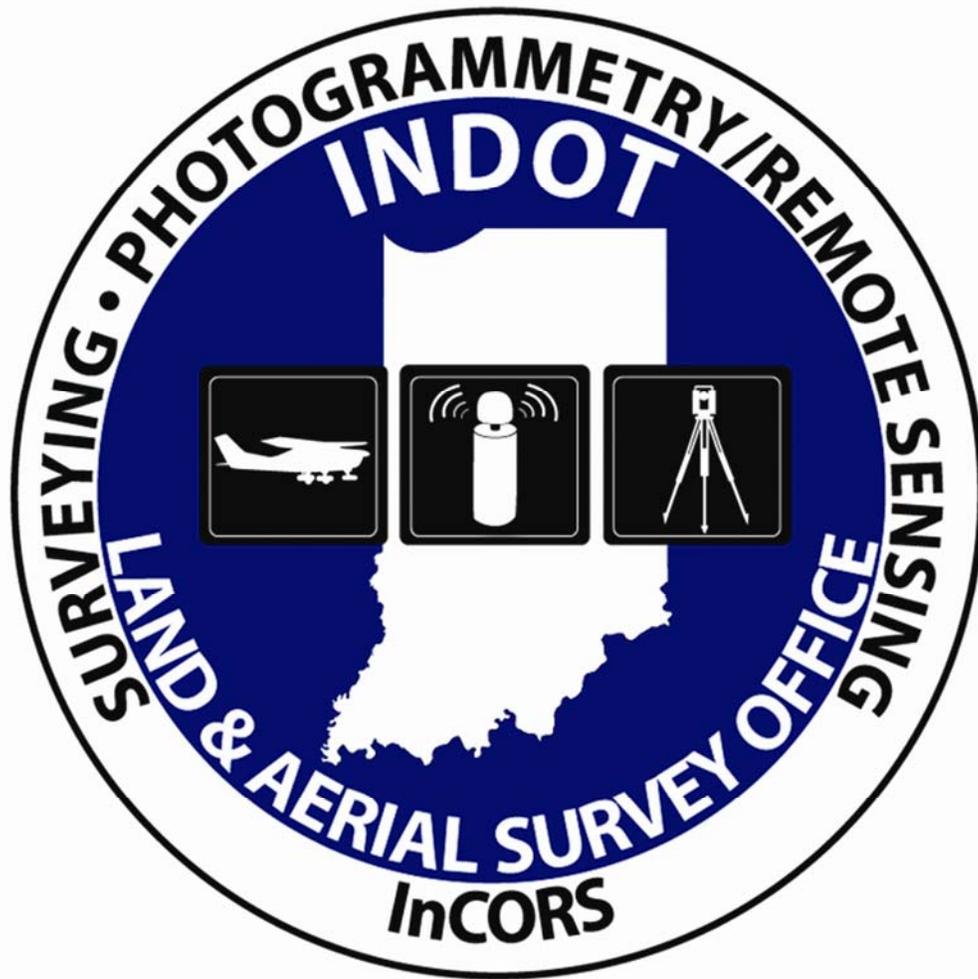


Indiana Department of Transportation

Photogrammetric Mapping Specifications and Services Manual



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Photogrammetric Mapping Services and Specifications Manual

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A. Mission Statement

"INDOT will plan, build, maintain, and operate a superior transportation system enhancing safety, mobility and economic growth¹."

The Photogrammetry Section of the Land & Aerial Survey Office (LASO), part of the Engineering Services & Design Support within the Indiana Department of Transportation is responsible for providing Design Scale Digital Mapping and associated products in a timely, cost efficient, and professional manner.

B. Purpose of Manual

The *Photogrammetric Mapping Services and Specifications Manual* defines standards and procedures for preparing, collecting, delivering, and archiving electronic photogrammetric mapping data and imagery that is created for the Indiana Department of Transportation (INDOT). To ensure the desired accuracy and integrity of all data, these standards shall be used in the preparation and delivery of all electronic deliverables defined within. These specifications shall apply to projects delivered by INDOT staff and consulting firms, unless otherwise approved by the Land & Aerial Survey Office (LASO).

The purpose of these standards and procedures is to obtain an optimal degree of statewide uniformity within the INDOT Aerial/Ground Combination Survey process, to establish and maintain Photogrammetric Standards for INDOT and contracted consultants, and allow for all of the project data to be effectively managed from conception to completion.

The effective date of the policies and procedures within this manual is February 9, 2011. This manual shall be updated on a continuing basis, with revisions issued periodically. The revision date shall be shown on the cover page of this document. The most current version shall be available electronically on the INDOT Land & Aerial Survey Office web site (www.LASO.indot.in.gov) and shall supersede any printed version(s). Some modifications to this manual are the direct result of changes in specifications, Department organization, and other requirements or as a result of recent experiences and technological advances. Other improvements or proposed revisions may be suggested by users. Suggestions to improve or revise the manual or reports of errors or omissions should be transmitted to the Land & Aerial Survey Office.

A legal standard for Aerial/Ground Combination surveys is not established or intended by this manual.

¹ <http://www.in.gov/indot/>



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C. Contacts

For more information, to discuss your specific needs or to request Land & Aerial Survey services please feel free to contact us:

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D. Services

1. **Preliminary/Planning Photography** - This type of photography is often referred to as “Small Scale”, which indicates that the ground features in this type of photography are at a smaller, less detailed size. 1”=1000’ is the most commonly used photo scale for this type of aerial photography. This imaging is generally used to provide an overview of a proposed project area to aid in planning.
2. **Design Scale Photography** - This type of photography is often referred to as “Large Scale”, which indicates that the ground features in this type of photography are at a larger, more detailed size. 1”=166’ is the only acceptable photo scale for this type of aerial photography. This imaging is used primarily to produce design grade mapping products.
3. **Oblique Photography** - These are side-on, angled photos that are captured at low altitude with our High Resolution hand held Digital Camera. These photos are most commonly used for scenic, panoramic or construction progress views. These images provide an increase coverage area within one photograph, however they are not used for making accurate quantitative measurements.

All of the photography scales and styles are used for general views of an area, planning/preliminary design, public hearings, legal court cases, hydrology studies, material borrow pit quantities, environmental issues and construction progress. The only Scale that is acceptable for stereo compilation is the Design Scale Photography.

4. **Digital Imaging** – This is the process in which the developed aerial film is used to produce digital image files. These files are created with the use of a photogrammetric scanner that meets all geometric and radiometric requirements.
5. **Aerial Triangulation** - Aerial triangulation is a mathematical process used to determine the easting, northing and vertical coordinates of an infinite number of points. The primary function of this process is to extend and densify the provided ground control in the aerial photo pairs. This process greatly reduces the number of points that shall be located during the ground survey and provides a means of verifying survey and stereo compilation accuracy, thus reducing project costs across the board.
6. **Digital Stereo Compilation** – This is the process that recreates the internal geometry of the aerial camera to produce a three-dimensional (3D) model of the terrain that is viewed on a high resolution computer monitor. The digital stereo compilation workstations support the real-time



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graphics to allow the CAD features to be viewed graphically overlaid in the 3D environment. After proper orientation, a digital terrain model (DTM) and topographic maps (contours) can be produced.

7. **Digital Terrain Models** – This is a digital representation of the ground surface topography or terrain in a pre-defined area. These terrain models are created by digitizing specific terrain features that depict the changes in the earth's surface. These terrain models are often used in the production of topographic contour maps, to determine earthwork quantities, or to produce orthorectification photography.
8. **Cartographic Editing** – This is the process in which the photogrammetry staff will perform the final QA/QC for all of the stereo compilation data. During this process all of the Supplemental Ground Survey data shall also be added and checked for horizontal and vertical accuracies in relation to the three-dimension terrain view. In addition to checking the geographic accuracies the photogrammetry staff shall also review the data to check for missing data, digitizing correctness and for proper symbology placement.

E. Aerial\Ground Combination Survey Process

Aerial Photogrammetry can be defined as the science of compiling accurate measurements in aerial photographs to locate features on or above the surface of the earth. The end result produces the easting, northing and vertical coordinate position of a particular point, a planimetric feature, or a graphic representation of the earth's terrain.

Once a project is selected for Aerial Mapping services the photogrammetry staff will obtain the project limits to start the aerial flight planning process. From there the photogrammetry staff shall select the appropriate locations for the aerial ground control points based on the aerial flight lines and shall forward that information to the Land Surveyor in charge of the project. Once the field survey crew has physically placed the aerial ground control points, the aerial flight crew will be alerted and will be sent to acquire the aerial photography as soon as weather conditions are favorable. After the aerial photography acquisition mission is complete the photogrammetry section will have the film developed by a contracted consultant or an outside vendor. Once the film has been developed and returned, the Aerial Specialist will digitally scan the film and complete a QA/QC check on the film to make sure that the imagery meets the INDOT required specification. After the film has been scanned to produce digital image files, it is the responsibility of the Certified Photogrammetrist to complete all necessary Aerial Triangulation. Once the Aerial Triangulation results have been verified to meet or exceed INDOT required specifications, it shall be the responsibility of the Aerial Compilation staff to obtain the existing terrain data and convert it into useful CAD information for various INDOT programs. During the aerial



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compilation process, it shall be the responsibility of the photogrammetry staff to alert the Land Surveyor in charge of any items or areas that cannot be collected from the aerial photography. After the aerial compilation and the supplement ground survey has been completed, all CAD data shall need to be merged into one deliverable Bentley InRoads workspace. At the completion of merging all of the terrain data, the photogrammetry section shall produce orthorectified imagery that encompasses the project area.

F. Aerial Photogrammetry Advantages vs. Disadvantages

The technological era has pushed the Photogrammetry industry into a position where the advances have increased the details that can be collected, but at the same time this process is still a limited substitution for ground surveying. The photogrammetry process can relieve survey crews of time consuming tasks required to produce topographic maps and Digital Terrain Models (DTMs), but the ground survey methods will always remain an “essential and irreplaceable” part of the photogrammetric process. Increased amounts of information that pertain to a specific terrain area allow designers to investigate alternative alignments without having to collect additional field information. Surveys collected with the Aerial\Ground Survey Combination principle have both advantages and disadvantages in comparison.

1. Aerial Photogrammetry Advantages

- As a general rule of thumb, projects that are 2 miles long (350 acres in total area) or larger will see a substantial cost savings by using Aerial Photogrammetric procedures to collect all needed Digital Terrain Models, Topographic Mapping and Orthorectified Imagery, compared to traditional ground survey methods.
- Aerial Photography provides a permanent “hard copy” record of the conditions as they were during the acquisition of the imagery.
- Aerial Photography can be supplied as an information resource that is available to the general public, federal and state agencies, and other INDOT programs.
- Reduction in amount of traffic disruptions necessary when ground survey crew must collect data in traffic zones.
- Provides a safer alternative to field survey crews collecting data in high volume traffic zones.



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- Small scale Aerial Photography and Mosaics also provide an expansive overview for a projected area, and aids in the identification of project sensitive features. Aerial Photography can be utilized in locations that are complex or impractical to access from the ground.
- Extension of the DTM limits and additional planimetric features can be extracted from the aerial photography with relatively little effort and cost.

2. **Aerial Photogrammetry Disadvantages**

- Due to seasonal conditions, the acquisition process of the aerial photography could be delayed affecting the overall delivery schedule.
- Given that the aerial photography is collected from above the planimetric features, it presents the issue that some data collection could be challenging due to dense vegetation, dark shadows, overhangs and water.

G. **Specifications**

Objective of Specifications

The objective of the Photogrammetry Specifications is to obtain an optimum degree of statewide uniformity in Aerial\Ground Combination Surveys procedures and to establish and maintain Photogrammetric standards. These specifications are to be used to define the performance and completion of work that is requested of the INDOT photogrammetry staff and all INDOT Photogrammetry Consultants.

1. **Aerial Photography**

- General** – As stated in the objective, the goal of these specifications is to obtain state wide uniformity. Effective immediately as a standard operating procedure, **All INDOT** projects that have an **Aerial Photography** or **Aerial/Ground Combination Survey** component are to be submitted to the Land & Aerial Survey Office (LASO) Photogrammetry Section for services. Once the requested products for any given project have been indentified, the Photogrammetry Section shall make the determinations if needed, to allocate any or all project needs to available contracted consultants.
- Aircraft** – Currently the Land & Aerial Survey Office (LASO) utilizes a Cessna 206 aircraft for all Aerial Photography Acquisition Missions. All consultants performing Aerial Photography Acquisition Missions shall utilize an aircraft capable of flying at the required



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operational altitude and ground speed to insure the accuracy standards as dictated by the project specifications. It shall also be required that the flight crews keep an accurate flight log to the nearest tenth (0.1) of an hour between takeoff and landing. This flight log will need to be signed by the pilot and /or photographer and submitted to the Program Director of the Photogrammetry Section. All project DES numbers shall be clearly denoted on all flight logs submitted to the Photogrammetry Section.

- c. **Camera** – The LASO Photogrammetry Section’s aerial camera system shall be utilized for aerial photography acquisition missions to aid in the process of product uniformity. If the Photogrammetry Section is unable to acquire the needed aerial photography, it shall be assigned to a contracted consultant. It shall be the responsibility of the consultant to utilize an aerial camera system that is equal to or exceeds the accuracy of the aerial camera system employed by the Photogrammetry Section. The consultant shall also provide the technical specifications for the aerial camera system prior to any aerial photography acquisition. Once the system specifications have been submitted to the Photogrammetry Section, the Photogrammetry Section Coordinator shall issue written consent to utilize said aerial camera system for the aerial photography acquisition mission. Any aerial camera system used by a contracted consultant shall have a focal length that does not exceed 153 mm, shall have a camera calibration that is not older than 3 years and shall provide proof that the aerial camera system is accompanied by a Forward Motion Compensation system.
- d. **Aerial Film** – All aerial photography acquisitions missions shall be collected using Agfa’s Aviphot Color X-400 PE1 aerial film. This film base is a panchromatic negative maskless color film with high color saturation, designed for aerial photography from low to medium altitudes and provides better capability to acquire images in shadowed areas. All consultants shall operate with the understanding that any Aerial Film or Contact Prints produced are the sole property of INDOT and shall not be used by the consultant for any other purpose, unless authorized in writing by INDOT. If aerial film is provided by the Land & Aerial Survey office to a consultant for the aerial photography acquisitions mission any unused film shall be returned at the conclusion of the aerial flight. If the consultant has provided the aerial film, it shall be submitted to the Photogrammetry Section at the completion of the aerial project.



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- e. **Airborne GPS/IMU** – When available and depending on project requirements the Airborne Global Positioning Systems and Inertial Measurement Unit technology shall be employed to supplement the aerial ground control. The INCORS network is to be utilized as the primary static ground GPS receivers. If needed, due to irregularity in the project shape, additional static ground GPS receivers can be used in the adjustment process. All determinations to use or not to use Airborne GPS/IMU shall be determined by the Photogrammetry Sections Certified Photogrammetrist prior to any aerial acquisition mission.
- f. **Flight Conditions** – The acquisition of high quality Aerial Photography is dependent on several factors including cloud cover, snow cover, vegetation canopy, wind speeds, sun angle and equipment functionality. Below are the prominent variables that can impact the acquisition and quality of the aerial photography:
- 1) **Weather** – Day to day weather conditions in Indiana are hard to predict and can cause delays in the acquisition of the aerial photography. The optimal weather condition(s) for the acquisition of aerial photography would be clear skies, no winds and dry ground.
 - 2) **Seasonal** – In Indiana the most favorable window for Design Scale Photography is from March 1 to November 30, during which time the sun angle is greater than 30 degrees, allowing for enough reflective light to minimize the effects of long shadows. During the winter months of December-February Preliminary/Planning Photography can be acquired, if needed, depending on what planimetric features need to be visible, and when weather conditions are favorable. To determine what the exact sun angle is for any given time of the day in Indiana, the following web site may be referenced:
<http://www.srrb.noaa.gov/highlights/sunrise/azel.html>
 - 3) **Vegetation** – Spring is the best time for the acquisition of Design Scale Photography, because the deciduous trees haven't budded and the tall weeds and grass areas have been packed down from the winter snow. This is not to say that late fall wouldn't suffice for an aerial photography acquisition, as long as the leaves are off the trees and the majority of crops have been harvested. In both spring and fall acquisitions there shall not be any snow cover.



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- g. Aerial Mission Planning** – All of the Aerial Photography Acquisition Mission Planning shall be performed by the LASO's Photogrammetry Section's Aerial Specialist or coordinated through the Aerial Specialist if the acquisition mission has been contracted to a consultant. If the mission planning is completed by the consultant, it is mandatory that the consultant submit a visual reference to the LASO Photogrammetry Section prior to the actual acquisition mission. Once the LASO Photogrammetry Section has received the aerial acquisition visual reference from the consultant, the Photogrammetry Sections Coordinator shall give written consent to the consultant to proceed with the Aerial Photography Acquisition Mission.
- h. Flying Height** – All Design Scale Aerial Photography shall be flown at one thousand feet (1000') above ground elevation. The flying height for Design Scale Photography shall not deviate more than +/- 5 percent (+/-5%) from the original one thousand feet (1000') above ground elevation. Preliminary/Planning Photography flying height shall be specified by the Department making the request for photography. All Aerial Photography collected shall be inspected by the Aerial Specialist for proper flying height, tip, tilt and crab. Any photography that deviates more than +/- 5% from the original flying height shall be rejected. If Aerial Photography is rejected it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.
- i. Coverage, Crab, Tip and Tilt** – After the Aerial Photography has been acquired and processed, the Aerial Specialist shall inspect the aerial film to verify that the area originally requested was collected with sufficient coverage and that the crab, tip and tilt are to specification. The crab of the Aerial Photography can be compensated by the aerial camera system to a certain degree, but the allowable amount of crab cannot be greater than 3 degrees. If the crab is greater **than 3 degrees for two or more** consecutive aerial frames, that portion of the Aerial Acquisition Mission shall be rejected. The same can be said for the tip and tilt within the aerial frames. If the tip and tilt in a single aerial frame is greater than 4 degrees, this frame and any other aerial frames that are affected shall be rejected. If any Aerial Photography is rejected it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.
- j. Photo Scale** – 1:2000 (1"=166') is the Photo Scale used for all Design Scale Photography collected for the LASO Photogrammetry Section. All other Preliminary/Planning and Oblique photo scales shall be determined as required by requested geographic details.



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- k. Photo Overlap** - The most commonly used average for the forward or endlap of the photography is 60 percent of the image frames. This shall be the preferred percentage of endlap for all photography collected for the Photogrammetry Section regardless of photo scale. The allowable limits of deviation in the endlap will be no less than 57 percent and no greater than 65 percent. If the endlap differs from these percentages, the Aerial Photography shall be rejected. In addition to the endlap, any project that has adjacent or parallel flight lines shall need to have a preferred minimum of 30 percent sidelap. In areas with increased terrain relief the minimum sidelap shall need to be increased to no less than a preferred 35 percent sidelap. The allowable limits of deviations in the sidelap shall be no less than 20 percent for areas with little terrain relief and no less than 25 percent for areas with greater terrain relief. If the sidelap differs from these percentages the Aerial Photography shall be rejected. Rejected Aerial Photography shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.
- l. Blank and Test Frames** – At the end and the beginning of the Aerial Acquisition Mission there shall be no less than 4 tests and blank frames included with the aerial photography. These test and blanks frames are needed by the aerial film processing company to ensure the ability to process the aerial film to it greatest potential.
- m. Film Processing** – After the Aerial Acquisition Mission is completed the consultant shall ship the aerial film to:

Aerial Photo Lab, Inc.
200 Fentress Blvd., Suite D
Daytona, Beach Fl. 32114
P-(386)253-5041
F-(386)253-5031

Once the aerial film has been shipped to Aerial Photo Lab, Inc. by the consultant, the consultant shall contact the Coordinator of the LASO Photogrammetry Section to confirm that shipping has occurred and provide a tracking number for accountability. At this point the Photogrammetry Section shall contact Aerial Photo Lab, Inc. in regards to return shipping directly to the Photogrammetry Section. Once the processed film has been received by the Photogrammetry Section's Coordinator, the Aerial Specialist shall begin the process of verifying that the aerial film has met all requirements.



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n. **Aerial Film Annotation** – The aerial camera system shall need to be configured to imprint the following information on the aerial photography for any given aerial acquisition mission:

- 1) Date and time the photo was taken
- 2) Project DES number
- 3) Flight line number
- 4) Frame number
- 5) Latitude
- 6) Longitude
- 7) Photo Scale
- 8) Altitude (ASL)

Any and all annotation shall be required to be imprinted by the aerial camera system. The Photogrammetry Section shall not accept any aerial film that has this information annotated “by hand” and it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.

2. **Aerial Photo Ground Control**

a. **General** – The Photogrammetry Section makes every effort possible to make sure that the Aerial Photo Ground Control data that is used for any given project is held to the highest accuracy standards.

b. **Photo Control Placement/Layout** – The photo control placement/layout for all Aerial Photogrammetric projects shall be performed by the Lead Photogrammetrist in the LASO Photogrammetry Section. The computation of the aerial triangulation solution is one of the primary responsibilities of the Lead Photogrammetrist and shall ultimately be held responsible for the accuracy of the final solution. Due to this fact it is in the best interest of the Photogrammetry Section to have the Lead Photogrammetrist specify where and how many photo control points are required. Once the Lead Photogrammetrist has determined the specific number and spatial distribution of the photo control points, the determination shall then be made if the control placement needs can be completed by the LASO Survey Section or if there is a need for part or all of the control work to be delegated to a survey consultant. After the determination of any delegation of services it shall be the responsibility of the Lead Photogrammetrist to provide the supporting placement documentation to the consultant or Surveying Section to aid in the proper placement of all photo control.



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c. **Datum and Coordinate System** – All project control and mapping performed for INDOT shall meet the following positioning parameters unless otherwise directed by the appropriate District Survey Operations Manager:

- 1) **Vertical Positioning** – provide the vertical position using the following:
 - i. Orthometric Height Datum –NAVD88
 - ii. Geoid Model – GEOID09
- 2) **Horizontal Positioning** – provide the horizontal positions using the following:
 - i. Coordinate System - Indiana State Plane
 1. East or West Zone as appropriate
 2. Combined Scale Factor from grid to ground as appropriate
 - ii. Map Projection – Transverse Mercator
 - iii. Reference Frame – NAD83
 - iv. Ellipsoid – GRS80
- 3) **Units and transformations** – Provide units in U.S. Survey feet. The U.S. Survey foot is defined as 1 meter = 39.37 inches. Use the following conversion factor:

$$1 \text{ meter} = 3.280833333 \text{ U.S. Survey feet.}$$

Perform all transformations in accordance with the NGS documented procedures.

d. **Types of Aerial Photo Control** – All Aerial Photo Ground Control targeting shall be located per the specifications outlined in Appendix A.

3. Digital Images

a. **General** – The LASO Photogrammetry Section utilizes the latest versions of photogrammetric image scanning hardware and software offered by the current vendor. The hardware and software allows the Photogrammetry Section to produce high quality digital images in a timely manner, while keeping the image files sizes to a manageable size. Digital Photogrammetric Imagery that needs to be produced for **Any INDOT** project shall be created utilizing the Photogrammetry



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Section's scanning technologies. This also includes all imagery production for projects which might be delegated to a contracted consultant.

- b. Scanning Resolution** – The standard scanning resolution for all Design Scale photography shall be 12.5 microns (2136 dpi). The most commonly requested scanning resolution for Preliminary/Planning Photography is 40 microns (636 dpi). Custom scan resolutions can be achieved, but shall need to be specified in writing by the person(s) or Department requesting services prior to scanning.
- c. Image Compression** – All Design Scale Imagery shall be produced with a JPEG compression factor 25 percent (25%). This shall aid in the manageability of mass amounts of digital imagery. The compression shall not affect the overall high resolution requirements. Preliminary/Planning Digital Imagery shall not have a JPEG compression unless otherwise specified.
- d. Image Overviews** – During the process of creating the Digital Imagery, if needed, the Image Overviews shall be created and automatically embedded in the image files.
- e. File Formats** – The only acceptable file format for Photogrammetric Digital Imagery is the **TIFF** (Tagged Image File Format). All imagery shall be delivered in the **TIFF** format unless otherwise specified in writing. The Photogrammetry Section has the capability to convert Digital Photography to other needed file formats if necessary.
- f. Delivery Medium** – All Digital Images shall be submitted on portable media or DVD. All images shall be accompanied by all aerial acquisition or digital scanning documentation.

4. Aerial Triangulation

- a. General** – Aerial Triangulation is the mathematical process of establishing precise and accurate measurements between the individual aerial photos and a defined [datum](#). All Aerial Triangulation (AT) shall be performed by the LASO Lead\Certified Photogrammetrist for all INDOT Aerial Photogrammetric projects, unless otherwise authorized by LASO. If the Aerial Triangulation is to be completed by a contracted consultant, it shall be completed by an ASPRS Certified Photogrammetrist and all results shall be submitted to the LASO Photogrammetry Section's Lead\Certified Photogrammetrist prior to any topographic mapping collection.



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- b. **Imagery** – The Aerial Triangulation process for all INDOT Aerial Photogrammetric projects shall be completed using high resolution color digital images, scanned at no less than 12.5 microns or 2100 dpi.
- c. **Camera Calibration** – It is the responsibility of the consultant to submit to the LASO Photogrammetry Section, prior to image acquisition, a copy of the current Camera Calibration for the aerial camera system to be used. The camera calibration shall be no more than 3 years old, shall be performed by USGS, shall be on USGS letter head and signed by the authorized authority. Any other form of camera calibration **shall not** be accepted by the Photogrammetry Section. A copy of the Camera Calibration can be sent by mail, faxed or emailed to the Photogrammetry Section Coordinator.
- d. **Aerial Photo Ground Control** – All Aerial Photo Survey Ground Control shall be submitted to the LASO Lead Photogrammetrist in the Photogrammetry Section. The required delivery format for the ground control file(s) is a digital ASCII file, with individual fields separated by a comma and those fields titled with PNEZD or PENZD. This will allow the Lead Photogrammetrist to import the control coordinates into the aerial triangulation software. The electronic delivery of the control file will also aid in eliminating number transposition, instead of manually entering the control coordinates.
- e. **Airborne GPS/IMU** – All Airborne GPS/IMU data collected for Aerial Photogrammetric projects shall be processed by the consultant that is responsible for the Aerial Acquisition Mission. Any supporting documentation or reports shall be submitted with the electronic GPS/IMU files to the Photogrammetry Section prior to the Aerial Triangulation process.
- f. **Interior Orientation** – When performing the Interior Orientation for each individual photo in the Aerial Photogrammetric project the Lead Photogrammetrist shall measure all 8 photo fiducials and shall maintain the Acceptable RMSE Threshold which shall be no greater than 1.00 pixel or 12.5 microns per photo Interior Orientation.
- g. **Stereo Pair Measurements** – It is standard Aerial Triangulation procedure for the Photogrammetry Section to measure no less than 8 Von Gruber (Pass Points) per stereo model. See Appendix B for a visual representation of what a “Normal” first model of any flight line will typically look like.
- h. **Stereo Point Measurement ID’s** – The standard naming convention for all Pass Points measured for any Aerial Triangulation project shall be *Flight Line ID_Photo ID_Point ID* i.e. *1_100_1*. All Aerial Photo



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Control Point ID's will already be predefined, but the point ID's shall range from 0700 to 0999.

- i. **Aerial Triangulation Solution Results** – The following is the minimum required Triangulation Results for all Design Scale Photography:

Relative Orientation Sigma = 3.5 microns or less

Absolute Orientation RMS = 0.075 of a foot or less

Overall Sigma a priori = 4.5 microns or less

Overall RMS for X, Y, Z = 0.075, 0.075, 0.05, respectively, of a foot or less

In addition to the above overall results the Stereo Point Measurements shall **not** include Blundered Points, Single Ray Point, or Two Ray points. These points shall be deleted from the over solution.

All Aerial Triangulation Solutions shall be conducted and/or reviewed by an ASPRS Certified Photogrammetrist. The Certified Photogrammetrist shall also be required to Stamp and Sign all Result Reports that are created and submitted to the Photogrammetry Section

5. Supplemental Ground Survey

- a. **General** – This is the process in which the Field Survey Crew shall be responsible for collecting specific topographic features that the Photogrammetry Section is unable to notate or visually collect before and after the Aerial Data Compilation is completed.
- b. **Specific Supplemental Features** – Appendix C contains a detailed list of items that all Field Crews shall be required to collect.
- c. **Topographic Collection Procedures** – All Supplemental Field Survey Data shall meet the requirements as outlined in the INDOT Design Manual, Part III “Location Surveys”, Chapter Twenty-Three or current INDOT Survey Manual. If any part of the submitted Field Survey data does not meet the INDOT specifications, the originating provider shall make all necessary changes and re-submit until all data meets specifications at no additional cost to INDOT.

6. Digital Stereo Compilation

- a. **General** – This is the process in which the Photogrammetry Section shall utilize the overlapping aerial photography to create the 3D environment that will allow for the collection of all project specific



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topographic features. The creation of a 3D environment allows the staff of the Photogrammetry Section to produce the Digital Terrain Models that represent the ground surface topography or terrain in a

pre-defined area. **All INDOT projects that have an Aerial/Ground Combination Survey component shall be submitted to the LASO Photogrammetry Section for services, unless otherwise authorized by LASO. Once the requested products for any given project have been indentified, LASO shall make the determination, if needed, to allocate any or all project needs to available contracted consultants, to include the Stereo Compilation component.**

- b. Design Files** – All Digital Stereo Compilation shall be collected using Microstation V8i or the current CADD software in use by INDOT. It shall be required that the **INDOT_Imperial_SVFT_seed.dgn** seed file be used for the creation of the individual Model files for each Stereo pair of Aerial Photography. This seed file can be downloaded from the INDOT CAD Home page at:

<http://www.in.gov/dot/div/contracts/cadd/index2.html>

- c. Design Files Naming Convention** – All Stereo Compilation Models shall be named as follows:

Road#_Flight Line #,Left Photo #_Flight Line #, Right Photo #
For example: *SR57_216_217.dgn*

All Model files that do not follow this naming convention shall be rejected when delivered and shall need to be renamed before resubmission. At the conclusion of the aerial compilation all individual Stereo Compilation Model files shall be delivered to the LASO Photogrammetry Section.

- d. Stereo Model Boundaries** – The Model Boundary for each individual Stereo Model shall be defined by a rectangular polygon placed by the Photogrammetric operators. The Model Boundary shall be produced in reference to the Main Project Mapping Limits and shall be required to encompass only the overlapping 3D photography between adjacent Fiducials.
- e. Linear & Symbolic Digitizing Parameters** – Appendix D outlines the proper Linear and Symbolic descriptions for compilation in the INDOT InRoads Workspace. If the compilation process is to be completed by a contracted consultant, it shall be mandatory that all of the Linear and Symbology Elements are set to the INDOT Workspace parameters to ensure Aerial/Ground uniformity. This uniformity will



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also aid in the process used to merge the Supplemental Ground Survey and the Aerial Data Compilation at a later date with NO data transformations needed. It shall be mandatory that all INDOT Field Survey Crews, Photogrammetry Section and all contacted consultants

adhere to these Digitizing Methods. In addition, all items shall be digitized at the ground elevation unless otherwise stated. All Linear and Symbology parameters that differ shall be rejected and it shall be the responsibility of the consultant, field crew, Photogrammetrist, or compiler to fix the data for resubmission at no additional cost to INDOT. During the compilation of any INDOT project should the consultant have any questions regarding the procedures they are to contact the Lead Photogrammetrist or the INDOT CAD Department

- f. **Cell Library** – Appendix E contains the Table that visually represents all of the Cells used in the INDOT InRoads Cell Library. These cells are utilized for the Aerial/Ground Combination Surveys. To ensure Aerial/Ground uniformity, it shall be mandatory for all contracted consultants performing compilation that all digitized cells match the INDOT Cell Library. This uniformity will also aid in the process used to merge the Supplemental Ground Survey and the Aerial Data Compilation at a later date with NO data transformations needed. All digitized cells that differ from the table below shall be rejected, and it shall be the responsibility of the contracted consultant to correct the data for resubmission at NO additional cost to INDOT.

7. **Orthorectification Images**

- a. **General** – This section outlines all requirements for any Orthorectification Imagery produced. If the Orthorectification process is to be completed by a contracted consultant the following minimum standards shall be adhered to. If not, all data that differs shall be rejected and resubmitted at no additional cost to INDOT.
- b. **Datums and Coordinates** – All Ortho Imagery for INDOT Roadway Design projects shall be projected in the INDOT Project Coordinate System that has been previously defined for the Aerial Triangulation and Digital Compilation Process. If the Ortho Imagery is for a Non Design related project, all imagery shall be projected in State Plane North American Datum of 1983 (NAD83) unless otherwise specified by LASO.
- c. **Radiometric Balancing** – When a mosaic of two or more images is made, the brightness and color values of the other images shall be adjusted to match that of the principal image. The seamlines between



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the overlapping images shall be chosen to minimize tonal variations. Localized adjustment of the brightness and color values shall be done to reduce radiometric differences between adjacent areas. Changes in color balance across the project, if they exist, shall be gradual. Abrupt tonal variations between image files are not acceptable. These images shall be rejected and resubmitted at no further cost to INDOT.

- d. Edge Matching and Overlap** – Excessive horizontal displacement along seamlines or at image file boundaries shall not be permitted. The maximum allowable mis-join between transportation features or other well defined linear features is ± 3 pixels. All Orthorectified Images shall overlap adjacent images with an overlap distance of no less than fifty feet (50'). Any Images that do not meet the required overlap distance shall be rejected and it shall be the responsibility of the contracted consultant to rectify the errors and resubmit the files in question to LASO at no additional cost to INDOT.
- e. Resolution** – The color final Orthorectified Imagery files shall be rectified to a ground pixel resolution of no greater than twenty-five hundredths of a foot (0.25'). If the final pixel resolution is not adhered to, all files that do not conform shall be rejected and shall be resubmitted to LASO at no additional cost to INDOT.
- f. Horizontal Accuracy** – Ortho Imagery accuracy shall be determined using all Surveyed Control point and all Digitized CAD data. If any portion of the Orthorectified Image is horizontally inaccurate by more than five hundredths of a foot (0.05'), that Image will be rejected and shall be corrected and be resubmitted to LASO at no additional cost to INDOT.
- g. Image Format** – Images shall be submitted in a compressed (near lossless), un-tiled, Geo-rectified TIFF format. Each Image shall also be accompanied by the corresponding TIFF World File.
- h. File Naming Convention** – For projects in INDOT Project Coordinates file names for the 4000 x 4000 ft ortho image files shall be derived from the southwest corner of each image. The file name shall consist of the X and Y INDOT Project coordinate of the southwest corner. For projects in State Plane/feet, file names for the 4000 x 4000 ft ortho image files shall be derived from the southwest corner of each image. The file name shall consist of the X and Y State Plane coordinate of the south-west corner. All Ortho Image corner coordinates shall be whole numbers preferably ending in “5” or “0”, any decimal or non whole number coordinated shall be rejected.



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- i. **Quality Control** – A visual inspection of Orthorectification Images shall be performed by the photogrammetry staff to ensure that all Orthorectification products produced by the contracted consultant adhere to LASO Specifications. The following is the criteria that LASO shall utilize for the inspection of all Orthorectification Images.
1. Completeness of data to cover the specified geographic extent, with no omissions or corrupt data.
 2. Tonal balancing problems across the block.
 3. Ground Sample Distance to ensure that it meets the specified resolution.
 4. Mis-joins between linear features greater than 3 pixels
 5. Cloud cover, smoke/haze, corrupt data, and void areas.
 6. Extreme tonal or color variation across seamlines.
 7. Excessive horizontal displacement along seamlines in images (more than ± 3 pixels along transportation features).
 8. Excessive tilt in bridges, buildings, and other raised features.
 9. Transportation features that are obstructed by buildings or shadows.
 10. Tall buildings in urban areas that obscure features in the interior of a city block.
 11. Clipping of features (e.g. radio towers, water tanks, buildings) at image file boundaries.
 12. Building/structure, bridge, or road warp that may indicate bad elevation data.
 13. Smearing.
 14. Evidence of oversaturation or under-saturation as a result of image processing or histogram manipulation.
 15. Evidence of image compression.

All Orthorectification Imagery that doesn't pass any of these criteria shall be rejected. It shall be the responsibility of the contracted consultant to rectify the errors and shall resubmit the files in question to the Land & Aerial Survey Office at no additional cost to INDOT.

- j. **Delivery Medium and Format** – Digital Orthorectified Images shall be submitted on portable media or DVD. Image files shall be accompanied by an index sheet and DGN file suitable for loading into Microstation.



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8. InRoads Files to be delivered

- a. **General** – This section outlines the InRoads data files that INDOT requires to be delivered with all Aerial/Ground Combination Survey or Traditional Ground Survey projects.
- b. **File Requirements** – All INDOT InRoads projects require that the final Aerial topography files be delivered in a certain file format and naming convention. Appendix F outlines all files that shall be delivered to the Land & Aerial Survey Office for all survey projects. If the final Aerial topography files are NOT delivered in the proper file format or don't adhere to the proper naming conventions all files shall be rejected and shall be resubmitted following the guidelines at no additional cost to INDOT.
- c. **Acceptable Delivery Medium** – All INDOT InRoads project files shall be delivered on CD or DVD, clearly labeled to depict all Aerial files being delivered and in an adequate jewel case for storage. If any or all of the requirements are not adhered to, LASO shall reject the delivery of the final project files. All rejected files shall be resubmitted at no further cost to INDOT.



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Appendix A

INDOT Land & Aerial Survey Office Aerial Photo Ground Control

INDOT will provide the desired Lat/Long locations of the photo control points in a .gpx file that can be uploaded into a handheld GPS unit. If requested, an ASCII file with panel locations listed in latitude and longitude can be provided. This location information will be used to place the panel points prior to the aerial photography being flown. The panel points need to be of high contrast as compared to their background (either light color placed on a dark background or vice versa). Additionally, they will be placed such that they are not blocked from above by any overhanging features (trees, buildings, etc.). Also they should not be placed on a significant sloping surface.

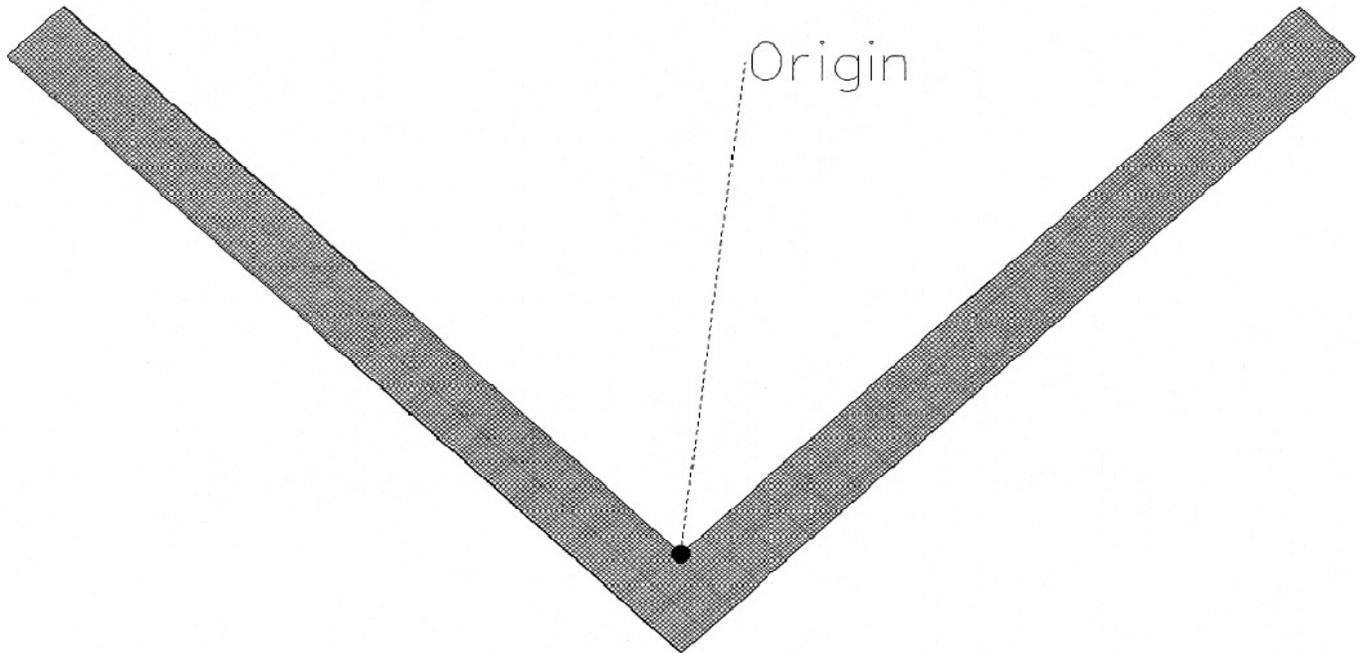
Chevron type panel point:

Where possible, the preferred panel point style will be painted on hard surfaces (e.g. pavement, concrete) in the shape of a chevron (“V”). The legs of the chevron will be at least 24 inches in length, and the legs will be at least 2 inches wide forming a 90° angle. The inside corner of the chevron is the XYZ “origin” point for this style of panel point (see diagram below). The field survey crews will need to create the necessary templates for this type of panel.

Once the field crew has created the panel templates, the field person(s) can navigate to the desired panel location, drive a nail into the surface and then using a small brush or broom clean the surface area of any debris. The field person should then lay the template such that the inside corner is located directly over the nail and then paint the whole chevron (White paint is preferred). Once the chevron is mostly dry, the template can be removed and the inside part of the template can be placed directly over the white chevron. Black paint can now be sprayed around the insert, leaving a black outline around the newly painted white chevron. After the painting of the chevron has occurred the field person will need to use either pink or orange marking paint to label the chevron with the provide photo control point number. These numbers need to be painted within 2 feet of the panel and the numbers need to be at least 6 inches tall.



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Cross type panel point:

Where there is not a suitable surface to paint on, the cross type panel point will be constructed by adhering black weather resistant film to a white plastic material (Celtic material is strongly recommended). This type of panel point is temporary, and is the less desirable style of panel points.

These panel points will be made by taking a 3/8" thick, 48" by 96" sheet of Celtic and cutting it into pieces that approximately measure 16" by 19.2". First cut the 48" wide sheet into three 16" wide strips, and then cut the 96" long strips into five equal pieces (approximately 19.2" long). This will yield 15 panels per each 4' by 8' sheet. The cross is then made by placing a 2" wide black vinyl film strip from each opposing corner of the Celtic panel (see diagram below). In the field, drive a 1" by 1" by 12" hub stake into the ground so it is flush, and then fasten this panel to the hub stake with a nail driven through the center of the cross. The center of the cross will be the XYZ "origin" point for this style of panel point.

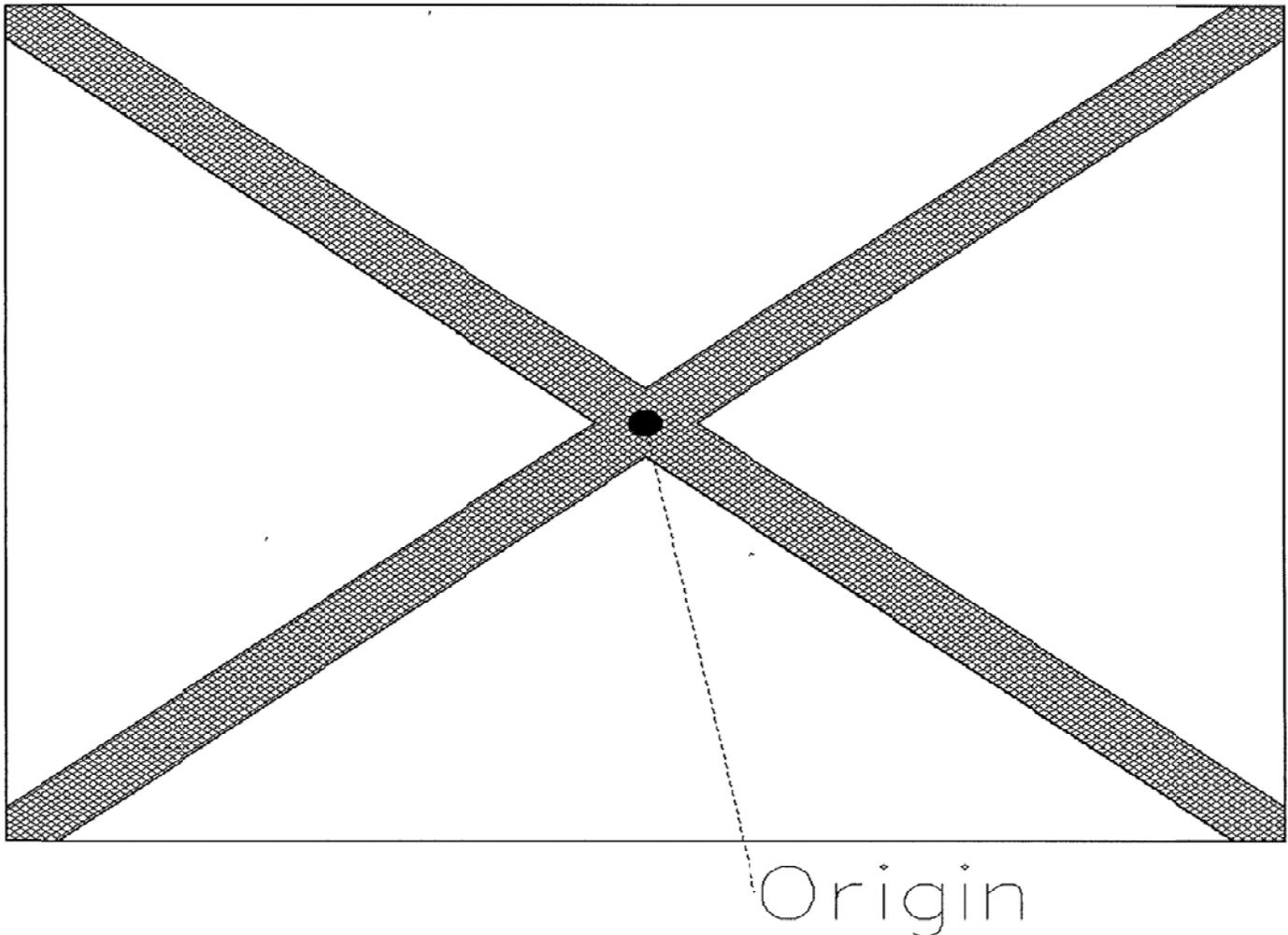
Consultants-To obtain the necessary materials for producing this style of panel point you can contact the following company:

The Plastic Center (A division of Myer Plastics)
5167 E. 65th St. Indianapolis, IN. 46220-4816
317-634-4528

Districts- Please contact either Don Mohid or Danny Greenberg to obtain these materials.



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Important note regarding the movement of panel points:

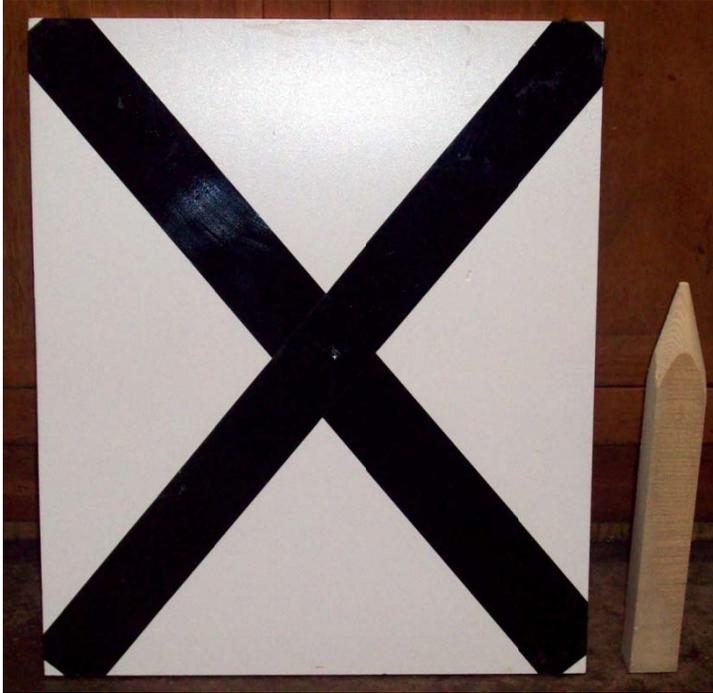
No control point should be moved more than 50 feet from its original projected location without contacting INDOT's LASO Department. When contacting LASO regarding a desired panel point move, please indicate the point ID number, and the desired direction and distance of the proposed move. If there are any questions about the panel points please do not hesitate to contact Chip Campbell at 317-610-7251 ext.298



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Examples of Panel Types:

Celtic Panel with Weather resistant black film and 1"x1" wood hub



Chevron painted on a sidewalk (concrete surface)



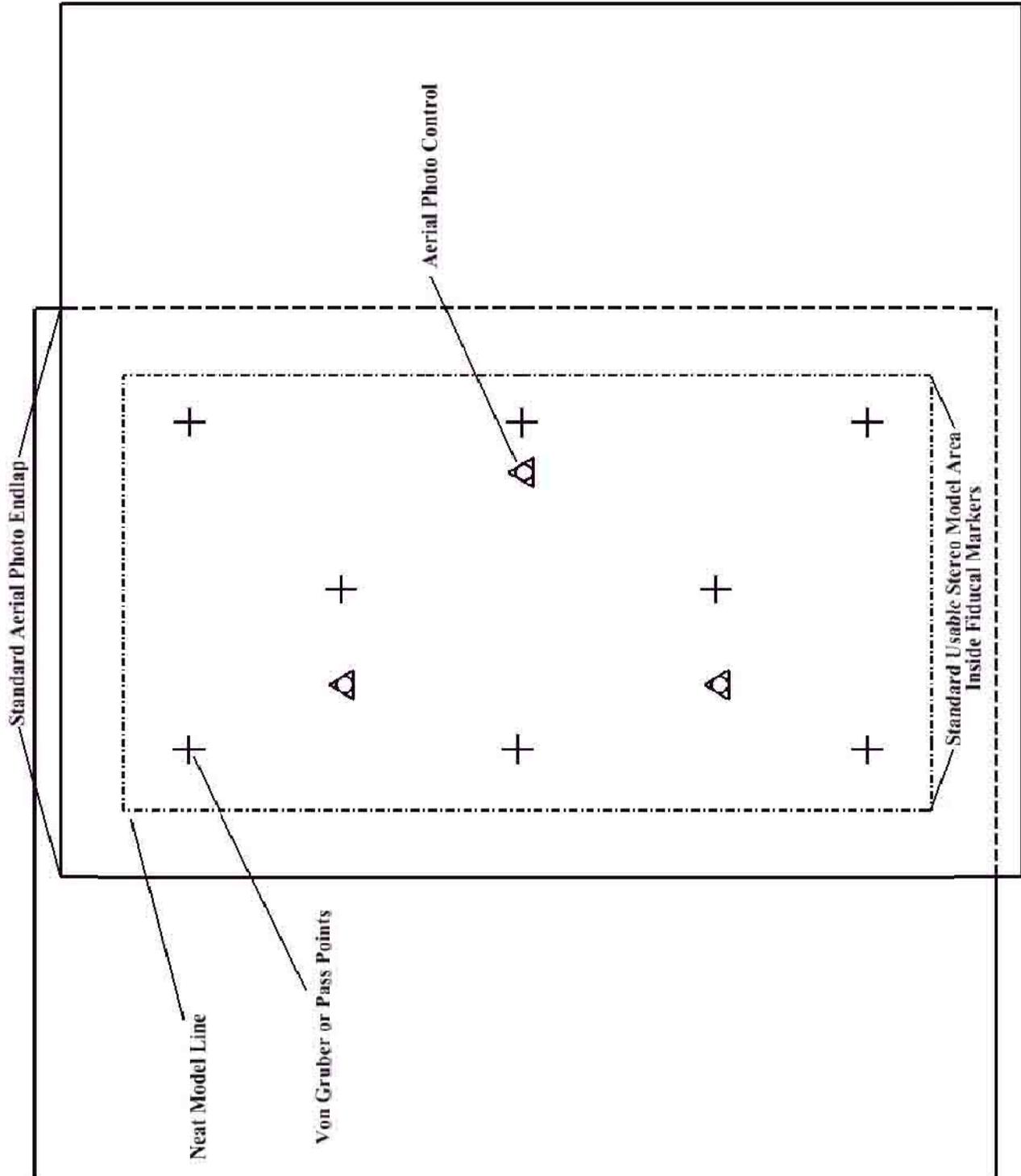


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Appendix B Stereo Point Measurements





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Appendix C

Specific Supplemental Features

When conducting supplemental ground surveying, feature and location data information will be collected on, but not limited to, the following, unless otherwise determined unnecessary based on project scope by the LASO Photogrammetry Section:

1. Items not observable or obscured on aerial imagery (e.g. under canopy, under bridge deck, etc).
2. Utilities to include, but not limited to, surface indications and markings of subsurface utilities, pedestals, poles, etc..., with identifying annotations.
3. Inverts of pipes with notes of size & material type.
4. Ditch lines, concrete paved side ditches, intermittent streams, creeks and stream flow lines that may be obscured with vegetation or canopy. Continue strings under bridges when present.
5. Individual trees 4" in diameter or larger (DBH) with annotation of size & species. For forested or dense wooded areas, locate area limits and note prevailing size or range.
6. Manholes with pertinent feature data (e.g. material type, size, depth, flow lines of pipes coming in or going out, sizes and shots on directions of pipes coming in or going out).
7. Storm Inlets (curb and other) with all pertinent feature data.
8. PMAT (material type) shots where needed.
9. Signage with annotation as to type, support size, and information represented.
10. Mailboxes with annotation as to type and number of boxes, and type and size of mount/support.
11. Buildings, walls, fences, and other improvements as needed, located at grade.
12. As accurately as the evidence permits, the location of cemeteries, gravesites and burial grounds observed.
13. Items that require P (point) or S (line) notes.

Note:

In order to maintain cost effectiveness, it should be noted that the primary purpose of the supplemental ground surveying is to identify and collect data on features that cannot be collected from aerial photography (i.e., covered, obscured, or sub-surface). If features are clearly visible from the air, some information may not need to be collected directly on the ground to ensure efficient use of ground field work.

During the aerial survey stereo-compilation process (mapping), there may be a need for additional ground survey information to be collected in any areas that were obscured in the aerial photography. In those cases, the Land & Aerial Survey Office will provide the necessary information, in most cases to the original ground survey crew(s), in order to have the remaining feature data collected.



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Appendix D

Linear & Symbolic Digitizing Parameters

Level Name	Level Digitizing Descriptions	Associated Cells
S_BR_abutment	<i>The substructure element supporting each end of a single span or the extreme ends of a multi-span superstructure and, in general, retaining or supporting the approach embankment. Also, digitize an additional level string at the ground elevation as needed.</i>	
S_BR_Bent	<i>The substructure unit supporting each end of a bridge span; also called a pier; made up of two or more columns or column-like members connected at their top most ends by a cap, strut, or other member holding them in their correct positions.</i>	
S_BR_deck	<i>The roadway portion of a bridge that directly supports vehicular and pedestrian traffic.</i>	
S_BR_exposed footing	<i>The enlarged, lower portion of a substructure that distributes the structure load either to the earth or to supporting piles; the most common footing is the exposed concrete slab.</i>	
S_BR_Hand Rail	<i>The top center of all Hand Rails.</i>	
S_BR_Overhead Ped Walkway	<i>The outline of all Overhead Pedestrian Walkways.</i>	
S_BR_Seat	<i>The top leading edge of all Bridge Seats.</i>	
S_BR_Wheel Guard	<i>Top leading edge of the Wheel Guard on all Bridge Decks.</i>	
S_BR_Wingwall	<i>The top leading edge of all Wing Walls, also place breakline at ground elevation outlining the Wing Wall.</i>	
S_CTRL_aerial cross	<i>All Aerial Control Panels or Chevrons. This cell must be digitized in the inside of all Chevrons and the center of all Control Panels at ground elevation</i>	PSSC
S_CTRL_Bench mark	<i>All Temporary Benchmarks. This cell must be digitized in the center of the benchmark.</i>	PBMK
S_CTRL_Boat spike	<i>All Boat Spike Monuments. This cell must be digitized in the center of the Boat spike.</i>	PBSP
S_CTRL_Brass plug	<i>All Brass Plug Monuments. This cell must be digitized in the center of the Brass plug.</i>	PBRP
S_CTRL_CheckShot	<i>All field survey Check Shots.</i>	PCHE
S_CTRL_County Benchmark	<i>All County Benchmarks. This cell must be digitized in the center of the benchmark.</i>	PBCT
S_CTRL_Countyline Marker	<i>All County Line Markers. This cell must be digitized in the center of the marker.</i>	PCTY
S_CTRL_Drill hole in Conc	<i>All Drill Holes found in Concrete. This cell must be digitized in the center of the Drill Hole.</i>	PDRH
S_CTRL_GPS control	<i>All GPS Monuments. This cell must be digitized in the center of the GPS monument.</i>	PGPS
S_CTRL_INDOT BM	<i>All INDOT, IDOH, ISHC Benchmarks. This cell must be digitized in the center of the benchmark.</i>	PIDT
S_CTRL_INDOT flood control BM	<i>All DNR, IFC-WRC Benchmarks. This cell must be digitized in the center of the benchmark.</i>	PIFC
S_CTRL_Instr or alignmt	<i>All Center Line Alignment control points. This cell must be digitized in the center of all control or instrument markers.</i>	PSSA
S_CTRL_Iron pin	<i>All Iron Pins. This cell must be digitized in the center of the pin.</i>	PPIN
S_CTRL_Iron pipe	<i>All Iron Pipes. This cell must be digitized in the center of the pipe.</i>	PIPO
S_CTRL_Mon	<i>All Monuments that are not specifically designated in the INDOT workspace. This cell must be digitized in the center of the monument.</i>	PMON
S_CTRL_Nails-MagNail	<i>All Mag Nails. This cell must be digitized in the center of the nail.</i>	PMAG
S_CTRL_Nails-PkNail	<i>All PK Nails. This cell must be digitized in the center of the nail.</i>	PPKN



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Level Name	Level Digitizing Descriptions	Associated Cells
S_CTRL_NGS triangulation sta.	All NGS Triangulation Stations. This cell must be digitized in the center of the NGS Station.	PNGS
S_CTRL_Point-Fly Stations 1	All Survey Random Control Points. This cell must be digitized in the center of the Fly Station.	PFLY
S_CTRL_Point-Resection Pts	All Survey Resection Points. This cell must be digitized in the center of the Resection Marker.	PRES
S_CTRL_Point-Traverse Pts 1	All Survey Traverse Points. This cell must be digitized in the center of the Traverse Marker.	PTRA
S_CTRL_Railroad spike	All Railroad Spikes. This cell must be digitized in the center of the Railroad Spike.	PRRS
S_CTRL_Rebar	All Size Rebar. This cell must be digitized in the center of the rebar.	PRE0
S_CTRL_Road nail	All Road Nails. This cell must be digitized in the center of the nail.	PRDN
S_CTRL_section Cor traver	All Section Corner Points. This cell must be digitized in the center of the Section Corner Marker.	PSST
S_CTRL_State line marker	All State Line Markers. This cell must be digitized in the center of the marker.	PSLM
S_CTRL_Stone Mon	All Stone Monuments. This cell must be digitized in the center of the monument.	PSTO
S_CTRL_USC and GS bench mark	All USC&GS Benchmarks. This cell must be digitized in the center of the benchmark.	PUSC
S_CTRL_USGS bench mark	All USGS Benchmarks. This cell must be digitized in the center of the benchmark.	PUSG
S_CTRL_Wood stake	All Wooden Survey Stakes and Hubs. This cell must be digitized in the center of the stake or hub.	PHUB
S_DR_500UpDownStreamTopWater	All Up/Downstream Water Readings. This cell must be digitized at the surface above flow line. Note the depth.	PWTR
S_DR_Catch basin	All non Round or Square Catch Basins. This cell must be digitized in the center of the grate.	PCBD
S_DR_Catch Basin Round	All Round Catch Basins. This cell must be digitized in the center of the grate.	PCBR
S_DR_Catch Basin Square	All Square Catch Basins. This cell must be digitized in the center of the grate.	PCBS
S_DR_Conc paved side ditch	The top edge of any Concrete Ditch.	
S_DR_Ditch line	The top leading edge for all Ditches.	
S_DR_Drainage pipe	The Invert or Top of the opening for all pipes.	
S_DR_Edge of gutter line	The Gutter Line of all Curbs.	
S_DR_Header-bottom	The bottom leading edge of all Drainage Headers.	
S_DR_Header-top	The top leading edge of all Drainage Header.	
S_DR_Headwall	The top edge of Head Wall. Also place a Level String at ground elevation outlining the Head Wall.	
S_DR_Inlet-curb	All Curb Inlets. This cell must be digitized in the center top of the leading edge and rotated to correct angle.	
S_DR_Inlet-drop	All Drop Inlets, square or round. This cell must be digitized at the elevation of the grate.	
S_DR_intermittent small str m	The flow line of Intermittent Stream.	
S_DR_Ordinary High Water	All Linear Ordinary High Water Marks.	
S_DR_Ordinary High Water	All Ordinary High Water Marks flags. If flag is numbered note the number.	PORD
S_DR_Retaining wall	The top leading edge of all Retaining Wall. Also place a Level String at ground elevation outlining the Retaining Wall.	
S_DR_Sluiceway	All man-made channels designed to redirect excess water.	



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Level Name	Level Digitizing Descriptions	Associated Cells
S_DR_Spillway	<i>The outside edge of all drainage Spillways.</i>	
S_DR_Swamp symbol	<i>All Swamps. This cell must be digitized at ground elevation.</i>	PSWP
S_DR_Swamp-marsh-wetland	<i>All Wetlands, Swamps or Marsh out lines at ground elevation. Do not label as wetland, swamp or marsh.</i>	
S_DR_Water flow line	<i>The Water Flow Line in ditches, streams, canals, etc.</i>	
S_DR_Waters edge	<i>The edge of all water for rivers, lakes, ponds, etc.</i>	
S_PROP_Athletic Field	<i>The outline of all Athletic Fields on school properties, college campuses, city parks, state parks, ect.</i>	
S_PROP_Billboard-metal	<i>The top leading edge of all Metal Billboards.</i>	
S_PROP_Billboard-wood	<i>The top leading edge of all Wood Billboards.</i>	
S_PROP_Bldg	<i>All building foundations at the ground elevation.</i>	
S_PROP_Bldg-overhang	<i>The edge of roof that hangs over the building foundations.</i>	
S_PROP_Bush	<i>All Bushes. This cell must be digitized in the center of the Bush at ground elevation. The</i>	PBUS
S_PROP_Canopy Cor	<i>The edge of any overhead Canopy Structure.</i>	
S_PROP_Car wash vacuum	<i>All Vacuums located at car washes or gas stations. This cell must be digitized in the center of the vacuum at the elevation of the ground or concrete slab.</i>	PVAC
S_PROP_Cistern	<i>All Cisterns. This cell must be digitized in the center of the cover.</i>	PCIS
S_PROP_Fence-barbed	<i>The center of all Barbed Wire Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-chain link	<i>The center of all Chain Link Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-Elec	<i>The center of all Electric Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-farm field	<i>The center of all Farm Field Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-iron	<i>The center of all Iron Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-metal	<i>The center of all Metal Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-other	<i>The center of all Other type of Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-privacy	<i>The center of all Privacy Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-stone	<i>The center of all Stone Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-wood	<i>The center of all Wood Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Fence-woven rail	<i>The center of all Woven Rail Fences. The fence must be digitized at ground elevation.</i>	
S_PROP_Garden	<i>The outline of all residential Gardens at ground elevation.</i>	
S_PROP_Gas fill cap	<i>All Gas Fill Caps. This cell must be digitized in the center of the cap.</i>	PGFC
S_PROP_Gas pump	<i>The outline of all individual Gas Pumps at the elevation of the island or ground.</i>	
S_PROP_Gas pump island	<i>The top leading edge of the island containing Gas Pumps. Also digitize a Level Sting at the bottom of the island.</i>	
S_PROP_Gate	<i>Center of all Gates. The gate must be digitized from the center of the Gate Post to the end of the gate.</i>	



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Level Name	Level Digitizing Descriptions	Associated Cells
S_PROP_Gate post	<i>All Gate Posts. This cell must be digitized in the center of the post at ground elevation.</i>	PGPT
S_PROP_GC Cart Path	<i>The edge of all Golf Course Cart Paths. If needed also digitize a Level Sting at the bottom of the car path at the ground elevation.</i>	
S_PROP_GC Fairway	<i>The edge of all Golf Course Fairways at ground elevation.</i>	
S_PROP_GC Green	<i>The edge of all Golf Course Greens at ground elevation.</i>	
S_PROP_GC Sand Trap	<i>The top leading edge of all Golf Course Sand Traps. If needed digitize a Level Sting at the bottom of the leading edge of the sand trap at ground elevation.</i>	
S_PROP_GC Tee Box	<i>The edge of all Golf Course Tee Boxes at ground elevation. If the tee box is elevated digitize Level Stings where needed.</i>	
S_PROP_Grave approx location	<i>The approximate location of all Single Grave locations.</i>	
S_PROP_Landscaping	<i>The outline of all Commercial or Residential Landscaping.</i>	
S_PROP_Leachfield	<i>The outline of all Leach Fields. Leach Fields must be digitized at ground elevation.</i>	
S_PROP_Line-field division	<i>The outline of all Farm Fields at ground elevation.</i>	
S_PROP_Mail box (double box)	<i>All Double Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.</i>	PMBD
S_PROP_Mail box (mult. boxes)	<i>All Multiple Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.</i>	PMBM
S_PROP_Mail box (single box)	<i>All Single Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.</i>	PMBX
S_PROP_Mail box (USPS-FedEx)	<i>All United States Postal Service, FedEx or UPS Mail Boxes ect. This cell must be digitized in the center of the box at ground elevation.</i>	PMUS
S_PROP_Orchard	<i>The outside edge of all Orchards at ground elevation.</i>	
S_PROP_Outline of Porch or Deck	<i>The outside edge of Porches or Decks.</i>	
S_PROP_Pole-flag	<i>All Residential or Commercial Flag Poles. This cell must be digitized at the center of the pole at ground elevation.</i>	PFLP
S_PROP_Post	<i>All Posts. This cell must be digitized in the center of the post at ground elevation.</i>	PPST
S_PROP_Private lamp post	<i>All Private Lamp Posts. This cell must be digitized in the center of the lamp post at ground elevation.</i>	PLPT
S_PROP_Property owner	<i>All Property Owners. This cell must be digitized at ground elevation and noted with the Property Owners Name and/or other pertinent information.</i>	POWN
S_PROP_Satellite dish	<i>All Satellite Dishes. This cell must be digitized in the center of the Satellite Dish.</i>	PSAT
S_PROP_Septic tank	<i>All Septic Tanks. This cell must be digitized in the center of the tank opening.</i>	PSTK
S_PROP_Sidewalk	<i>The top leading edge of all Sidewalks. If the sidewalk is elevated place additional Level Sting at the ground elevation.</i>	
S_PROP_Sign post-commercial	<i>All Commercial Signs. This cell must be digitized in the center of the post.</i>	
S_PROP_Sign-commercial	<i>The outline of all Commercial Signs. All Commercial signs must be digitized at ground elevation or at elevation of pedestal.</i>	PPSN
S_PROP_Sign-dbl post	<i>All Double Post Signs. This cell must be digitize between the double posts and rotated to correct angle.</i>	PSND
S_PROP_Sign-railroad	<i>All Railroad Signs. This cell must be digitized in the center of the post.</i>	PRSN
S_PROP_Sign-single post	<i>All Single Post Signs. This cell must be digitized in the center of the post.</i>	PSGN
S_PROP_Sprinkler head	<i>All Sprinklers. This cell must be digitized in the center of the sprinkler head.</i>	PSHD



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Level Name	Level Digitizing Descriptions	Associated Cells
S_PROP_Steps	<i>The outline of all Steps.</i>	
S_PROP_Storage tanks	<i>The outline of all Storage Tanks.</i>	
S_PROP_Swimming pool	<i>The outline of all Swimming Pools.</i>	
S_PROP_T-post (Fence Post)	<i>All Fence T-Posts. This cell must be digitized in the center of the post</i>	PTFP
S_PROP_Turn apron	<i>The edge of all Turn Aprons.</i>	
S_PROP_Well	<i>All Wells. This cell must be digitized in the center of the well opening.</i>	PWEL
S_PROP_Well Pit	<i>All Well Pits. This cell must be digitized in the center of the well pit.</i>	PWLP
S_RDWY_Asphalt-approach	<i>The edge of any Asphalt Approach. If elevated place additional Level String at the ground elevation.</i>	
S_RDWY_Asphalt-island	<i>The top leading edge of all Asphalt Islands. Also place an additional Level String at the ground elevation.</i>	
S_RDWY_Asphalt-slab	<i>The edge of all Asphalt Slabs. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Controller Cab-traffic	<i>All Traffic Control Cabinets. This cell must be digitized in the center and at elevation of ground or concrete slab.</i>	PCCT
S_RDWY_Curb-back	<i>The back edge of all Curbs.</i>	
S_RDWY_Curb-bottom	<i>The bottom of all Curbs if there is no apparent Gutter Flow Line.</i>	
S_RDWY_Curb-rolled	<i>The center of all Rolled Curbs.</i>	
S_RDWY_Curb-top	<i>The top leading edge of any Curb. Also place an additional Gutter Flow Line or Level String at ground elevation.</i>	
S_RDWY_Drive-commercial	<i>The edge of all Commercial Drives, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Drive-field	<i>The all Field Drives, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Drive-private	<i>The edge of all Private Drives, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Edge of gravel	<i>The edge of any Gravel that is not related to a Road or Drive, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Guardrail-aluminum	<i>The top of Aluminum Guard Rail where it meets the blockouts or post.</i>	
S_RDWY_Guardrail-beam	<i>The top of Beam Guard Rail where it meets the blockouts or post.</i>	
S_RDWY_Guardrail-cable	<i>The top of Cable Guard Rail where it meets the blockouts or post.</i>	
S_RDWY_Guardrail-other	<i>The top of Other Type Guard Rail where it meets the blockouts or post.</i>	
S_RDWY_Guardrail-wooden	<i>The top of Wooden Guard Rail where it meets the blockouts or post.</i>	
S_RDWY_Mail box approach	<i>The edge of all Mailbox Approaches, also digitize the correct material symbology to define the type of approach material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Median cross over	<i>The edge of all Median Crossovers, also digitize the correct material symbology to define the type of approach material. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Pavement-edge	<i>The edge of Pavement for all Public Roads. If elevated place an additional Level String at the ground elevation.</i>	



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Level Name	Level Digitizing Descriptions	Associated Cells
S_RDWY_Road crown	<i>The Road Crown of all roads. This may or may not be the center line of the road.</i>	
S_RDWY_Shoulder-edge	<i>The edge of Shoulder for all Public Roads. If elevated place an additional Level String at the ground elevation.</i>	
S_RDWY_Underdrain	<i>All Underdrain features.</i>	
S_RW_Line-cemetery	<i>The outside edge of all Cemeteries. If elevated place an additional Level String at the ground elevation.</i>	
S_RW_Line-county	<i>All County Lines.</i>	
S_RW_Line-Natl Forest	<i>All National Forest Lines.</i>	
S_RW_Line-property	<i>All Property Lines.</i>	
S_RW_Line-Right of Way	<i>All Right of Way Lines.</i>	
S_RW_Line-state	<i>The Indiana State line.</i>	
S_RW_Line-town-city	<i>All Town Lines.</i>	
S_RW_R-W marker Conc	<i>All Concrete Right of Way Markers. This cell must be digitized on the backside center of the monument.</i>	PCON
S_RW_R-W marker granite	<i>All Granite Right of Way Markers. This cell must be digitized on the backside center of the monument.</i>	PGBD
S_RW_R-W marker stone	<i>All Stone Right of Way Markers. This cell must be digitized on the backside center of the monument.</i>	PSBD
S_RW_Town line marker	<i>All Town Line Markers. This cell must be digitized in the center of the marker.</i>	PTLM
S_SURF_Aerial Boundary	<i>All Aerial Mapping Model Boundaries. This boundary must represent the neat models lines and must remain inside the usable stereo coverage areas. Also, these boundaries must be snapped to adjacent boundaries.</i>	
S_SURF_boundary string	<i>All Interior and Exterior Boundary Strings. These boundary strings must be snapped to all vertically sensitive data at the edge of the Aerial Mapping coverage.</i>	
S_SURF_Level string	<i>The sharp changes in the ground Topography.</i>	
S_SURF_Toe of slope	<i>All Toes of Slope at ground elevation.</i>	
S_SURF_Top of bank	<i>All Tops of Bank at ground elevation.</i>	
S_TOPO_Aerial Obscured	<i>All Aerial Obscured areas. Add text to describe what the ground is obscured by.</i>	
S_TOPO_Brick-Block Wall	<i>The top leading edge of all Brick or Block Walls. Also place a Level String at ground elevation outlining the Brick or Block Wall.</i>	
S_TOPO_Conc elevation	<i>An elevation reading for all Concrete slabs,porches and steps.</i>	PCEL
S_TOPO_Controller Cab-RR	<i>All Railroad Control Cabinets. This cell must be digitized in the center of the cabinet and at elevation of ground or concrete slab.</i>	PCCR
S_TOPO_Edge of Conc	<i>The edge all Concrete. If elevated place an additional Level String at the ground elevation.</i>	
S_TOPO_Edge of Conc slab	<i>The edge of all Concrete Slabs. If elevated place an additional Level String at the ground elevation.</i>	
S_TOPO_Finished floor	<i>All Finished Floor Elevations. This cell must be digitized just inside the threshold of doorway for Commercial or Residential property. Typically used for Flood Zone Exemptions.</i>	PFEL
S_TOPO_Matl Prop-Asphalt	<i>All Asphalt Material.</i>	PBLT
S_TOPO_Matl Prop-Boulder	<i>All Boulder material. This cell must be digitize in the center top of the boulder or center top of a pile or mound of boulders.</i>	PROC



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Level Name	Level Digitizing Descriptions	Associated Cells
S_TOPO_Matl Prop-Brush	<i>All Weeds material.</i>	PBRs
S_TOPO_Matl Prop-Conc	<i>All Concrete material.</i>	PCRT
S_TOPO_Matl Prop-Crushed Stone	<i>All Crushed Stone material.</i>	PCRS
S_TOPO_Matl Prop-Dirt	<i>All Dirt material. This cell must be digitized at ground elevation or at the top of any pile or mound.</i>	PCRT
S_TOPO_Matl property	<i>All Materials not listed.</i>	PMAT
S_TOPO_Matl Prop-Grass	<i>All Grass material.</i>	PGRS
S_TOPO_Matl Prop-Gravel	<i>All Gravel material. This cell must be digitized at ground elevation or at the top of any pile or mound.</i>	PGRV
S_TOPO_Matl Prop-Mulch	<i>All Mulch material. This cell must be digitized at ground elevation or at the top of any pile or mound.</i>	PMUL
S_TOPO_Matl Prop-Pond	<i>All Ponds. This cell must be digitized in the center of the pond at the elevation of the water surface.</i>	PPON
S_TOPO_Matl Prop-Stone	<i>All Stone material. This cell must be digitized at ground elevation or at the top of any pile or mound.</i>	PSTN
S_TOPO_Matl Prop-Weeds	<i>All Weed material.</i>	PWED
S_TOPO_Matl Prop-Woods	<i>All Woods material.</i>	PWOD
S_TOPO_New feature	<i>The center of all Unknown Objects.</i>	PZZZ
S_TOPO_Nursery	<i>The outline of all Commercial or Residential Nursery's.</i>	
S_TOPO_Point-new topo string	<i>The outline of all Unknown Objects.</i>	
S_TOPO_Railroad	<i>The top inside gauge of all Railroad tracks.</i>	
S_TOPO_Riprap	<i>The edge of all Rip-Rap.</i>	
S_TOPO_Rock outcrop	<i>The edge of all Rock Outcrop.</i>	
S_TOPO_Row of trees-coniferous	<i>The beginning and the end of a Row of Coniferous Trees.</i>	
S_TOPO_Row of trees-deciduous	<i>The beginning and the end of a Row of Deciduous Trees.</i>	
S_TOPO_Spot elevation	<i>All Spot Elevations. The cell for Spot Elevations must be digitized at ground elevation.</i>	PELV
S_TOPO_Stone wall	<i>The top leading edge of all Stone Walls. Also place a Level String at ground elevation outlining the Stone Wall.</i>	
S_TOPO_Stump	<i>All Stumps. This cell must be digitized in the center of the stump.</i>	PSTP
S_TOPO_Text	<i>Any annotation need to describe Unknown items or Obscured areas.</i>	
S_TOPO_Tree coniferous	<i>All Coniferous Trees. This cell must be digitized in the center of the tree.</i>	PTCS
S_TOPO_Tree deciduous	<i>All Deciduous Trees. This cell must be digitized in the center of the.</i>	PTDS
S_TOPO_Woods-brush line	<i>The edge of all Woods or Brush areas.</i>	
S_TRAF_Arrow left turn only	<i>All painted Left Turn Arrow markers on the roadways.</i>	SN_EARLT
S_TRAF_Arrow left-straight	<i>All painted Left Turn/Straight Arrow markers on the roadways</i>	SN_EARCLT
S_TRAF_Arrow right turn only	<i>All painted Right Turn Arrow markers on the roadways.</i>	SN_EARRT
S_TRAF_Arrow right-straight	<i>All painted Right Turn/Straight Arrow markers on the roadways.</i>	SN_EARCRT



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Level Name	Level Digitizing Descriptions	Associated Cells
S_TRAF_Arrow straight only	All painted Straight Arrow markers on the roadways.	SN_ARTHR
S_TRAF_Box Truss Cell	The post for all Box Truss Signs. This cell must be digitized in the center of the post.	POBS
S_TRAF_Cable Span Cell	The post for all Cable Span Signs. This cell must be digitized in the center of the post.	POCS
S_TRAF_Delineator Post	All Delineator Post. This cell must be digitized in the center of the post.	PDEL
S_TRAF_Double Arm Cant Cell	The post for all Double Arm Cantilever Signs. This cell must be digitized in the center of the post.	PODS
S_TRAF_Handhole	All Hand Holes. This cell must be digitized in the center of the Hand.	PHHL
S_TRAF_Lane Lines	All Lane Line Markings Solid or Dashed.	
S_TRAF_Magnetic detector sleeve	All Magnetic Detector Sleeves.	
S_TRAF_MonotubeCell	The post for Monotube Signs. This cell must be digitized in the center of the post.	POMS
S_TRAF_Painted Crossing	All painted X-ING markers on the roadways.	SN_XING
S_TRAF_Painted ONLY	All painted ONLY markers on the roadways.	SN_EONLY
S_TRAF_Painted RR Xing	All painted Railroad crossing markers on the roadways.	SN_RR
S_TRAF_Painted School Xing	All painted SCHOOL crossing markers on the roadways.	SN_SCHOOL
S_TRAF_Pullbox	All Pull Boxes. This cell must be digitized in the center of the pole.	PPBX
S_TRAF_Railroad Sig	All Railroad Signals. This cell must be digitized in the center on the signal.	PRSL
S_TRAF_Sig conduit	The location of all Signal Conduits.	
S_TRAF_Sig loop detector	The center of all Signal Loop Detector cables.	
S_TRAF_Sig loop detector box	All Traffic Signal Loop Detector Boxes. This cell must be digitized in the center of the box.	PSLD
S_TRAF_Sig-no mast arm	All Traffic Signals that do not contain a mast arm. This cell must be digitize in the center of the signal.	PSGL
S_TRAF_Sign-Oh box truss	The top edge of all Box Truss Signs.	
S_TRAF_Sign-Oh cable span	The top edge of all Cable Span Signs.	
S_TRAF_Sign-Oh double arm cant	The top edge of all Double Arm Cantilever Signs.	
S_TRAF_Sign-Oh monotube	The top edge of all Monotube Signs.	
S_TRAF_Sign-Oh single arm cant	The top edge of all Single Arm Cantilever Signs.	PASC
S_TRAF_Sign-Oh tri cord	The top edge of all Tricord Signs.	
S_TRAF_Single Arm Cant Cell	The post for all Single Arm Cantilever Signs. This cell must be digitized in the center of the post.	
S_TRAF_Stop bar	All painted Stop bars in the roadways.	
S_TRAF_Street light conduit	The location of all Street Light Conduit.	
S_TRAF_Tricord Cell	The post for all Tricord Signs. This cell must be digitized in the center of the.	POTS
S_UTIL_Air Conditioning Unit	All Air Conditioning Units for Commercial or Residential property. This cell must be digitized in the center of the unit.	PACU
S_UTIL_Anchor for guy rope	All Guy Cable Anchors. This cell must be digitized in the center of the anchor where it enters the ground.	PANC



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Level Name	Level Digitizing Descriptions	Associated Cells
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S_UTIL_Controller Cab-Elec	All Electric Control Cabinets. This cell must be digitized in the center of the cabinet	PCCE
S_UTIL_Controller Cab-Tel	All Telephone Control Cabinets. This cell must be digitized in the center of the cabinet.	PCCP
S_UTIL_Elec transformer box	The outline of the Transformer Box.	
S_UTIL_Fiber optic marker	All Fiber Optic Markers. This cell must be digitized in the center of the cabinet.	PFOM
S_UTIL_Fire hydrant	All Fire Hydrants. This cell must be digitized in the center top of the Fire Hydrant.	PHYD
S_UTIL_Gas shutoff	All Gas Shut Off Valves. This cell must be digitized in the center of the valve.	PGSO
S_UTIL_Gas Station Mon Well	All Gas Monitoring Wells. This cell must be digitized in the center of the cover.	PGMW
S_UTIL_Gas vent pipe	All Gas Vent Pipes. This cell must be digitize in the center of the pipe(s).	PGVT
S_UTIL_Ground light	All Residential or Commercial Ground Lights. This cell must be digitized in the center of the light.	PGLT
S_UTIL_Hedge	The outline of all Hedges. Hedges must be digitized at ground elevation.	
S_UTIL_High pressure tap	All High Pressure Taps. This cell must be digitized in the center of the tap	PHPT
S_UTIL_Manhole-cable TV	All Cable TV Manholes. This cell must be digitized in the center of the manhole.	PMHC
S_UTIL_Manhole-drainage	All Drainage Manholes. This cell must be digitized in the center of the manhole.	PMHD
S_UTIL_Manhole-Elec	All Electric Manholes. This cell must be digitized in the center of the manhole.	PMHE
S_UTIL_Manhole-gas	All Gas Manholes. This cell must be digitized in the center of the manhole.	PMHG
S_UTIL_Manhole-GasStation	All Gas Station Manholes. This cell must be digitized in the center of the manhole.	PMGS
S_UTIL_Manhole-other	All Other Types off Manholes. This cell must be digitized in the center of the manhole.	PMHO
S_UTIL_Manhole-sewer	All Sewer Manholes. This cell must be digitized in the center of the manhole.	PMHS
S_UTIL_Manhole-Tel	All Telephone Manholes. This cell must be digitized in the center of the manhole.	PMHT
S_UTIL_Manhole-traffic Sig	All Traffic Signal Manholes. This cell must be digitized in the center of the manhole.	PMHI
S_UTIL_Manhole-water	All Water Manholes. This cell must be digitized in the center of the manhole.	PMHW
S_UTIL_Metal tower	All Metal Towers. This cell must be digitized in the center of the tower at ground elevation and rotated, then scaled.	PTOW
S_UTIL_Meter-Elec	All Electric Meters. This cell must be digitized in the center of the meter.	PELM
S_UTIL_Meter-gas	All Gas Meters. This cell must be digitized in the center of the Gas Meter.	PGAM
S_UTIL_Meter-water	All Water Meters. This cell must be digitized in the center of the meter.	PWAM
S_UTIL_Natural gas storage well	All Natural Gas Storage Wells. This cell must be digitized in the center of the well opening.	PGWS
S_UTIL_Natural gas well	all Natural Gas Wells. This cell must be digitized in the center of the well opening.	PGWL
S_UTIL_NaturalGasShutOff	All Natural Gas Shut off Valves. This cell must be digitized in the center of the valve.	PGSN
S_UTIL_Pedestal-cable	All Cable Pedestals. This cell must be digitized in the center of the pedestal.	PEDC
S_UTIL_Pedestal-Elec	All Electric Pedestals. This cell must be digitized in the center of the pedestal.	PEDE
S_UTIL_Pedestal-gas	All Gas Pedestals. This cell must be digitized in the center of the pedestal.	PEDG



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Level Name	Level Digitizing Descriptions	Associated Cells
S_UTIL_Pedestal-Tel	<i>All Telephone Pedestals. This cell must be digitized in the center of the pedestal.</i>	PEDT
S_UTIL_Petroleum HPV	<i>All Petroleum Gas Shut Off Valves. This cell must be digitized in the center of the valve.</i>	PPSO
S_UTIL_Petroleum vent pipe	<i>All Petroleum Vent Pipes. This cell must be digitized in the center of the vent pipe.</i>	PPVT
S_UTIL_Pole	<i>All Poles. This cell must be digitize in the center of the pole.</i>	PPOL
S_UTIL_Pole-guy or stub	<i>All Guy Wire Poles or Stubs. This cell must be digitized in the center of the pole.</i>	PGUY
S_UTIL_Pole-joint power-Tel	<i>All Joint Power and Telephone Poles. This cell must be digitized in the center of the pole.</i>	PJNT
S_UTIL_Pole-light	<i>All Light Poles. This cell must be digitized in the center of the pole.</i>	PLIT
S_UTIL_Pole-light on joint	<i>All Lights on Joint Poles. This cell must be digitized in the center of the pole.</i>	PLTJ
S_UTIL_Pole-light on power	<i>All Lights on Power Poles. This cell must be digitized in the center of the pole.</i>	PLTD
S_UTIL_Pole-mast arm	<i>All Mast Arm Poles. This cell must be digitized in the center of the pole.</i>	PMAP
S_UTIL_Pole-power	<i>All Power Poles. This cell must be digitized in the center of the power pole.</i>	PPWP
S_UTIL_Pole-Tel	<i>All Telephone Poles. This cell must be digitized in the center of the pole.</i>	PTEL
S_UTIL_Pole-telegraph	<i>All Telegraph Poles This cell must be digitized in the center of the pole</i>	PTGP
S_UTIL_Pole-traffic Sig-strain	<i>All Traffic Signal Strain Poles This cell must be digitized in the center of the pole</i>	PTSP
S_UTIL_Prop-Elecal Box	<i>All Electric Boxes This cell must be digitized in the center of the box</i>	PELB
S_UTIL_Riser-Elec	<i>All Electric Risers and for Electric Lines that run up poles This cell must be digitized in the center of the riser.</i>	PELR
S_UTIL_Riser-Tel	<i>All Telephone Risers and for Telephone Lines that run up poles This cell must be digitized in the center of the riser.</i>	PTER
S_UTIL_Riser-television	<i>All Cable TV Risers and for Cable TV Lines that run up poles This cell must be digitized in the center of the riser.</i>	PTVR
S_UTIL_Riser-water	<i>All Water Risers This cell must be digitized in the center of the riser.</i>	PWAR
S_UTIL_Tel booth	<i>All Telephone Booths This cell must be digitized in the center of the booth</i>	PBTH
S_UTIL_Tel-press canister	<i>All Canisters This cell must be digitized in the center of the post that the canister is attached to.</i>	PCAN
S_UTIL_Tel-splice tub	<i>All Telephone Splice Tubs This cell must be digitized in the center of the tub.</i>	PTUB
S_UTIL_Ug Gas Vault	<i>All Underground Gas Vault features.</i>	
S_UTIL_Ug-cable TV	<i>All Underground Cable TV features.</i>	
S_UTIL_Ug-Elec	<i>All Underground Electric features.</i>	
S_UTIL_Ug-gas	<i>All Underground Gas features.</i>	
S_UTIL_Ug-high pressure gas	<i>All Underground High Pressure Line features.</i>	
S_UTIL_Ug-other	<i>All Other or Unknown Underground features.</i>	
S_UTIL_Ug-petroleum	<i>All Underground Petroleum features.</i>	
S_UTIL_Ug-sanitary sewer	<i>All Underground Sanitary Sewer features.</i>	
S_UTIL_Ug-storm san sewer	<i>All Underground Rain or Storm Water Sewer features.</i>	



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Level Name	Level Digitizing Descriptions	Associated Cells
S_UTIL_Ug-Tel	<i>All Underground Telephone features.</i>	
S_UTIL_Ug-water	<i>All Underground Water features.</i>	
S_UTIL_Valve box	<i>All Residential and Commercial Irrigation Valves Boxes This cell must be digitized in the center of the valve box.</i>	PVBX
S_UTIL_Water gate	<i>All Water Gates This cell must be digitized in the center top of the gate.</i>	PWGT
S_UTIL_Water shutoff	<i>All Water Shutoff Valves This cell must be digitized in the center of the valve.</i>	PWSO



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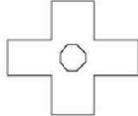
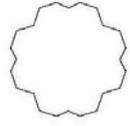
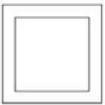
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Appendix E

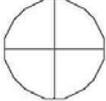
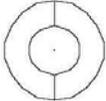
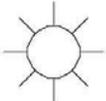
INDOT/Land & Aerial Survey - InRoads Cell Library

AIR CONDITIONING UNIT PACU Material Property - Air Conditioning	 PANC Guy Rope Anchor	 PASC Sign - Single Arm Cantilever	 PASE Aerial Survey Tilt Control	 PBCT County Bench Mark
BLACKTOP PBLT Material Property - Blacktop	 PBMK Bench Mark	 PBRK Point Break for Triangulations	 PBRP Brass Plug	BRUSH PBRB Material Property - Brush
 PBSP Boat Spike	 PBTH Telephone Booth	 PBUS Bush - Not Annotation Cell	 PCAN Telephone - Pressurized Canister	 PCBD Catch Basin
 PCBR Catch Basin Round	 PCBS Catch Basin Square	 PCCE Controller Cabinet - Electrical	 PCCP Controller Cabinet - Telephone	 PCCR Controller Cabinet - Railroad
 PCCT Controller Cabinet - Traffic	 PCEL Concrete Elevation	 PCIS Cistern	 PCON R/W Marker Concrete	 PCRB Inlet - Curb
CRUSHED STONE PCRS Material Property - Crushed Stone	CONCRETE PCRT Material Property - Concrete	 PCST Top of Drainage Casting	 PCTY County Line Marker	 PDEL Delinicator Post



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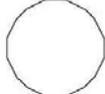
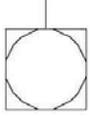
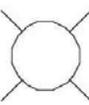
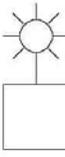
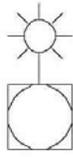
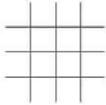
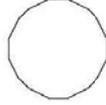
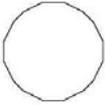
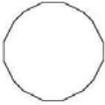
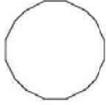
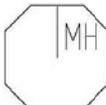
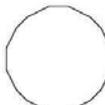
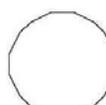
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 PDDI Inlet - Drop	ODH PDRH Drill Hole in Concrete	 PED-C PEDC Pedestal - Cable	 PED-E PEDE Pedestal - Electric	 PED-G PEDG Pedestal - Gas
 PED-T PEDT Pedestal - Telephone	ELECTRIC BOX PELB Material Property - Electric Box	 OEM PELM Meter - Electric	 ER PELR Riser - Electric	 PELV Spot Elevation
 PEEL Finished Floor	 FFP PFLP Pole - Flag	 PFLY Fly Stations Symbol	 FOM PFOM Fiber Optic Marker	 OGM PGAM Meter - Gas
 GR PGAR Riser - Gas (Old)	 PGBD R/W Marker Granite	 PGFC Gas Fill Cap	 PGLT Ground Light	 GMW PGMW Gas Station Monitoring Well
 PGPS GPS Control	 GP PGPT Gate Post	GRASS PGRS Material Property - Grass	DIRT PGRT Material Property - Dirt	GRAVEL PGRV Material Property - Gravel
 GSO-N PGSN Gas Shut Off - Natural	 GV PGSO Gas Shutoff	 PGUY Pole - Guy or Stub	 PGVT Gas Vent Pipe	 PGWL Natural Gas Well



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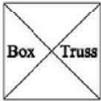
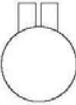
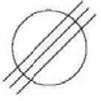
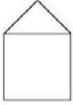
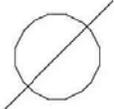
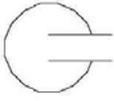
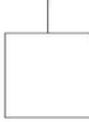
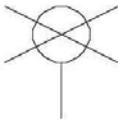
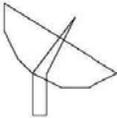
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 <p>PGWS Natural Gas Storage Well</p>	 <p>PPHL Hand Hole</p>	 <p>PHMD Manhole - Drainage</p>	 <p>PHPT High Pressure Tap</p>	 <p>PHUB Wood Stake</p>
 <p>PHYD Fire Hydrant</p>	 <p>PIDT INDOT Bench Mark</p>	 <p>PIFC Indiana Flood Control Bench mark</p>	 <p>PIP0 Iron Pipe - Other Size or Unknown</p>	 <p>PINT Pole - Joint Power & Telephone</p>
 <p>PLIT Pole - Light</p>	 <p>PLPT Private Lamp Post</p>	 <p>PLTD Pole - Light on Power Pole</p>	 <p>PLTJ Pole - Light on Joint Pole</p>	 <p>PMAG Nails - Mag Nail</p>
 <p>PMAP Pole - Mast Arm</p>	 <p>PMAT Material Property</p>	 <p>PMBD Mailbox (Double Box)</p>	 <p>PMBM Mailbox (Multiple Boxes)</p>	 <p>PMBX Mailbox (Single Box)</p>
 <p>PMGS Manhole - Gas Station</p>	 <p>PMHC Manhole - Cable TV</p>	 <p>PMHD Manhole</p>	 <p>PMHE Manhole - Electric</p>	 <p>PMHG Manhole - Gas</p>
 <p>PMHI Manhole - Traffic Signal</p>	 <p>PMHO Manhole - Other</p>	 <p>PMHS Manhole - Sewer</p>	 <p>PMHT Manhole - Telephone</p>	 <p>PMHW Manhole - Water</p>



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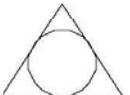
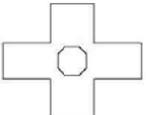
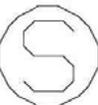
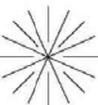
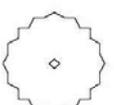
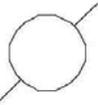
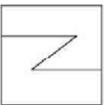
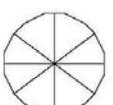
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	MULCH	 MB-USPS		
PMON Monument	PMUL Material Property - Mulch	PMUS Mailbox - USPS Boxes	PNGS NGS Triangulation Station	PNUM Index String - Non survey
				O.H.W. 
POBS Sign - Box Truss	POCS Sign - Cable Span	PODS Sign - Double Arm Cantilever	POMS Sign - Monotube	PORD Ordinary High Water Mark
				
POTS Sign - Tricord	POWN Property Owner	PPBX Pullbox	PPIN Iron Pin	PPIN Nails - PkNail
	POND			
PPOL Pole	PPON Material Property - Pond	PPSN Sign post - Commercial	PPSO Petroleum High Pressure Valve	PPST Post
				
PPVT Petroleum Vent Pipe	PPWP Pole - Power	PRDN Road Nail	PRBO Rebar - Other Size	PPRS Resection Point
BOULDER				
PROC Material Property - Boulder	PRRS Railroad Spike	PRSL Railroad Signal	FRSN Sign - Railroad	PSAT Satellite Dish



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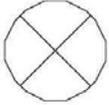
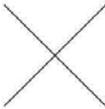
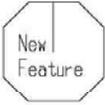
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PSBD R/W Marker Stone	PSGL Traffic Signal - No Mast Arm	PSGN Sign - Single Post	PSHD Sprinkler Head	PSLD Singnal Loop Detector Box
				
PSLM State Line Marker	PSND Sign - Double Post	PSSA Control - Instrument or Alignment	PSSC Control - Aerial cross	PSST Control - Section Corner Traverse
	STONE Material Property - Stone			
PSTK Septic Tank	STONE Material Property - Stone	PSTO Stone Monument	PSTP Stump	PSWP Swamp Symbcl
				
PTCS Tree Coniferous - Not Annotation Cell	PTDS Tree Deciduous - Not Annotation Cell	PTEL Pole - Telephone	PTER Riscr - Telephone	PTFP T-Post (Fence)
				
PTGP Pole - Telegraph	PTLM Town Line Marker	PTOW Metal Tower	PTRA Traverse Points	PTSP Pole - Traffic Signal-Strain
				
PTUB Telephone - Splice Tub	PTVR Riser - Telephone	PUSC USC and GS Bench Mark	PUSG USGS Bench Mark	PVAC Car Wash Vacuum



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 <p>PVBX Valve Box</p>	 <p>PWAM Meter - Water</p>	 <p>PWAR Riser - Water</p>	 <p>PWEL Well</p>	 <p>PWGT Water Gate</p>
 <p>PWLP Well Pit</p>	<p>WOODS</p> <p>PWOD Material Property - Woods</p>	<p>WEEDS</p> <p>PWRS Material Property - Weeds</p>	 <p>PWSO Water Shutoff</p>	 <p>PWTR Top of Water 500' Up/Downstream</p>
 <p>PZZZ Point - New Topo String</p>	 <p>SN_ARTHR Arrow Thru</p>	 <p>SN_EARCLT Arrow Left Turn and Thru</p>	 <p>SN_EARCRT Arrow Right Turn and Thru</p>	 <p>SN_EARLT Arrow Left Turn</p>
 <p>SN_EARRT Arrow Right Turn</p>	<p>ONLY</p> <p>SN_EONLY Only</p>	 <p>SN_RR Railroad</p>	<p>SCHOOL</p> <p>SN_SCHOOL School</p>	<p>X-ING</p> <p>SN_XING Crossing</p>



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Appendix F

InRoads Files to be Delivered

The department has established a standard naming convention for all InRoads survey files to make the data more portable so all users can easily recognize and use the files created by others. In addition, the conventions also provide information on file contents at a glance. InRoads Survey files submitted to INDOT shall use the format and provide the content as described below.

Example file name convention: **DES#_SRxx Name.extension**

Key:

DES#: = designation number for project as provided by INDOT

SRxx: = route number of project, for example: SR37, SR162, I64, US150

Name: = descriptive name of information in file, for example: Topo, LCRS Plat

Extension = file extension name, for example: .xin, .dgn, .fwd

The following files shall be submitted to INDOT for all survey.

1. Des #_SRxx Control Points.fwd
2. Des #_SRxx LCRS Plat.pdf
3. Des #_SRxx LCRS Plat.dgn
4. Des #_SRxx Survey Alignment.alg
5. Des #_SRxx Survey Book.docx
6. Des #_SRxx Survey Surface.dtm
7. Des #_SRxx Survey Surface Boundary.dtm
8. Des #_SRxx Survey.xin
9. Des #_SRxx Topo.dgn
10. Des #_SRxx Topo.fwd

Each file shall include, at a minimum, the data described below for each respective file.

1. Des #_SRxx Control Points.fwd

This file includes all centerline, partial list of fly stations (random control points), bench marks, and United States Public Land Survey (USPLS) subdivision corners, to include corners of property not falling within USPLS areas, necessary to describe any acquisition parcels.



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- a. Centerline: All centerline points of each survey line within the survey project shall be included in this file
 - 1) Code for centerline points shall be “PSSA”
 - 2) Notes for each “PSSA” shall include location (e.g., POT, PC, POST, etc.) stationing, line letter, PI information (delta angle, degree of curve or radius length, tangent length, arc length, and external length), description of monument, and location of top of monument relative to ground surface or pavement surface
- b. Fly station: All fly stations traversed through during establishment or reestablishment of survey lines shall be included in this file. All “fly” locations set during topographic collection shall NOT be in this file, but shall be included in the “Des #_SRxx Topo.fwd” file
 - 1) Code for fly station shall be “FLY”
 - 2) Notes for “FLY” shall include description of monument and location of top of monument relative to ground surface or pavement surface for each point
- c. Bench marks used for survey data collection shall be included in this file
 - 1) Monuments shall be coded per the .xin file provided by INDOT
 - 2) Bench mark notes shall include the name and description of the monument, a description of the structure that the monument is placed in or on, the station and offset from the survey line, and the survey line name
 - i. Examples include: BM#1, Boat Spike in root of 21 inch Oak tree, 125 feet left of Station 123+45, Line “A”; or INDOT BM 19 V 1030, disc in north end of concrete headwall, 55 feet right of Station 35+25, Line “S-1-A”
- d. USPLS corners, or corners of property not falling within USPLS areas, necessary to describe acquisition parcels, shall be included in this file:
 - 1) Monuments shall be coded per the .xin file provided by INDOT
 - 2) Notes for monuments shall include location of corner, for example, “N ¼ Corner of Section 34, T2N, R2W”, for those areas within USPLS. Or, for example, “NE Corner of Division “C” of the Vincennes Commons Lands” for those areas not within USPLS.
 - 3) Notes shall include description of monument and location of monument relative to ground surface or pavement surface for each monument.



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2. Des #_SRxx LCRS Plat.pdf

This file is a copy of the Location Control Route Survey Plat as recorded in the respective Office(s) of the County Recorder, for the survey project. This copy shall have the seal and signature of the Licensed Land Surveyor in responsible charge, as well as all recording information placed on the LCRS by the Office of the Recorder for the county in which the survey is located.

3. Des #_SRxx LCRS Plat.dgn

This Microstation file shall contain multiple models containing the following items:

- a. Model(s) containing the Location Control Route Survey (LCRS) plat used to generate LCRS plat for recording with the County Recorder. This shall be provided for design reference and use.
- b. Model(s) for survey control points and references, containing the following:
 - 1) Description of point along alignment (e.g., POT, PC, POST, etc.).
 - 2) Stationing of survey line point (e.g., 123+45.67, etc.)
 - 3) Line letter (e.g., "A", "S-1-A", etc.)
 - 4) Description of monument (e.g., 5/8 inch rebar with cap stamped INDOT 0005, Mag Nail with washer stamped INDOT 0005, etc.)
 - 5) Location of top of monument relative to ground surface (e.g., Flush with surface, 0.1 feet below ground surface, protruding 0.4 feet above ground surface, etc.)
 - 6) Description of reference monument (e.g., Nail in Bottle Cap in 15 inch Maple, Nail in Bottle Cap in Corner Fence Post, X Cut in Concrete Headwall, etc.)
 - 7) Azimuth (to nearest degree) and distance (to nearest one hundredth of a foot) from control monument to reference monument
- c. Model(s) containing USPLS corners or corners falling within areas not part of the USPLS and references, containing, at a minimum, the following:
 - 1) Description of USPLS corners (e.g., W ¼ Corner of Section 24, T3N, R5W)
 - 2) Description of monuments not falling within USPLS areas (e.g., NE Corner of Division "C" of the Vincennes Commons Lands)



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- 3) Description of monument (e.g., 9" X 6" stone with "S 24 W ¼" cut on side of stone)
- 4) Location of top of monument relative to ground surface (e.g., Flush with surface, 1.5 feet below ground surface, protruding 0.7 feet above ground surface, etc.)
- 5) Description of reference monument (e.g., Nail in Bottle Cap in 15 inch Maple, Nail in Bottle Cap in Corner Fence Post, X Cut in Concrete Headwall, etc)
- 6) Azimuth, to the nearest degree, and distance, to the nearest one hundredth of a foot, from control monument to reference monument

4. Des #_SRxx Survey Alignment.alg

This file includes all alignments of the survey project.

- a. When writing Survey ("Des #_SRxx Control Points.fwd") to Geometry, in "Project Name" box, enter "Survey Alignment"
- b. When creating alignment, in "Name" box, enter "A" for Line "A", etc.
- c. If there is an "S" line, under "Survey Alignment", name alignment "S-1-A", "S-SRxx-A", etc.
- d. For the description of each alignment, use the applicable route name (e.g., SR 1, CR 250 W, etc)
- e. The alignment shall have the correct stationing applied.
- f. Save as "Des #_SRxx Survey Alignment.alg"

5. Des #_SRxx Survey Book.docx

This file includes all supplemental survey information not found in other files.

The .docx format is preferred; however .doc or .pdf would also be acceptable.

- a. Front Page notations, i.e. Des No., Route No., Terminal Points of Project, County, brief description of each line
- b. Title page and complete Table of Contents
- c. Date of survey: when survey was started, and when survey was completed
- d. Names of Survey Crew members
- e. Des Number and Page Numbers at top of each page
- f. Surveyors Report, as per IAC-865, as a minimum requirement
- g. Start and end of each line shown with equations and cross references to other surveys
- h. Control Points labeled; location (e.g., POT, PC, POST, etc.), stationing, line letter, location relative to surface (e.g. flush, 0.1' below ground level, etc.), and coordinates shown



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- i. Alignment data shown and checked
- j. References shown and checked, if no LCRS plat was prepared. If an LCRS plat was prepared, this information will be on the recorded LCRS Plat.
- k. Source of bearings described
- l. Utility ownership within limits of survey listed, with mailing address, together with a notation of any utilities not within limits
- m. Underground Utility Reference Number placed on Utility page
- n. High water elevation and date, together with source and date of information
- o. Source of level datum
- p. Bench mark descriptions complete
- q. Level Notes for all Bench Marks used for survey
- r. Legal flow line elevations of county ditches
- s. Level equations with other surveys shown, and explained

6. Des #_SRxx Survey Surface.dtm

- a. When writing Survey to Surface, in “Surface Name” box, enter “Survey Surface” and save as “Des #_SRxx Survey Surface.dtm”.
- b. For more than one surface within survey project, use “Survey Surface A”, etc. (see “Des #_SRxx Topo.fwd” below).
- c. All string crossings shall be resolved.
- d. Upon completion of the survey, with all corrections of field data completed, a “Survey Surface” shall be created. After determining this surface is correct, create a boundary string named “Boundary” by connecting all points and strings along exterior of survey that are to be included in the triangulation. “Survey Surface” will contain the survey surface and the exterior “Boundary” feature. This surface shall be saved as “Des#_SRxx Survey Surface.dtm”.

7. Des #_SRxx Survey Surface Boundary.dtm

- a. After creating the boundary string around survey perimeter, as described in item 7d above, that boundary shall be saved in a separate surface file as “Des #_SRxx Survey Surface Boundary.dtm”, which shall only contain that feature.
- b. For more than one boundary around a survey project, use “Survey Surface Boundary A” for boundary of “Survey Surface A”, etc. (see “Des #_SRxx Topo.fwd” file below).



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8. Des #_SRxx Survey.xin

This is the InRoads “xin” file used for this survey project. InRoads Standards for survey data processing have been set up in this file. This file includes the INDOT standards for Feature Codes, Feature Styles, and Feature Filters, Dialog Box Settings, Linestyles, Lineweights, colors, and other settings. This file is critical for use in the InRoads Survey Process and for accurate DTM and geometry object creation. It is advisable to NOT add additional Names Symbology or Styles in order for the .xin file to be consistent with current MicroStation settings so utilities will function properly.

- a. Shall be a copy of INDOT.xin, as provided by INDOT CAD Support, at the time of project inception.
- b. All modifications to the XIN shall not affect the ability of submitted files (.dtm, .alg, .fwd) to interact with later versions of the XIN in an error free manner (feature names, symbology, etc. shall not be changed).

9. Des #_SRxx Topo.dgn

Secondary display items such as Contours, Triangles, and Survey Graphics, may be written to additional .dgn files and provided as references

- a. MicroStation file used with InRoads for this survey project.
- b. Shall adhere to the appropriate unitary system for the survey, for example: US Survey Feet, seed files as provided by CAD Support.
- c. The following features shall be displayed (on separate levels, as defined by the INDOT.xin):
 - 1) DTM Features
 - 2) Existing Contours
 - 3) Existing Triangulation
 - 4) Survey Alignment with Annotation
 - 5) Survey Fieldbook Data written to Graphics
 - i. Symbols
 - ii. Names
 - iii. Elevations
 - iv. Notes
 - v. Codes

10. Des #_SRxx Topo.fwd

This file contains all topographic data of the survey project.

- a. All topographic data for survey project shall be included in 1 (one) field book (i.e., Des #_SRxx Topo.fwd”). An exception shall be if there are



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isolated survey locations in a lengthy Des # project, for example structure replacements in a resurface project, as discussed below.

- b. Under “Survey Data” in InRoads, create a new book named “Des #_SRxx Topo”.
- c. Import data collector (controller) or text file into InRoads to create a field book. Save the created field book as “Des #_SRxx Topo.fwd”.
- d. Data imported from a collector (controller) or a text file shall not have a file name containing more than 15 characters. Any file name longer than 15 characters will be truncated within InRoads to 15 characters after the field book is saved and then loaded again at the next session. Note that this is not the name of the field book as called for in item 11c above, but is the name of the data file used to create the field book.
- e. If more than one survey site is included in the survey project, the sites not being near each other (for example, two or more small structure replacements in a resurface project), create a different .fwd file for each site. For example, “Des #_SRxx Topo A” for the first site (south to north, or west to east) and “Des #_SRxx Topo B” for the second site, and continuing using same procedure.

For files that are created by Aerial Survey:

1. All files created by Aerial Survey shall follow the established InRoads survey file naming and technical conventions.
2. When naming these files, they shall have the suffix “_Aerial” appended at the end of the file name, prior to the file extension, for example: “Des #_SRxx Topo_Aerial.fwd”.
3. When a combination of Aerial and Ground Surveys are submitted, the Aerial and Ground Surveys shall be combined into a single .dtm survey surface.