line and the boundary line sufficient to show the relationship between the two.

6. A boundary survey updating a previous survey made by the same surveyor and mapper or business entity, and which is performed for the purpose of locating non-completed new improvements by measurements to the property lines or related offset lines placed on the property since the previous survey, need not have the property corners reset.

☐7. Side ties to locate or set monuments shall be substantiated by a redundancy of measurements.

(c) Boundary Inconsistencies:

☐1. Potential boundary inconsistencies that the survey process did not attempt to detect shall be clearly indicated and explained on the survey map or in the report. Where evidence of inconsistency is found, the nature of the inconsistency shall be shown upon the survey map, such as:

☐ a. Overlapping descriptions or hiatuses;

☐ b. Excess or deficiency;

☐c. Conflicting boundary lines or monuments; or

☐d. Doubt as to the location on the ground of survey lines or property rights.

☐2. Open and notorious evidence of boundary lines, such as fences, walls, buildings, monuments or otherwise, shall be shown upon the map, together with dimensions sufficient to show their relationship to the boundary line(s).

☐3. All apparent physical use onto or from adjoining property must be indicated, with the extent of such use shown or noted upon the map.

☐4. In all cases where foundations may violate deed or easement lines and are beneath the surface, failure to determine their location shall be noted upon the map or report.

(d) Rights-of-Way, Easements, and Other Real Property Concerns:

☐1. All recorded public and private rights-of-way shown on applicable recorded plats adjoining or across the land being surveyed shall be located and shown upon the map.

☐2. Easements shown on applicable record plats or open and notorious evidence of easements or rights-of-way on or across the land being surveyed shall be located and shown upon the map.

☐3. When streets or street rights-of-way abutting the land surveyed are physically closed to travel, a note to this effect shall be shown upon the map.

☐4. When location of easements or rights-of-way of record, other than those on record plats, is required, this information must be furnished to the surveyor and mapper.

☐ 5. Human cemeteries and burial grounds located within the premises shall be located and shown upon the map when open and notorious, or when knowledge of their existence and location is furnished to the surveyor and mapper.

(e) Real Property Improvements:

☐ 1. Location of fixed improvements pertinent to the survey shall be graphically shown upon the map and their positions shall be dimensioned in reference to the boundaries, either directly or by offset lines.

☐ 2. When fixed improvements are not located or do not exist, a note to this effect shall be shown upon the map.

☐ 3. Building corners are acceptable as monumentation so long as use of building corners as monumentation is clearly noted on survey drawing.

☐4. When a boundary survey updating a previous boundary survey is made by the same surveyor or survey firm for purpose of locating non-completed new improvements, then property corners need not be reset; however, when a boundary survey is updating a previous survey made by the same surveyor or survey firm and is performed for purpose of locating completed new improvements then property corners must be recovered or reset. When a boundary survey updates a previous boundary survey made by a different surveyor or survey firm for the purpose of locating either non-completed or completed new improvements, then property corners must be recovered or reset.

(3) Construction Layout Survey:

☐(a) When the surveyor and mapper provides construction staking, these stakes must be based on controls established using the survey standards set out in Rules 5J-17.051 and 5J-17.052, F.A.C., of this chapter. The stakes provided should be adequate in number and position so that the physical items can be constructed from the plans as designed.

☐(b) Horizontal and Vertical Controls for Public and Private Construction Layout:

1. Section 472.003(3), Florida Statutes, provides an exemption from licensing for certain classes of individuals performing construction layout from boundary, horizontal and vertical controls that have been established by a licensed professional surveyor and mapper. This rule is designed to set out what constitutes horizontal and vertical controls.

a. Horizontal control monumentation for the purpose of this rule includes:

☐(I) Points of Curve, Points of Tangency, Points of Tangent Intersections, Points on Line and Points on Curve.

☐(II) Points of Intersection of other streets or roads.

☐(III) Angle points or changes in direction.

☐b. Horizontal control monumentation for road center-lines, right-of-way lines, reference lines or base lines shall be at least a minimum of two (2) points placed so that no point on the line being monumented is more than 700 feet from a control monument.

☐c. Horizontal control monumentation for main utility lines (such as water, sewer, storm drainage, electric, telephone, television, gas, etc.) when not constructed within or along a road right-of-way control in accordance with sub-subparagraph 5J-17.052(3)(b)1.b.,F.A.C., shall be at least a minimum of two (2) points placed so that no point on the line being monumented is more than 700 feet from a control monument.

d. Horizontal control monumentation for buildings and/or primary constructions shall be at least:

☐(I) Boundaries, or

☐(II) Control or base lines (minimum of 2 points), or

☐(III) A minimum of a four-corner envelope for non-residential construction improvement layout.

☐e. Horizontal control monumentation required by plans as a control for horizontal location not included in sub-subparagraph 5J-17.052(3)(b)1.b., c., or d., F.A.C., shall meet the requirements of sub-subparagraph 5J-17.052(3)(b)2., F.A.C.

☐(c) All construction requiring benchmarks shall have a minimum of two (2) existent or established benchmarks for vertical control.

☐(d) Vertical control for linear type construction sites such as roads and sewer lines shall have a maximum of 1,100 feet between existent or established benchmarks.

☐(e) Vertical control for acreage construction sites shall have two (2) existent or established benchmarks on the first ten (10) acres plus an additional benchmark for each additional ten (10) acres.

☐(f) The only required documentation for this type of survey product shall be field notes.

(4) Control Survey:

☐(a) Geodetic Control Surveys: When applicable, all geodetic control surveys, both vertical and horizontal, shall conform to the Standards and Specifications for Geodetic Control Networks (1984) as set forth by the Federal Geodetic Control Committee (FGCC), which Standards and Specifications are incorporated herein by reference, effective 5-13-96, and the Geospatial Positioning Accuracy Standards Parts 1, 2, and 3, FGDC-STD-007.1-1998, entitled “Geospatial Positioning Accuracy Standards Part 2: Standards for Geodetic Networks”, and FGDC-STD-007.3-1998, entitled “Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy”, which are hereby incorporated by reference, effective 5-18-00, copies of which may be obtained via the internet web site (http://fgdc.gov/standards_publications/). No use of the terminology of these standards may be made without completely adopting and following all the standards in their entirety. When these standards are not employed, then a survey, map, or report shall explain applicable standards used in the geodetic control survey. All geodetic control survey maps or reports shall show the horizontal and vertical datum used and shall contain adequate graphical or written descriptions of the locations, construction and marking of all marks used or set and shall explain methods employed in the survey and adjustment.

☐(b) Other Control Surveys: Any control survey map or report shall detail the datum used and control stations used in a manner consistent with the general survey and map provisions of subsection 5J-17.051, F.A.C.

(5) Descriptions/Sketch to Accompany Description:

☐(a) Descriptions written by a surveyor and mapper to describe land boundaries by metes and bounds shall provide definitive identification of boundary lines.

(b) When a sketch accompanies the property description, it shall:

☐Show all information referenced in the description

☐State that such sketch is not a survey.

☐Contain an initial point in the description that shall be tied to either a government corner, a recorded corner, or some other well-established survey point.

(6) Digital Data:

☐(a) When survey information is provided in digital form only, the surveyor and mapper shall provide a signed and sealed report as set forth in paragraph 5J-17.051(3)(b)14.b., F.A.C.

(b) The digital file will reference the report and that

☐The digital file is not full and complete without the report.

(7) Ortho-Images/Photos:

☐(a) The survey, map, and/or report must contain a list of control points employed in geo-referencing the image along with the source of control positions used.

☐(b) Positional Accuracy: Feature accuracies shall be stated.

☐(c) The Ortho-Image/Photo shall comply with the December 1996 US Department of the Interior, US Geological Survey National Mapping Divisions, "National Mapping Program Technical Instructions Part 2 Specifications Standards for Digital Orthophotos," which are incorporated herein by reference.

☐(8) Quantity Survey: The surveyor and mapper shall obtain horizontal and vertical measurements adequate to delineate graphically geometric configurations and/or dimensions that can be mathematically computed.

(9) Raster Imagery:

(a) The survey and report must contain:

☐A list of control points employed in geo-referencing the image along with the source of control positions used.

☐A statement clearly stating that "This is not an ortho-image or ortho-photo."

☐(b) Feature accuracies shall be stated.

(10) Subdivision Record Plat: This rule shall not apply to plats being prepared for filing and recording pursuant to Chapter 177, Florida Statutes; however, this rule shall apply to any boundary survey performed during the preparation of the plat.

(11) Specific Purpose Survey:

☐ (a) Surveys which are performed for a purpose other than the purposes encompassed by the definitions in paragraphs 5J17.050(10)(a)-(i) or (k), F.A.C., shall be permitted only where unusual conditions make impracticable or impossible the performance of one of the types of surveys defined in paragraphs 5J-17.050(10)(a)-(i) or (k), F.A.C.

☐ (b) Such purpose and conditions shall be clearly shown upon the survey map or in the survey report.

☐ (c) Surveys performed for purposes of monumenting, referencing, describing, and mapping centerline or baseline may be performed as Specific Purpose Surveys. Additionally, surveys performed for the purpose of monumenting official right-of-way lines may be performed as Specific Purpose Surveys.

(12) Topographic Survey:

☐ (a) Topographic surveying and mapping by field methods shall meet general provisions applicable to all surveys and maps as set out in Rule 5J-17.051, F.A.C. A minimum of two site benchmarks on or near the survey shall be indicated upon the survey map.

☐ (b) Topographic Features.

1. Intended Features.

☐ Can you correctly interpret the intended map coverage?

☐ Report which topographic features were intended to be surveyed and mapped

☐ The style of cartographic representation employed for each feature

☐ Degree of intended completeness in the surveying and mapping of each feature stated.

☐ As with abbreviations, any symbols, line types, etc. shown on the survey map shall be explained and/or defined in a legend.

2. Obscured Areas.

☐ Features in obscured areas where the desired points or surfaces being mapped are not clearly visible on source images shall be clearly labeled on the map as “interpolated” or “estimated” through the use of notes

☐ Features in obstructed areas are depicted graphically clearly different from other surveyed features.

☐ 3. Scale of Map. The scale of the map that is selected when provided in hard copy shall be sufficient to accurately and clearly show the results of the survey.

☐ 4. Property Lines. Any depiction of property lines on a topographic map shall be accompanied with a statement as to the source of the property lines shown.

Right of Way Requirement Changes Tracking Form

Form Created: June 07, 2004; Updated; June 05, 2009, April 24, 2012, October 07, 2013, August 6,2015

FPN:	Section:	Project Description:		FDOT PM:
Design Firm:		EOR Name:	Signature:	Date:
60% Phase II Plans Approved/Comment Resolution Date:		R/W Req. & LOC to S&M (start 60% Map) Date:	60% Mapping Team Meeting (Parcel by Parcel Review) Date: Initial No. of Parcels:	
100% R/W Map Complete Date:		DOC's to R/W Date:	Final No. of Parcels:	
List Dates for Each Time Form is Updated With Changes:				

(1) All dates are actual, not scheduled dates.
(2) All rows are expanding, so please provide sufficient detail as required. To insert a row go to Table, Insert, Rows (this allows the form to be kept in Parcel No. order).
(3) The first four (4) columns below will be completed for all requirements/parcels with the initial date added being the same date r/w requirements are delivered to the R/W Surveyor to start 60% R/W Map stage. The initial form is required to be submitted both electronically and signed hard copy.
(4) The initial form will be completed during the 60% Mapping Team Meeting (parcel by parcel review) which will be held as soon as possible after delivery of the requirements.
(5) The remaining columns will be completed for only those parcels that are proposed for changes after the Mapping Team Meeting through right of way certified clear.
(6) Any issue that can not be resolved during the parcel by parcel review and proposed changes occurring after the parcel by parcel review will be submitted to the Department Heads for review and decision on the direction to take.
(7) Code: **01** Design Change to Scope (i.e. typical section , drainage design)
02 Variance or Exception Granted
03 Permitting Issue
04 Utility Design Issue
05 Local Agency (JPA) Delay or Default
06 Design Accommodation versus R/W Take (i.e. wall vs. slope easement)
07 Design Mistake
08 Survey Mistake
09 Property Changes Resulting from Complete Title Work (i.e. property split)
10 Tweaking of Design Due to Final Geometry Calcs on Property Lines
11 Avoid Impacts to Real Estate Improvements
12 Reduce Damages to Remainder Property
13 Development of the Property
14 Real Estate Costs
15 Real Estate Interest Change (i.e. fee to easement)
16 Property Owner's Request
17 Uneconomic Remnant
18 Other

Approximate Survey Line Station Lt. / Rt.	Parcel No. (Assigned By S&M)	Fee, PE,TE, LA	Date Parcel Added	Date of Request to Change Parcel	Discipline Requesting Change (Design, R/W, S&M)	Code	Reason for Change	Date Change Approved GR,JA,FL,AB

Approximate Survey Line Station Lt. / Rt.	Parcel No. (Assigned By S&M)	Fee, PE,TE, LA	Date Parcel Added	Date of Request to Change Parcel	Discipline Requesting Change (Design, R/W, S&M)	Reason for Change		Date Change Approved GR,JA,FL,AB
						Code		

FDOT Project Log

State Road No: _____
From: _____
To: _____
Financial Profect No: _____
County: _____
Road Section/Roadway ID No: _____
Name of Reporting Consultants _____

Begin Reporting Period Log

Reporting Period: From _____ To _____

Major Project Milestones

(Use N/A if not applicable. Add tasks if not shown. **Do not delete tasks/actions**)

FDOT Staff Hour Tab # 27, 28 or 30

		% Complete
27.01	Horizontal Project Network Control (by XXX)	
27.02	Vertical Project Control/Bench Run (by XXX)	
27.03	Alignment and Existing R/W Ties	
27.04	Aerial Targets (by XXX)	
27.05	Reference Points	
27.06	Topography/DTM (3D)	
27.07	Planimetric (2D)	
27.08	Roadway Cross-Sections/Profiles	
27.09	Side Street Surveys	
27.10	Underground Utilities (by XXX)	
27.11	Outfall Surveys	
27.12	Drainage Surveys (by XXX)	
27.13	Bridge Surveys	
27.14	Channel Surveys	
27.15	Pond Site Surveys	
27.16	Mitigation Surveys	
27.17	Jurisdictional Surveys	
27.18	Geotechnical Surveys	
27.19	Sectional/Grant Surveys	
27.20	Subdivision Location	

27.21	Maintained R/W	
27.22	Boundary Surveys	
27.23	Water Boundary Surveys	
27.24	R/W Staking/R/W Line	
27.25	R/W Monumentation	
27.26	Line Cutting	
27.27	Work Zone Safety	
27.28	Miscellaneous Surveys	
27.29	Supplemental Surveys	
28.01	Flight Preparation (by XXX)	
28.02	Control Point Coordination (by XXX)	
28.03	Mobilization (by XXX)	
28.04	Flight Operations (by XXX)	
28.05	Film Processing (by XXX)	
28.06	Photo Products (by XXX)	
28.09	Aerial Triangulation (by XXX)	
28.10	Digital Terrain Model (3D) (by XXX)	
28.16	Planimetrics (2D) (by XXX)	
28.18	CADD Edits (by XXX)	
28.19	Data Merging (by XXX)	
28.21	Field Review (by XXX)	

	Scheduled Date	Actual Date
Alignment Review Submittal		
30% Control Survey Map Submittal		
Mainline Design Survey Submittal		
60% Control Survey Map Submittal		
90% Control Survey Map Submittal		
Updated Design Survey Submittal		
30% R/W Map Submittal		
60% R/W Map Submittal		
100% Control Survey Submittal		
90% R/W Map Submittal		
100% R/W Map Submittal		
Certified Design Survey Deliverables		

Actions for Current Reporting Period: _____

Actions Expected for Next Reporting Period: _____

This report needs to reflect the present status (in percent complete) of the project when compared to the scoped tasks. This report needs to show all actions applicable to each reporting period, and must be submitted no later than the last Tuesday of every month or as otherwise requested.

PERCENTAGE OF FIELD WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900 NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0 DATABASE # : 0

PROJECT LIMITS: 0

Limiting Amount

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT DAYS/HOURS	TOTAL DAYS/HOURS USED	PERCENT OF TASK FIELD SURVEY	NOTES:
Horizontal PNC	2	1	50%	
Vertical PNC/Bench line	2	1	50%	
Alignment and/or Existing R/W lines	2	1	50%	
Reference Points	2	1	50%	
Topography (2D)	2	1	50%	
Digital Terrain Model (DTM)	2	1	50%	
Roadway Cross-Sections/Profile	2	1	50%	
Underground Utilities Designates	2	1	50%	
Underground Utilities Locates	2	1	50%	
work Zone Safety	2	1	50%	
Supplemental Surveys	2	1	50%	
TOTAL	22	11	**TOTAL FIELD WORK PERCENT:**	50%

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

Surveying & Mapping Consultant Management Department

PERCENTAGE OF CONTROL MAP WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900

NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0

DATABASE # : 0

PROJECT LIMITS: 0

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT HOURS	TOTAL HOURS USED	PERCENT OF TASK CONTROL MAP
COVER SHEET	2	1	50%
KEY SHEET(S)	2	1	50%
DETAIL SHEET(S)	2	1	50%
REFERENCE SHEET(S)	2	1	50%
QA/QC	2	1	50%
TOTAL	10	5	**TOTAL CONTROL MAP PERCENT:** 50%

NOTES:

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

District Right of Way Surveyor

PERCENTAGE OF RIGHT OF WAY MAP WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900

NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0

DATABASE # : 0

PROJECT LIMITS: 0

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT HOURS	TOTAL HOURS USED	PERCENT OF TASK RIGHT OF WAY MAP	NOTES:
COVER SHEET	2	1	50%	
KEY SHEET(S)	2	1	50%	
DETAIL SHEET(S)	2	1	50%	
TABLE OF OWNERSHIPS SHEET(S)	2	1	50%	
LEGAL DESCRIPITIONS	2	1	50%	
QA/QC	2	1	50%	
TOTAL	12	6	**TOTAL RIGHT OF WAY MAP PERCENT:**	50%

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

District Right of Way Surveyor

WEEKLY REPORT OF SURVEY ACTIVITIES

FIELD CREW HOURS SHOWN HEREON ARE FROM THE TIME THE FIELD CREW LEAVES THE CONSULTANT'S OFFICE IN THE MORNING TO THE TIME THEY RETURN TO THE OFFICE IN THE AFTERNOON, EXCLUDING TIME SPENT FOR LUNCH.

Contract No.: 0 Authorization No. 0 FM No.: 0 Database No. 0

CONSULTANT:	Project Description:	**Based on a 4 Man 8 Hour day F.C.**
0	0	

Date: 1/0/1900		Date: 1/1/1900		Date: 1/2/1900		Date: 1/3/1900		Date: 1/4/1900		Date: 1/5/1900		Date 1/6/1900	
Crew Name	Hours	Crew Name	Hour	Crew Name	Hours	Crew Name	Hours	Crew Name	Hour	Crew Name	Hours	Crew Name	Hours
TASK:		TASK:		TASK:		TASK:		TASK:		TASK:		TASK:	
Office Name	Hours	Office Name	Hour	Office Name	Hours	Office Name	Hours	Office Name	Hour	Office Name	Hours	Office Name	Hours
Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:	
Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper	
CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech	
Clerical:		Clerical:		Clerical:		Clerical:		Clerical:		Clerical:		Clerical:	
TASK:		TASK:		TASK:		TASK:		TASK:		TASK:		TASK:	

APPENDIX E

SURVEY REPORT

This section contains a standard format for survey reports that will be submitted to the Department. This format may not cover all necessary information for every survey report, as all projects and types of surveys are different. Because of this, some projects may require more information to be included in a survey report than what is outlined herein. It is always appropriate to include as much information as necessary when preparing a survey report.

SURVEY REPORT

1. PROJECT INFORMATION

1.1. Firm
1.2. Financial Project number
1.3. Project name
1.4. State Road number
1.5. Roadway Section Identification Number
1.6. Project limits, e.g. *This project is along SR 10 (US 90) between Magnolia Drive and Capital Circle NE in Leon County, FL.*
1.7. Survey date (give the start and end dates)
1.8. Units of measure

2. TYPE OF SURVEY

State the type of survey in accordance with Rule Chapter 5J-17.050, Florida Administrative Code. If the survey is a specific purpose survey, state the purpose.

3. METHODOLOGY

This section should explain the method(s) used in the survey process. If this is a topographic survey, give a description of the procedure(s) used to collect topographic information; if it is a control survey, state the procedure used in setting or locating monumentation.

Also, this is the place to explain the procedures used in the development of the Digital Terrain Model (DTM).

4. PROJECT CONTROL

4.1. Horizontal Datum

4.2. Horizontal Control Points – list all control points set and/or used. If the list is long, attach it as an appendix.

4.3. Vertical Datum

4.4. Vertical Control Points – list all control points set and/or used. If the list is long, attach it as an appendix**.**

5. SOURCES

Identify any sources used in the preparation of the survey, e.g. right of way maps, plats, legal descriptions, aerial imagery, abstracts of title, jurisdictional areas, ordinary high water lines, mean high water lines.

6. GENERAL NOTES

This section should include any survey notes that typically appear on the face of a survey map, e.g. *This survey is not valid without the signature and original raised seal of a Florida licensed surveyor and mapper* or *This map is intended to be displayed at a scale of 1/_ or smaller*.

7. LEGEND AND ABBREVIATIONS

This section should include all abbreviations, symbols and linetypes used in the digital file(s).

8. COMPILATION OF SURVEYS

When a survey project involves multiple surveyors or firms, a lead surveyor will be identified. A comprehensive survey report will be prepared by the lead surveyor and should detail the total survey, describing the roles and responsibilities of each surveying entity and will reference and include as attachments, all survey reports prepared by the other surveyors involved in the project.

9. FILES LIST

List all files that are part of the deliverable

10. CERTIFICATION

I hereby certify that this survey and all files herein are a true and accurate representation of a field survey made under my responsible charge, and that to the best of my knowledge meets the Standards of Practice as set forth by the Board of Professional Surveyors and Mappers in Rule Chapter 5J-17 of the Florida Administrative Code.

_____ _____

Name Date

Florida Professional Surveyor and Mapper

License Number _____