3-204. Imagery standard.

[Section 3-204 appears after this cover page in a legacy format.]

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1.0 Standard

1.1 Description

This standard provides requirements necessary for the creation, development, delivery, and maintenance of aerial imagery acquisition to support a statewide Nebraska Imagery Program. There are multiple uses for imagery and data acquisition is expensive and requires preplanning. These standards are set at a minimum such that the majority of applications and needs are met across the state.

It is important to collect ortho-rectified imagery so that ground features can be measured and other data layers can be created from the data source which has a strong relationship to ground control. The data required for ortho-rectification include orientation parameters for the source image(s) and a digital elevation model (DEM) of the geographic area to be covered by the imagery. Ortho-rectification corrects for tip and tilt of the aircraft and displacement in the photograph caused by changes in the ground elevation.

Generally, the development of ortho-rectified imagery requires the acquisition of overlapping photography of the same geography and some combination of surveyed ground control and airborne (Global Positioning System) GPS collection at the time of photography. A photogrammetrist performs image correlation techniques and aero-triangulation on the resulting block of photographs to establish the orientation parameters of the individual image. Using a most recent DEM source or new LiDAR DEM provides the base for which the new imagery is rectified. These operations make ortho-rectified imagery more expensive than uncorrected aerial photography, but also make it far more accurate and useful.

Ultimately, accurate base maps can be derived from ortho-rectified imagery because the image has been geometrically corrected such that the scale is uniform. Streets and roads, curbs, manholes, water edge, tree inventories, fire hydrants, and numerous other features can be accurately mapped from the imagery. This also allows for accurate measurements of features and relationships between features, directly on the photograph.

The standard provides a consistent structure for data producers and users to ensure compatibility of datasets within the same framework layer and when used between other Nebraska Spatial Data Infrastructure (NESDI) framework layers such as survey and geodetic control and LiDAR.

This standard does not restrict or limit additional buy-ups of imagery data and services. These standards are meant to be a minimum set of standards and are subject to be updated based on technology enhancements, necessary workflow changes, and other data requirements. Other imagery data that is available at specifications that are above the minimum standard will be evaluated on a case-by-case basis.

The standard is not intended to be a substitute for an implementation design. These standards can be used at local, state and federal level to ensure interdisciplinary compatibility and interoperability with other framework layers. These standards integrate with existing standards such as the American Society for Photogrammetry and Remote Sensing (ASPRS) and other NITC related standards.

1.2 Acquisition and Processing

1.2.1 Flight Specifications

Proper planning and pre-flight requirements are necessary steps prior to acquiring imagery. This includes consideration of temporal requirements, proper flight planning, and ensuring that the characteristics of the sensors used in acquisition of imagery meet these requirements.

1.2.1.1 Temporal Requirements

Time of Day: Imagery will need to be acquired during minimal shadow conditions. Image acquisition shall occur when the sun angle is equal to or greater than 30-degrees.

Time of Year: All imagery shall be collected during the late-Winter / early-Spring flying season during leaf-off conditions for deciduous vegetation in Nebraska. Exceptions can be made on a case-by-case basis for certain applications requiring leaf-on imagery.

1.2.1.2 Flight Plans

Flight line orientation for all flight lines shall be in a cardinal direction, either north-south or east-west orientation when feasible. Flight plans must be approved prior to imagery acquisition. Information will need to be provided including project boundary, flight line numbers, flight line locations, and recommended ground control locations. If a frame sensor is used, exposure numbers should be included as well. For quality assurance purposes, the vendor shall submit copies of flight logs as part of the preliminary imagery deliverables.

1.2.1.3 Sensor Characteristics

The entire mission in a given year must be flown with sensors having the same specifications. The system shall use square pixels (ground footprint) at all times during processing. The technique of using aggregated detectors resulting in a rectangular pixel before blending with other channels shall not be used. The aerial camera shall be a precision aerial mapping camera equipped with a low distortion, high resolution lens. Camera characteristics shall be such that the aerial photographs taken can be satisfactorily used with the vendor’s proposed photogrammetric compilation equipment and environment. Calibration certificates for all systems to be used for acquisition will need to be provided.

1.2.1.4 Sun Angle

The images should be acquired only during the portion of the day when the sun angle exceeds the minimum of 30 degrees. To expedite acquisition within the photo periods, different sun angles may be permitted, provided the image does not have excessive shadows that preclude interpretation and data collection.

1.2.2 Ground Control

Ground control needs to be established of sufficient density and accuracy to meet the accuracy requirements of the ortho-rectified imagery.

Ground controls points used for aerial triangulation should be at least three times better than the expected accuracy of aerial triangulation solution. For example, in order to produce an orthophoto with an $RMSE_r$ of 15cm, the aerotriangulation results should have an $RMSE_{xyz}$ of 7.5 cm and the ground control used should have $RMSE_{xyz}$ of 2.5 cm. The control shall be sufficient to supplement the airborne GPS and Inertial Measurement Unit (IMU) in order to meet the required product accuracies.

For all photogrammetric data sets, the accuracy of the aerial triangulation or INS orientation (if used for direct orientation of the camera) should be at least twice the accuracy of derived products, as evaluated at higher accuracy check points using stereo photogrammetric measurements. Ground control and blind quality control points shall be required for softcopy aero- triangulation and ortho-photography generation to meet the accuracies specified.

Both ground control and quality control points will be based on a county or project area size depending on the scope of the project to be flown. The control diagrams, indicating the anticipated vertical and horizontal accuracies, will be reviewed before imagery collection begins.

The availability and/or quality of any existing ground control will need to be determined prior to flight acquisition. Any new control established for a project area will be delivered including sketches, pictures of control locations, and an ISO 19115 compliant metadata file. Those responsible for evaluating ground control should not assume that control exists, but it could be beneficial to use existing control if possible.

1.2.2.1 Global Positioning Systems (GPS)

If additional ground control needs to be established, the ground control shall be established with survey grade instrumentation. The GPS control survey needs to be conducted with a licensed surveyor or engineer representing the quality control process. A plan will need to be provided to recommend and coordinate the placement of ground control target locations of a sufficient quantity and size to control the photogrammetric accuracy specifications. Any new ground control established must be tied to the Nebraska NAD83 horizontal datum. All ground control points must be documented as such so that they are easily located by other surveyors throughout the duration of the project.

The horizontal root-mean-square error (RMSE) of the airborne GPS control data shall not exceed 0.2m. The vertical RMSE of the Airborne GPS control shall not exceed 0.3m.

1.2.2.2 Digital Elevation Model (DEM)

Elevation data is necessary for ortho-rectifying imagery. A digital elevation model (DEM) shall be developed at a density level necessary to support the imagery ortho-rectification process.

The elevation data may come from various sources to build a DEM. Elevation data may be derived from LiDAR, photogrammetry or autocorrelation as long as it provides sufficient accuracy and precision to support imagery horizontal accuracy requirements. Preference is to use LiDAR where it is available in the state. The DEM shall consist of points spaced at regular intervals along a grid, points of significant high or low elevations, and ortho-photography specific breaklines at all significant terrain breaks. In cases, where breaklines are not available suitable breaklines will need to be created to support an elevation dataset. It is not necessary to capture break lines at all curbs, ditches, stream banks, or other similar minor terrain breaks. The DEM shall be free of artifacts and data voids. The vertical accuracy of the DEMs developed to support production of the ortho-rectified imagery shall be sufficient to guarantee the horizontal accuracy specified in these standards.

The U.S. Geological Survey's National Elevation Dataset (NED) has 1/3 arc-second digital elevation model (DEM) data. Unless an area is very flat, the NED should not be used for less than 12 inch resolution data where higher accuracy is required.

There is no guarantee that the available DEM will be adequate to meet the final product accuracy specifications. An updated DEM is necessary in order to support the ortho-rectification production specifications and accuracy standards. This may require the acquisition of LiDAR to complete this task.

Updates to the existing DEM need only support the ortho-rectification process and are not required to support contour modeling or other applications. The DEM data is not to be stored as a record (Z component) for each pixel of the ortho-rectified image.

1.2.3 Ground (Spatial) Resolution

The final imagery output needs to be at a minimum of 12 inch ground sample distance (GSD). GSD is referred to as spatial resolution. This orthoimagery should meet ASPRS Class II horizontal accuracy standards for digital Orthoimagery and 1:2,400 Digital Planimetric Data.

A scale that equivalents higher resolutions (i.e., 6 inch) can be acquired as long as it meets the respective scales and horizontal accuracies associated to its desired spatial resolution found in section 1.2.6.

1.2.4 Spectral Resolution

Imagery will need to be provided in four primary spectral bands at 12 bit including Red (R), Green (G) and Blue (B) and Infrared (IR). All color imagery shall be the equivalent of natural true color, to include 256 levels of value for each color band for RGB. The sensor or camera shall save the bands in the following order: Red, Green, Blue, and infrared.

1.2.5 Radiometric Resolution

The digital aerial images shall be clear and sharp in detail and of high radiometric quality. The sensor shall capture the images in an uncompressed “lossless” image format. The

sensor shall, at minimum, utilize 12 bits per pixel radiometric resolution. Up-sampling from a lower bit depth to a higher bit depth is not allowed (e.g. resampling 8 bit data to 12 bit data). Color balancing shall result in colors which appear natural to a human observer. Image contract and brightness shall be adjusted to minimize perceptible differences within and between adjacent images.

1.2.6 Horizontal Accuracy

Horizontal accuracy assessment will be required for both in absolute and relative conditions. The pixel size of the final digital orthoimagery is being considered for this assessment not the GSD of the raw image that is used to establish the horizontal accuracy class.

- Absolute requires the use of ground control points for testing purposes. These points, found in the image and coordinates from the ortho-rectified image, are compared to the published coordinates.
- Relative horizontal accuracy assessment involves the visual inspection of adjacent images for edge matching, and the comparison of the ortho-rectified image to planimetric data. The relative displacement would be quantified.
- Recommendations for achieving the horizontal accuracy assessment shall be provided prior to acquisition including the number of and the distribution of check points within the project. QC points should be included in flight and control layout prior to acquisition.

The final imagery output needs to meet horizontal accuracy requirements established by ASPRS Class II accuracy for a minimum 12 inch GSD as defined in the following table.

Horizontal Data Accuracy Class	**RMSEx and RMSEy**	**Orthophoto Mosaic Seamline Maximum Mismatch**	**Aerial Triangulation or INS-based RMSEx RMSEy and RMSEz**
I	Pixel size x 1.0	Pixel size x 2.0	Pixel size x 0.5
II	Pixel size x 2.0	Pixel size x 4.0	Pixel size x 1.0
III	Pixel size x 3.0	Pixel size x 6.0	Pixel size x 1.5
…			
N	Pixel size x N	Pixel size x 2N	Pixel size x 0.5N

When producing digital orthoimagery, the GSD as acquired by the sensor (and as computed at mean average terrain) should not be more than 95% of the final orthoimagery pixel size. In extremely steep terrain, additional consideration may need to be given to the variation of the GSD across low lying areas in order to ensure that the variation in GSD across the entire image does not significantly exceed the target pixel size.

The following table serves as a guide for three common ASPRS horizontal accuracy standards for planimetric maps intended for use at common map scales.

Orthophoto Pixel Size	Horizontal Data Accuracy Class	RMSEx or RMSEy (cm)	RMSEr (cm)	Orthophoto Mosaic Seamline Maximum Mismatch (cm)	Horizontal Accuracy at the 95% Confidence Level (cm)
7.5-cm (~3 in)	I	7.5	10.6	15.0	18.4
	II	15.0	21.2	30.0	36.7
	III	22.5	31.8	45.0	55.1
15-cm (~6 in)	I	15.0	21.2	30.0	36.7
	II	30.0	42.4	60.0	73.4
	III	45.0	63.6	90.0	110.1
30-cm (~12 in)	I	30.0	42.4	60.0	73.4
	II	60.0	84.9	120.0	146.9
	III	90.0	127.3	180.0	220.3

1.2.7 Projection and Datum

Imagery for the project will be referenced to the North American Datum of 1983 (NAD83) using the 2007 HARN adjustment, and the North American Vertical Datum of 1988 (NAVD 88) with the latest ellipsoid and Geoid09 adjustments. Imagery shall be oriented to the appropriate Nebraska State Plane using U.S. Feet.

1.2.8 Pixel Clarity

Pixel clarity is defined by pixel size and relation to the ground sample distance (GSD) of the specified pixel size. It is not recommended to resample from a coarser image to obtain a finer image resolution. The image can be resampled from a sharper image for a coarser image (i.e., obtaining an 18-inch pixel resolution from one foot).

1.2.9 Image Quality

Images shall be tonally balanced and image mosaics shall be uniform in contrast without abrupt variations between image tiles. Imagery shall be free of blemishes, and artifacts that obscure ground feature detail. Pixel resolution shall not be degraded by excessive image smear. Imagery shall have a tonal range that prevents the clipping of highlights or shadow detail from the image.

1.3.0 Environmental Conditions and Obstructions

To the extent possible, no clouds, snow, fog, haze, smoke, or other ground obscuring conditions shall be present at the time of the flights. Ground conditions are free of snow, flooding and excessive soil moisture. Streams and rivers should be within their normal banks, unless otherwise negotiated. Spectral reflectance from water must be minimized and should not obscure shoreline features. In no case will the maximum cloud cover exceed 5% per image.

1.3.1 Edge Effects

Sufficient end and side laps need to be taken into consideration to prevent any gaps in coverage and to provide all necessary coverage for accurate ortho-rectification and visual

interpretation. The crab shall not be in excess of three (3) degrees; and, tilt of the camera from verticality at the instant of exposure shall not exceed three (3) degrees.

1.3.2 Building Lean

Additional supplemental flight lines should be acquired in areas of tall buildings to limit building lean in city blocks. Recommended supplemental flight lines should be provided in preliminary flight layout for prior review and approval.

1.3 Data Format

The data format provided will need to be in uncompressed tiles in a GeoTIFF format that can be interpreted by commercial imagery and GIS software. Tile schemes will need to be provided at 5,000 feet x 5,000 feet. If mosaic imagery is suggested, the area of interest (AOI) or collection area (i.e., county, quadrangle, city, etc) will need to be provided. The mosaic imagery need to be compressed and provided as JPEG2000 with a compression ratio of 20:1.

1.4 Maintenance

Entities responsible for data acquisition and deliverables will need to assure data meets standards and are updated and maintained in a timely manner. After spatial and attribute updates and/or modifications are performed to the data it shall be submitted to the appropriate entity(s) responsible for performing quality control and maintenance of the data acquisition.

Maintenance of elevation data determines the suitability to support the greatest range of applications. Many projects require up-to-date, accurate and consistent elevation data and maintenance of this data is necessary to provide the maximum return on investment.

1.4.1 Reporting Errors and Handling Updates

The reporting of errors need to be directed to the appropriate entity in a timely manner. Updated spatial and attribute information in the data will also need to be redistributed. The date field in the metadata when the last record was modified will also need to be updated to ensure proper records management and communication with others in the workflow.

1.5 Quality Control

A quality control process is required by a third-party to ensure the delivery of an image product that satisfies the requirements as defined by these standards. The quality of imagery acquisition is evaluated based on the overall functional correctness and completeness of the technical requirements that also include a horizontal accuracy test. In the event that data does not meet specific requirements of these standards, the imagery will be rejected and the vendor will be required to either reacquire or re-process data appropriately to meet these standards.

1.5.1 Horizontal Accuracy Test

A number of check points will need to be collected within each area of interest to verify the horizontal accuracy of the ortho-rectified production process. The check points must be completely independent of ground control used during aero-triangulation and data

production. The recommended number of check points based on the size of area will follow ASPRS guidelines.

1.5.2 Re-Flights

A plan for re-flights of areas will need to be provided in the event of image rejection during the quality control process, or where original imagery could not be collected because weather or ground cover conditions, or other factors outside the control of the vendor precluded collection at the scheduled time of the flyover. Mechanical or technical problems shall not be considered a legitimate reason for non-collection.

1.6 Integration with other Standards

1.6.1 Street Centerline Standards (NITC 3-205)

These minimum standards for imagery acquisition are designed to ensure the acquisition of imagery sufficient to meet the requirements for digitizing street centerlines as required in the Street Centerline Standards NITC 3-205.

1.6.2 Address Standards (NITC 3-206)

These minimum standards for imagery acquisition are designed to ensure the acquisition of imagery sufficient to meet the requirements for digitizing street centerlines as required in the Address Standards NITC 3-206.

1.7 Metadata

Complete and comprehensive metadata is required for the acquired imagery. The metadata will require detailing the characteristics and quality of submitted imagery files. Information needs to be provided to allow the user sufficient information so they can determine the data's intended purpose as well as how to access the data. The metadata requires a process description summarizing collection parameters such as: contact information, data source, scale, accuracy, projection, use restrictions, and imagery acquisition dates. The process description will also need to be included to describe methodology towards the deliverable products.

1.7.1 Federal Metadata

The ISO 19115:2003(E) North American Profile (NAP) Metadata Standards should be used when feasible and in every effort possible to assure high quality rigorous standards. Metadata will need to be supplied for each tile and be provided in an XML format. All imagery datasets, and their associated attribute databases should be documented with ISO 19115 compliant metadata. Supplemental metadata information includes the following: (1) tested horizontal accuracy statement, (2) lineage, including, but not limited to: flight height, photo acquisition dates (and re-flights if any), overlap, sidelap, number of flight lines, number of exposures, direction of flight lines, control, resolution, tiling scheme, file sizes, description of the process used to create digital orthophotos, source of DEM, and (3) spatial reference information: projection, ellipsoid, horizontal and vertical datum, and horizontal and vertical units.

1.7.2 State Metadata

These standards need to apply to Nebraska's metadata standards located within NITC 3-201 Geospatial Metadata Standard. All metadata from imagery files will need to be registered through the metadata portal at NebraskaMAP (http://NebraskaMAP.gov). All developers of Nebraska-related geospatial data are encouraged to use the site to either

upload existing metadata and/or use the online tools available on the site to create the metadata for imagery.

2.0 Purpose and Objectives

2.1 Purpose

The purpose of this standard is to provide the necessary requirements for the creation, development, delivery, and maintenance of aerial imagery data and services to support the Nebraska Spatial Data Infrastructure (NESDI). These standards will help ensure that imagery acquisition is consistent, accurate, publicly accessible, and cost-effective.

2.2 Objectives

These standards will guide the statewide imagery program having the following objectives:

2.2.1 Provide guidance and necessary workflows to state and local officials as they work, either in-house or with private vendors, to create, develop and maintain aerial imagery data and services. This can increase the likelihood that the data created will be suitable for the range of intended applications and likely future applications. The maintenance of aerial imagery data is necessary for the data to be current and accurate.

2.2.2 Enhance coordination and program management across jurisdictional boundaries by insuring that aerial imagery data can be horizontally integrated across jurisdictional and/or project boundaries, and other framework data layers for regional or statewide applications.

2.2.3 Save public resources by facilitating the sharing of aerial imagery data among public agencies or sub-divisions of agencies by incorporating data standards and following guidelines. Data that is developed by one entity can be done in a way that is suitable to serve the multiple needs of other entities. This avoids the costly duplication of developing and maintaining similar data in the state.

2.2.4 Make aerial imagery data current and readily accessible to the wide range of potential users through NebraskaMAP and other necessary resources.

2.2.5 Facilitate harmonious, trans-agency and public policy decision-making and implementation by enabling multiple agencies and levels of government to access and appropriately use current aerial imagery data. This can make it more likely that intersecting public policy decisions, across levels of government, will be based on the same information.

2.2.6 Lay the foundation for facilitating intergovernmental partnerships for the acquisition and development of high-quality aerial imagery data by defining standards that increase the likelihood that this data will meet the needs of multiple users.

2.2.7 Establish and promote the integration and interrelationships of aerial imagery data with related NESDI framework layers through geometric placement and attributes.

3.0 Definitions

Accuracy

Absolute - A measure of the location of features on a map compared to their true position on the face of the earth.

Relative - A measure of the accuracy of individual features on a map when compared to other features on the same map.

Band - A range of wavelengths of electromagnetic radiation.

Check Point – One of the surveyed points in the sample used to estimate the positional accuracy of the data set against an independent source of higher accuracy.

Confidence Level – The percentage of points within a data set that are estimated to meet the stated accuracy; i.e., accuracy reported at the 95% confidence level means that 95% of the positions in the data set will have an error with respect to true ground position that are equal to or smaller than the reported accuracy value.

Datum – A set of values used to define a specific geodetic system.

Digital Elevation Model - A digital cartographic representation of the elevation of the land at regularly spaced intervals in x and y directions, using z-values referenced to a common vertical datum. A DEM also assumes bare-earth terrain, void of vegetation and manmade features. The USGS DEMs archived in the National Elevation Dataset (NED) have different formats based on 1-arc-second, 1/3-arc-second, and 1/9-arc-second grid spacing.

Forward Lap or End Lap - The extent to which sequential exposures in a flight line overlap

Ground Sample Distance (GSD) – The linear dimension of a sample pixel's footprint on the ground. Within these standards GSD is used when referring to the collection GSD of the raw image, assuming near-vertical imagery. The actual GSD of each pixel is not uniform throughout the raw image and varies significantly with terrain height and other factors. The GSD is assumed to be the value computed using the camera focal length and camera height above average mean terrain.

Ground (spatial) resolution or pixel size – As used within these standards, pixel size is the ground size of a pixel in a digital ortho-rectified imagery product, after all rectifications and resampling procedures.

Horizontal Accuracy - The horizontal component of the positional accuracy of a data set with respect to a horizontal datum, defined at the 95% confidence level.

Image Correlation – Directly comparing hardcopy or softcopy images, or patches of pixels on conjugate digital images, or indirectly comparing information derived from the stereo images, to determine that points on stereo images (viewed from different perspectives) represent the same points on the imaged surface. Automated image correlation is a computerized technique to match the similarities of pixels in one digital image with comparable pixels in its digital stereo image in order to automate or semi-automate photogrammetric compilation. Automated image correlation provides an efficient method for generating DEMs photogrammetrically, but automated correlation normally results in Digital Surface Models (DSMs) instead of DEMs because such correlation generates elevations of rooftops, treetops and other surface features as imaged on the stereo photographs.

Inertial Measurement Unit (IMU) - An electronic device that measures and reports velocity, orientation, and gravitational forces, using a combination of accelerometers and gyroscopes, sometimes also magnetometers. IMUs work to detect changes in pitch, roll, and yaw of an aircraft. IMUs are typically used to maneuver aircraft, including unmanned aerial vehicles (UAVs), among many others, and spacecraft, including satellites and landers.

Leaf-Off / Leaf-On - Leaf-off and leaf-on refer to the presence or lack of the foliage of woody species. Leaf-off means that there is no foliage or a reduced amount of foliage on the tree or shrub species. Leaf-on imagery means that there is foliage on the tree or shrub species (or the species of interest). Sometimes it is beneficial to have leaf-off imagery so that you can see ground features more distinctly. This is helpful for mapping features such as buildings and roads, which may be obscured by tree foliage during the growing season. Leaf-off imagery is also used in forestry applications because the lack of leaves on some trees facilitates the classification of tree types. There are times when you might want leaf-on imagery, especially if the tree or shrub species has a distinctive spectral reflectance that can be distinguished from other vegetation. Leaf-on imagery is also used in agricultural applications to measure the quantity and health of crops. Many woody species may have similar spectral reflectance or structure that may benefit from either a leaf-off or leaf-on flyover.

Map or Cartographic Scale - The relationship between a given distance on the ground and the corresponding distance on a photograph or image. Scale is expressed in at least two different ways. Both are ratios. In the first, commonly used measuring systems are compared; for example 1" = 200' (one inch on the map equals 200 feet on the earth). In the second, the map unit is arbitrary; for example, 1:200 means that one of anything (an inch, a foot, a centimeter, etc.) on the map equals 200 of that same unit on the earth. (1"=200' is the same scale as 1:2400). Scale is presented in several ways: as a bar at the bottom of the map, as a ratio (1:200), or as an equation (1"=200').

Nebraska Spatial Data Infrastructure (NESDI) - A framework of geospatial data layers that have multiple applications, used by a vast majority of stakeholders, meet quality standards and have data stewards to maintain and improve the data on an ongoing basis. These layers are also consistent with the Federal National Spatial Data Infrastructure (NSDI).

Ortho-rectification - The process by which a photograph is prepared from a perspective photograph by removing displacements of points caused by tilt, relief and perspective.

Planimetric - Data about non topographic features on the earth surface that are represented only by their horizontal position.

Projection – A map projection flattens the earth, allowing for locations to be systematically assigned new positions so that a curved surface can be represented on a flat map.

Resolution – The smallest unit a sensor can detect or the smallest unit an ortho-rectified image depicts. The degree of fineness to which a measurement can be made.

Root Mean Square Error (RMSE) – The square root of the average of the set of squared differences between data set coordinate values and coordinate values from an independent source of higher accuracy for identical points.

RMSEr – The horizontal linear RMSE in the radial direction that includes both x- and y-coordinate errors.

RMSEx – The horizontal linear RMSE in the X direction (easting).

RMSEy - The horizontal linear RMSE in the Y direction (northing).

RMSEz - The vertical linear RMSE in the Z direction (elevation).

Side Lap **-** The extent to which the exposures of adjacent flight lines overlap, typical side lap for a block of aerial photography is 30%.

State Plane Coordinate System - The State Plane Coordinate System is a set of 124 geographic zones or coordinate systems designed for specific regions of the United States. It uses a simple Cartesian coordinate system to specify locations rather than a more complex spherical coordinate system (the geographic coordinate system of latitude and longitude). By thus ignoring the curvature of the Earth, "plane surveying" methods can be used, speeding up and simplifying calculations. The system is highly accurate within each zone (error less than 1:10,000). Outside a specific state plane zone, accuracy rapidly declines, thus the system is not useful for regional or national mapping.

4.0 Applicability

4.1 State Government Agencies

State agencies that have the primary responsibility for developing and maintaining aerial imagery data for a particular jurisdiction(s) or geographic area (e.g. for counties for which it has assumed the primary role) are required to comply with the standards as described in Section 1. Those state agencies with oversight responsibilities in this area are required to ensure that their oversight guidelines, rules, and regulations are consistent with these standards. The Nebraska Department of Roads has other imagery acquisition requirements for wetland and reconnaissance projects. They will continue to adhere to their independent photogrammetry requirements as suggested in the NDOR On-Call Digital Aerial Photography, Photogrammetric and Airborne LiDAR Services.

4.2 State Funded Entities

Entities that are not State agencies but receive State funding, directly or indirectly, for aerial imagery development and maintenance for a particular jurisdiction or geographic area are required to comply with the standards as described in Section 1.

4.3 Other

Other entities, such as city and local government agencies (e.g. County Engineer, assessors, and municipalities) that receive state funds have the primary responsibility for developing and maintaining aerial imagery data are required to comply with the standards as described in Section 1.

5.0 Responsibility

5.1 NITC

The NITC shall be responsible for adopting minimum technical standards, guidelines, and architectures upon recommendation by the technical panel. Neb. Rev. Stat. § 86-516(6)

5.2 State Agencies

The State of Nebraska, Office of the CIO (OCIO) GIS Shared Services will be responsible for assuring that metadata is completed and the data is registered and available for distribution through NebraskaMAP.

5.3 Granting Agencies and Entities

State granting or fund disbursement entities or agencies will be responsible for ensuring that these standards are included in requirements related to fund disbursements as they relate to aerial imagery.

5.4 Other

Local government agencies that have the primary responsibility and authority for aerial imagery acquisition will be responsible for ensuring that those sub-sections defined in Section 1 will be incorporated in the overall imagery data development efforts and contracts.

6.0 Authority

6.1 NITC GIS Council

According to Neb. Rev. Stat. § 86-572(2), the GIS Council shall: Establish guidelines and policies for statewide Geographic Information Systems operations and management (a) The acquisition, development, maintenance, quality assurance such as standards, access, ownership, cost recovery, and priorities of data bases; (b) The compatibility, acquisition, and communications of hardware and software; (c) The assessment of needs, identification of scope, setting of standards, and determination of an appropriate enforcement mechanism; (d) The fostering of training programs and promoting education and information about the Geographic Information Systems; and (e) The promoting of the Geographic Information Systems development in the State of Nebraska and providing or coordinating additional support to address Geographic Information Systems issues as such issues arise.

7.0 Related Documents

7.1 American Society for Photogrammetry and Remote Sensing (ASPRS), ASPRS Accuracy Standards for Digital Geospatial Data (2014).

7.2 FGDC Content Standard for Digital Geospatial Data Version 2 (FGDC-STD-001-1998).

7.3 ISO 19115:2003(E) North American Profile (NAP) Metadata Standards. National Oceanic and Atmospheric Administration (NOAA). January 2012.