Scope of Services

for

2024 Pikes Peak Geospatial Alliance Orthoimagery Project

October 26, 2023

Revision History

Revision	Date	Description
1.0	*08/21/2023*	*Previous RFP scopes, managed by CSU, were revised to account for changing specifications and new requirements.*
1.1	*8/31/2023*	*Adjusted text for comments provided by Tim Thomas. Still awaiting area confirmation for potential SA1 expansion.*
1.2	*10/16/2023*	*Exhibit appendices have been added to the document. Confirmed no changes to the SA1 area. Confirmation of Colorado Springs mosaic deliverables and stereo pair area still needed.*

Contents

1.0 Introduction

The goal of the 2024 PPGA project is for the Pikes Peak Geospatial Alliance (PPGA), through Colorado Springs Utilities (UTILITIES), to receive high quality digital orthoimagery in a timely fashion for both El Paso and Teller counties. The CONTRACTOR shall take a conservative approach to the project to ensure that the accuracy and aesthetics of the final product are free from defects and meet or exceed PPGA expectations.

Because the desired product is to be created under "leaf-on" conditions, aerial flights are anticipated during typical summer months of June to August. Proper CONTRACTOR preparation and resource and asset management can result in acquiring and producing the product without major issues. CONTRACTOR shall approach this project in such a way as to be in the position to meet final delivery specifications without undue delays.

2.0 Background

The Orthoimagery Project 2024 addresses on-going needs for current digital aerial imagery by multiple governmental agencies in a two-county area of the Pikes Peak region. The following subsections describe the area of interest of each of the participants and the resulting project sub-areas. Four Band, Color/Infra-Red, digital orthorectified aerial imagery must be delivered for the entire project area. All four sub-areas may require some level of Digital Elevation Model (DEM) updating or development. As detailed in Section 3, it may also be necessary to establish additional survey control points in the sub-areas. Map accuracy requirements shall be specified in terms of standards set by the American Society of Photogrammetry and Remote Sensing (ASPRS).

UTILITIES is administering this project on behalf of the PPGA. The PPGA, for this project is comprised of the following participants:

- El Paso County
- Teller County
- El Paso - Teller E-911 (E911)
- Colorado Springs Utilities (UTILITIES)
- City of Colorado Springs

3.0 Scope of Services

3.1. Purpose

UTILITIES shall oversee this project and will designate an individual to act as the official Project Manager. The Project Manager shall, with the consent of the participating members of the PPGA Steering Committee, perform the following duties and functions relative to this project:

1. Interpret and define project specifications regarding the Contractor's work activities
2. Direct and coordinate the (PPGA) responsibilities
3. Review Respondent's performance
4. Manage deliverables from Respondent(s) to other PPGA participants
5. Approve payments to Respondent(s) in accordance with defined payment and deliverable acceptance terms
6. Perform such other activities as may from time to time be necessary in the performance of the terms of the contract

7. Issue final acceptance of all deliverable products and services
8. Issue any change orders or modifications to the scope of the contract.

3.2. CONTRACTOR Responsibilities:

1. At the time of contract Amendment execution and subject to UTILITIES approval, CONTRACTOR shall assign a Project Manager with at least ***five years*** of project management experience to the project. CONTRACTOR shall obtain written approval from the PPGA prior to any change to the assigned project manager.
2. Develop a complete and concise project schedule
3. CONTRACTOR Project Manager shall strictly adhere to developed project plans, schedules and communication agreements.
4. At the time of fully executed Amendment and subject to UTILITIES approval, CONTRACTOR shall retain all required subcontractors needed to complete the project as per the project schedule.
5. Develop and document procedures to meet specifications as contracted;
6. Produce required new digital orthophotography in accordance with specifications;
7. Implement stringent QA/QC procedures and maintain specified quality standards;
8. Deliver all deliverable products as per the detailed schedule;
9. Provide project management and support services, such as required reporting, demonstrations, data handling, progress reports, and others as required.

3.3. Contract Administration

CONTRACTOR shall be responsible for the professional quality, technical accuracy, timely completion, and the coordination of all digital files, specifications, reports, and other products and services required to be furnished by it under this Agreement. PPGA shall have full and complete authority to reject any work deemed unacceptable pursuant to this Agreement. CONTRACTOR shall, without additional compensation, correct or revise any errors or deficiencies in such products and services if products do not conform to the specifications. In cases of rejection of CONTRACTOR's work, UTILITIES may suspend further deliveries and payments until the work tasks (products and services hereafter defined) in question are redelivered and reclassified as accepted.

4.0 Tasks and Deliverables

4.1 Project Area and Sub-Areas

Historically, the total project has been divided geographically into four (4) sub-areas, each reflecting a change in the delivery date. The map in Appendix B-1 illustrates these boundaries as well as a tiling scheme in which the tiles are dimensioned at 4,000' x 4,000'.

Note that all areas are represented in terms of tiles. Tiles within each of the four sub-areas are further grouped into project deliverable areas. The project deliverable areas equate to the desired delivery sequence. Deliverables for the OP 2024 project shall therefore include fifteen (15) area deliverables (Refer to Figure 1- 2024 Area Deliverables).

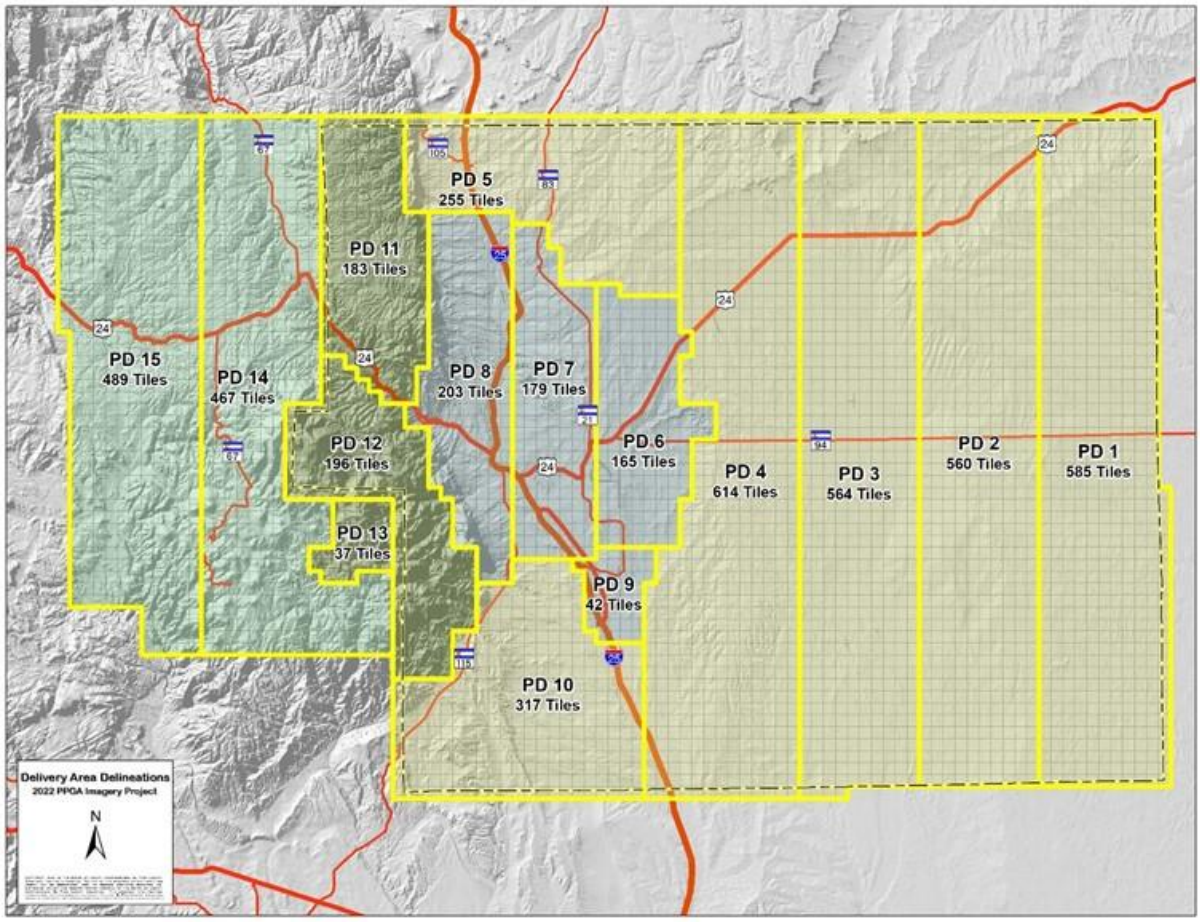

Figure 1 – 2024 Area Deliverables

Digital data representing the area and sub-area boundaries, tile layout, and deliverable areas shall be made available to CONTRACTOR. ***The total project area is approximately 2787 square miles.***

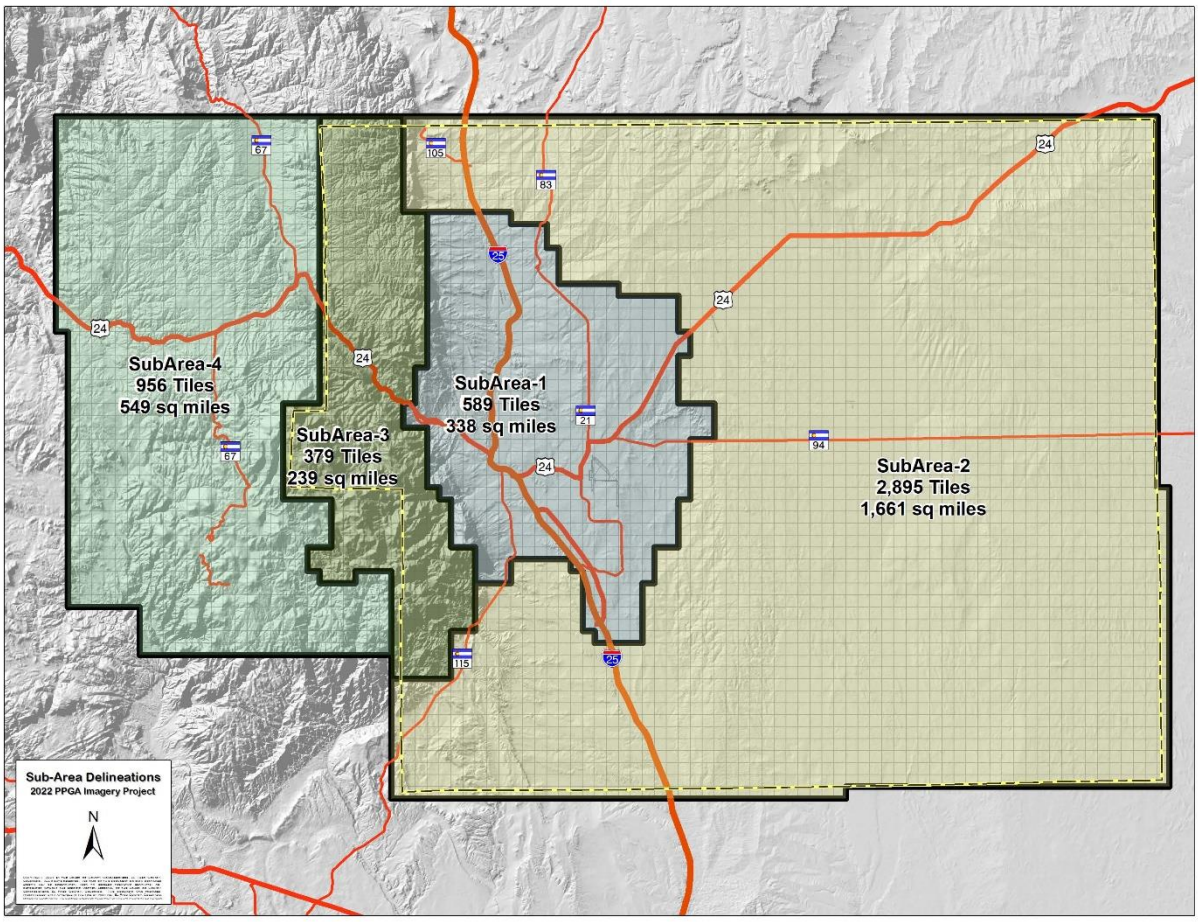

Figure 2 – 2024 Sub Areas

4.1.1 Sub-Area 1

Sub-Area 1 consists mostly of the Colorado Springs metropolitan area, including the US Air Force Academy and the City of Fountain (refer to Appendix B-1). The City of Colorado Springs and Colorado Springs Utilities have a primary interest in this sub-area with overlapping interests by E911 and El Paso County.

Sub-Area 1 must be flown in the spring of 2024 during leaf-off conditions. Depending on conditions, Sub-Area 1 flights must be conducted starting on or around March 15, 2024, and concluding on or around April 30, 2024. ***Sub-area 1 is 338 square miles, comprised of 589 tiles.***

4.1.2 Sub-Area 2

Sub-Area 2 shall encompass Ft Carson and the majority of El Paso County east of the mountains; less Sub-Area 1(refer to Appendix B-1). El Paso County and E911 have the primary interest in Sub-Area 2 with the City of Colorado Springs and Colorado Springs Utilities having an interest in portions of the area as well.

Sub-Area 2 must be flown during the spring of 2024. Depending on conditions, Sub-Area 2 flights must be conducted starting on or around April 15, 2024, and concluding on or around May 31, 2024. ***Sub-area 2 is 1,661 square miles, comprised of 2,895 tiles.***

4.1.3 Sub-Area 3 & 4

Sub-Area 3 and 4 are comprised of the mountainous areas of the western portion of El Paso County and all of Teller County. E911, El Paso County, Colorado Springs Utilities, and El Paso County all have predominant interest in the sub-area. **Due to snow considerations, Sub-Area 3 and 4 must be flown during the summer of 2024. Depending on conditions, Sub-Area 3 and 4 flights must be conducted starting on or around June 1, 2024, and concluding no later than July 31, 2024.** ***Sub-area 3 is 239 square miles and comprised of 416 tiles while Sub Area 4 is 549 square miles and comprised of 956 tiles.***

4.2 Sub-Area Specifications

Project Specification Overview				
Sub Area	SA-1	SA-2	SA-3	SA-4
Total Area / Tiles	338 sq mi / 589 tiles	1661 sq mi / 2895 tiles	239 sq mi / 416 tiles	548 sq mi / 956 tiles
Ground Sampling Distance	0.5'	1.0'	1.0'	1.0'
Ortho Resolution	Six Inch (6")	One Foot (1')	One Foot (1')	One Foot (1')
Orthoimagery Accuracy	ASPRS Class 1 for 1:1200 Map Scale (One Foot RMSE)	ASPRS Class 1 for 1:2400 Map Scale (Two Foot RMSE)	ASPRS Class 1 for 1:2400 Map Scale (Two Foot RMSE)	ASPRS Class 2 for 1:2400 Map Scale (Four Foot RMSE)
DEM Source	2018 LiDAR Data – Updated as needed to meet accuracy	2018 LiDAR Data – Updated as needed to meet accuracy	2018 LiDAR Data – Updated as needed to meet accuracy	Latest Available USGS NED data of 1/3 arc seconds (10 meters)
Coordinate System / Datum / Units	Colorado State Plane Central Zone, NAD 83 (HARN)	Colorado State Plane Central Zone, NAD 83 (HARN)	Colorado State Plane Central Zone, NAD 83 (HARN)	Colorado State Plane Central Zone, NAD 83 (HARN)
Control Source	CSU FIMS NAVD88 (DEM Update)	NGS, Colorado State Plane Central Zone, NAD 83 (HARN) NAVD 88 (DEM UPDATE)	NGS, Colorado State Plane Central Zone, NAD 83 (HARN) NAVD 88 (DEM Update)	NGS, Colorado State Plane Central Zone, NAD 83 (HARN) NAVD 88 (DEM Update)
Tiled Delivery Format	TIFF/TFW	TIFF/TFW	TIFF/TFW	TIFF/TFW
Mosaic Delivery Format	JP2	JP2	JP2	JP2
Imagery Type	RGBNIR	RGBNIR	RGBNIR	RGBNIR
Tile Scheme	PPGA 4000 x 4000	PPGA 4000 x 4000	PPGA 4000 x 4000	PPGA 4000 x 4000
Target Flight Window	Mar 15 – Apr 30	Apr 15 – May 31	Jun 1 – Jul 31	Jun 1 – Jul 31

4.3 Sub-Areas 1

4.3.1 Image Resolution

Image pixel resolution for Sub-Area 1 shall be six (6) inch.

4.3.2 Ground Sampling Distance

CONTRACTOR is not to exceed flying heights for the 6" pixel acquisition. CONTRACTOR shall not deviate from these requirements unless prior approval is obtained by the PPGA. Statistical sampling (RMSE) must show that these GSD values are achieved. **Offsets from the required ground sampling distances should not exceed ten percent (10%).**

Sub-area 1: Resolution = 0.5’ GSD MAXIMUM

4.3.3 Horizontal Accuracy

All final image products must meet the horizontal accuracy specifications listed below:

- ASPRS Class 1 accuracy standard for 1:1200 mapping. This specifies a point coordinate accuracy requirement in which the horizontal Root Mean Square Error (RMSE) for a minimum of 20 well defined points is less than 1.0 ‘

4.3.4 Digital Elevation Model (DEM)

The existing 2018 DEM ground surface, originally derived from the 2018 LiDAR data, shall be used as the rectification source for the 2024 flight. CONTRACTOR shall update any tile or tiles of DEM data for the surface to be adequate for accurate orthoimagery rectification.

Should the DEM for an orthophoto imagery tile need to be updated, the PPGA requires that the DEM be re-delivered in tile format (4000’x4000’) containing all DEM data used for that tile. This updated data shall be delivered in an LAS format.

4.3.5 Coordinate System

The coordinate system for this project shall be Colorado State Plane Coordinate System, Central Zone, Datum of NAD83 (HARN), units of US Survey Feet. Although limited to the DEM delivery, the Vertical Datum shall be NAVD88.

4.3.6 Flight Dates

Imagery shall be flown when deciduous foliage is generally under leaf-off condition. Thus, the target flight window shall be from June 1, 2024, to August 31, 2024. The appropriate flight dates are listed below and may be adjusted due to ground or weather conditions upon prior approval of UTILITIES.

Area	Start Date	Finish Date
Area SA-1	March 15, 2024	April 30, 2024

4.4 Sub-Area 2

4.4.1 Image Resolution

Image pixel resolution for Sub-Area 2 shall be one (1) foot.

4.4.2 Ground Sampling Distance (GSD)

CONTRACTOR is not to exceed flying heights for the 1’ pixel acquisition. CONTRACTOR shall not deviate from these requirements unless requested by CONTRACTOR and approved by UTILITIES. Statistical sampling (RMSE) must show that these GSD values are being achieved. **Offsets from the required ground sampling distances should not exceed ten percent (10%).**

Sub-area 2: Resolution = 1.0’ GSD MAXIMUM

4.4.3 Horizontal Accuracy

All final image products must meet the horizontal accuracy specifications listed below:

- ASPRS Class 1 accuracy standard for 1:2400 mapping. This specifies a point coordinate accuracy requirement in which the horizontal Root Mean Square Error (RMSE) for a minimum of twenty (20) well defined points is less than 2.0 ‘

4.4.4 Digital Elevation Model (DEM)

The existing 2018 DEM ground surface, originally derived from the 2018 LiDAR data, shall be used as the rectification source for the 2024 flight. CONTRACTOR shall update any tile or tiles of DEM data for the surface to be adequate for accurate orthoimagery rectification.

Should the DEM for an orthophoto imagery tile need to be updated, the PPGA requires that the DEM be re-delivered in tile format (4000’x4000’) containing all DEM data used for that tile. This updated data shall be delivered in an LAS format.

4.4.5 Coordinate System

The coordinate system for this project shall be Colorado State Plane Coordinate System, Central Zone, Datum of NAD83 (1996), units of US Survey Feet. Although limited to the DEM delivery, the Vertical Datum shall be NAVD88.

4.4.6 Flight Dates

Imagery shall be flown when deciduous foliage is generally under leaf-off condition. Thus, the target flight window shall be from April 15, 2024, to May 31, 2024. The appropriate flight dates are listed below and may be adjusted due to ground or weather conditions upon prior approval of UTILITIES.

Area	Start Date	Finish Date
Area SA-2	April 15, 2024	May 31, 2024

4.5 Sub Area 3

4.5.1. Image Resolution

Image pixel resolution for Sub-Area 3 shall be one (1) foot.

4.5.2. Ground Sampling Distance

CONTRACTOR is not to exceed flying heights for the 1’ pixel acquisition. CONTRACTOR shall not deviate from these requirements unless approved by UTILITIES. Statistical sampling (RMSE) must show that these GSD values are being achieved. **Offsets from the required ground sampling distances should not exceed ten percent (10%).**

Sub-area 3: Resolution = 1.0’ GSD MAXIMUM

4.5.3. Horizontal Accuracy

All final image products must meet the horizontal accuracy specifications listed below:

- ASPRS Class 1 accuracy standard for 1:2400 mapping. This specifies a point coordinate accuracy requirement in which the horizontal Root Mean Square Error (RMSE) for a minimum of 20 well defined points is less than 2.0 ‘

4.5.4. Digital Elevation Model

The existing 2018 DEM ground surface, originally derived from the 2018 LiDAR data, shall be used as the rectification source for the 2024 flight. CONTRACTOR shall update any tile or tiles of DEM data for the surface to be adequate for accurate orthoimagery rectification.

Should the DEM for an orthophoto imagery tile need to be updated, the PPGA requires that the DEM be re-delivered in tile format (4000’x4000’) containing all DEM data used for that tile. This updated data shall be delivered in an LAS format.

4.5.5. Coordinate System

The coordinate system for this project shall be Colorado State Plane Coordinate System, Central Zone, Datum of NAD83 (1996), units of US Survey Feet. Although limited to the DEM delivery, the Vertical Datum shall be NAVD88.

4.5.6. Flight Dates

Imagery shall be flown when deciduous foliage is under leaf-on condition yet early enough to minimize shadows and reduce the chance of snow. Thus, the target flight window shall be from June 1, 2024, to July 31, 2024. The appropriate flight dates are listed below and may be adjusted due to ground or weather conditions upon prior approval of UTILITIES.

Area	Start Date	Finish Date
Area SA-3	June 1, 2024	July 31, 2024

4.6 Sub Area 4

4.6.1 Image Resolution

Image pixel resolution for Sub-Area 4 shall be one (1) foot.

4.6.2 Ground Sampling Distance

CONTRACTOR is not to exceed flying heights for the 1’ pixel acquisition. CONTRACTOR shall not deviate from these requirements unless approved by UTILITIES. Statistical sampling (RMSE) must show that these GSD values are being achieved. **Offsets from the required ground sampling distances should not exceed ten percent (10%).**

Sub-area 3: Resolution = 1.0’ GSD MAXIMUM

4.6.3 Horizontal Accuracy

All final image products must meet the horizontal accuracy specifications listed below:

- ASPRS Class 2 accuracy standard for 1:2400 mapping. This specifies a point coordinate accuracy requirement in which the horizontal Root Mean Square Error (RMSE) for a minimum of 20 well defined points is less than 4.0 ‘

4.6.4 Digital Elevation Model

Existing DEM data available from the USGS shall be used as the DEM data source. National Elevation Dataset (NED) available data of 1/3 arc-second, or approximately 10 meters, can be downloaded for free from the USGS using the National Map viewer. CONTRACTOR is responsible for downloading this publicly available data to cover Sub-Area 4. Note that available data may be in multiple files and based on different collection years. CONTRACTOR is expected to update or supplement this DEM data, if necessary, to ensure that final orthophotos for the area meet specified horizontal accuracy tolerances.

4.6.5 Coordinate System

The coordinate system for this project shall be Colorado State Plane Coordinate System, Central Zone, Datum of NAD83 (1996), units of US Survey Feet.

4.6.6 Flight Dates

Imagery shall be flown in late spring to early summer, under leaf-off conditions if conditions make that possible, and early enough to minimize shadows and reduce the chance of snow. The appropriate flight dates are listed below and may be adjusted due to ground or weather conditions upon prior approval of UTILITIES.

Area	Start Date	Finish Date
Area SA-4	June 1, 2024	July 31, 2024

5.0 Overall Aerial Photography Requirements

5.1. Digital Aerial Camera

The aerial camera used shall be a precision large-format digital aerial camera equipped with low distortion, high-resolution optics, and high pixel count charge-coupled device (CCD) sensors. It must be capable of:

- Ground resolution equal to or better than 6”
- Generating four-band imagery from separate red, green, blue, and near infrared bands

- Supporting high geometric accuracy through forward motion compensation and image stabilization
- Producing images that are compatible with existing softcopy photogrammetric environments (Image station)

A digital camera calibration report shall be submitted. If not, any available results of camera tests completed by the USGS or other organizations independent of CONTRACTOR shall be submitted. In addition, to be submitted are 1) the results of testing done by the camera manufacturer and/or CONTRACTOR and 2) detailed camera specifications. CONTRACTOR shall own the digital aerial camera and that there are spare cameras of the same make and model available should issues occur with camera performance.

5.2. Multi-spectral Image Acquisition

For all project areas, the color (RGB) and near-infrared (NIR) bands are to be acquired simultaneously such that a four-band image (RGBNIR) can be created for delivery. Any attempt to use image compression during image acquisition must be approved by the PPGA prior to the start of the project.

5.3. Flight Conditions

To ensure product uniformity, it is imperative that CONTRACTOR addresses adherence to the specific flight conditions. Flight time schedules, quality assurance of color balancing processes, continuity between flights and continuity from one sub area to the next are all conditions that must be addressed in CONTRACTOR responses.

The sun angle for all flights shall not be less than thirty (30) degrees and orthophoto imagery shall be acquired generally between 10:00 am and 2:00 pm local time. In no case shall orthophoto imagery be undertaken when the ground is obscured by snow; in the presence of obscuring fog or dust; when streams are not within their normal banks; or when cloud shadows appear on more than two percent (2%) of the area in any one image. Photographs shall not contain objectionable shadows (e.g., obscuring roads and other important features) caused by relief or low solar altitude. CONTRACTOR shall use photographic targets for use in establishing horizontal control during aerial triangulation, targets should be of an appropriate size to be easily recognizable within the aerial imagery.

Note: UTILITIES and the PPGA strongly prefers flights to be under sunny conditions and encourages CONTRACTOR to not fly during overcast conditions. CONTRACTOR should contact UTILITIES before flying under overcast skies.

5.4. Flight Plans

All flight lines shall be submitted digitally in a standard ESRI shape file format and in the coordinate system specified for the given project area. Flight line features shall be attributed with appropriate identification information. Flight lines may be broken up into flight segments to accommodate terrain changes, atmospheric problems, or military flight approval. Ground sampling distances shall be maintained throughout the flight line, which would be flown at the same altitude. Each segment of a flight line shall be flown continuously, without interruption. The principal points of the first two (2) and the last two (2) exposures of each flight line shall fall outside the boundaries of the area to be covered by the flight, and all side boundaries shall be

covered by a minimum of 25% of the photo stereo image format. The principal points of the first two (2) and the last two (2) exposures of each flight segment shall overlap. These flight plans shall be submitted for approval by the PPGA prior to the aerial photography imagery phase. Upon completion of the photographic missions, all revised, final flight lines shall be submitted with photo centers.

Note: There are several military reservations within the project area. Authorization for over flights of these areas and for flights within Traffic Control Zones associated with both military and civil air operations may have to be secured and shall be the responsibility of CONTRACTOR to do so. The PPGA, if requested, can set up a meeting with Colorado Springs municipal airport and Ft Carson officials (Ft. Carson absolutely requires overflight authorization) to assist with flight coordination and other communication requirements. All final arrangements shall be the responsibility of CONTRACTOR and must be reported to UTILITIES. Any issues securing clearance in these areas must be reported to the PPGA within twenty-four (24) hours.

5.5. Re-flights

Unacceptable orthophoto imagery shall be corrected, at no additional cost to UTILITIES. The re-flight coverage shall overlap the accepted orthophoto imagery by at least two (2) stereo models. Re-flights fall under the same quality control standards and guidelines as all other imagery in this project. Upon completion of the re-flight(s), CONTRACTOR shall submit a detailed quality control report to the PPGA project manager for approval based upon stated specifications.

5.6. Aircraft

Any aircraft to be used on the project shall be equipped with all essential navigational and photographic instruments, including Airborne Global Positioning Satellite (ABGPS) enhanced navigational systems. All aircraft must be operated by a well-trained and experienced crew. Performance of the aircraft shall be adequate to complete the proposed project in accordance with the technical specifications. All operations shall be in conformity with the applicable official regulations and ordinances. Appropriate Federal Aviation Administration documentation indicating that the aircraft used is within current requirements and operating specifications shall be submitted by CONTRACTOR prior to the first flight in which the aircraft is used on the project. CONTRACTOR shall provide evidence that all aircraft used for this project are properly insured.

The aircraft shall have a proven service ceiling with an operating load of not less than five percent (5%) above the highest altitude requirements to secure the specified orthophoto imagery. It is not mandatory, but it is preferred, that CONTRACTOR own the aircraft used for the OP 2024 project and that CONTRACTOR has access to a backup aircraft.

5.7. Spacing of Images

Overlapping images in each flight line and between flight lines shall provide full stereoscopic coverage of the area to be mapped in accordance with the end lap and side lap specifications.

5.8. End lap

Images used as stereoscopic pairs shall have overlap of between fifty-five percent (55%) and sixty-five percent (65%) in the respective frames. Consecutive images in each flight line shall have an end lap of approximately sixty percent (60%) to ensure full stereoscopic coverage.

5.9. Side lap

Side lap between adjacent parallel flight lines shall be adequate to satisfy the requirement for stereoscopic coverage, and shall be approximately thirty percent (30%), plus or minus five percent (5%).

5.10. Crab

Any flight or portion thereof in which crab is more than three degrees (3˚) shall be cause for rejection of orthophoto imagery. CONTRACTOR shall describe how the proper crab shall be maintained and documented throughout the flight.

5.11. Tilt

Tilt of the camera from vertical at the instant of exposure shall not exceed three degrees (3˚), nor shall it exceed five degrees (5˚) between successive exposure stations. Average tilt over the entire project shall not exceed one degree (1˚). CONTRACTOR shall describe how the proper tilt shall be maintained and documented throughout the flight.

5.12. Flight Height

Proper flight heights must be maintained to meet the ground sampling distance requirements as outlined in section 4 of this document. The departure above or below the flying height required to maintain the specified photo scale must not exceed five percent (5%). CONTRACTOR shall be responsible for maintaining proper flying height throughout the project.

5.13. Flight Data Tagging

CONTRACTOR shall provide a digital photo flight line index containing the geographic centers of each flight line in an ESRI shape file format. The index shall be in the coordinate system specified for this project and must include the following information.

- Flight line number
- Exposure number/IDTime of day of exposure (in the format: hr:min:sec)
- Date of flight line flight (in the format: mm/dd/yyyy)
- Elevation in feet above sea level
- Scale of orthophoto imagery
- Ground Sampling Distance

5.14. Disposition of the Original Imagery

The original orthophoto imagery and products provided shall be the property of the PPGA. Delivery of the original imagery to UTILITIES in TIFF format is required. UTILITES prefers deliveries using portable hard drives with USB connectors. Any other type of delivery method must be approved by UTILITIES prior to delivery. CONTRACTOR shall not make, sell, or loan copies of this data except as approved in writing by UTILITIES.

5.15. Photo Point Index

CONTRACTOR shall provide a digital photo point index containing the geographic centers of each original image in an ESRI shape file format. The index shall be in the coordinate system specified for this project and must include the following information:

- Flight line number
- Exposure number/ID
- Date of exposure (in the format: mm/dd/yyyy)
- Time of day of exposure (in the format: hr:min:sec)
- Elevation in feet above sea level
- X Location of Point
- Y Location of Point
- Scale of orthophoto imagery
- Ground Sampling Distance

6.0 Survey Control and Analytical Triangulation Requirements

6.1 Ground Control Points

CONTRACTOR shall need to select and use enough ground control points as necessary to facilitate both Airborne GPS data capture and sufficient ground referencing. CONTRACTOR should identify the desired location of the ground control points as part of their operational flight map.

These points shall be delivered to the PPGA in a standard ESRI shape file format, in the coordinate system specified for this project and must include the following information:

- Point Name
- X Location of Point
- Y Location of Point
- Z Location of Point

6.2 Survey Control

Survey control points currently exist across a portion of the project area, generally within the Colorado Springs city limits. The Colorado Springs Utilities Land Base Services group shall be available to CONTRACTOR as available to help identify survey control points within the Colorado Springs city limits as needed for this project. CONTRACTOR is responsible for control in all other areas. Sub area delineations can be found in Appendix B-1. Note that delivery area order must be maintained. Delivery area order shall not be changed without the consent of the PPGA.

6.2.1 Sub-Area 1

Portions of Sub-Area 1 have been photographed and mapped under several previous projects and therefore most of the area has sufficient control to ensure proper adjustment of new imagery. The PPGA shall work with CONTRACTOR to provide existing control point information within this area.

If new control is required within sub-area 1, if available, the PPGA may be able to provide survey services within the city limits and will provide reports of any survey efforts indicating the accuracy attained in capturing new control points. All surveying shall be conducted under the direct supervision of a licensed Colorado Professional Land Surveyor. The accuracy of any new control surveys shall meet or exceed the accuracy requirements for this project.

CONTRACTOR shall be responsible for collecting new control outside of the city limits. CONTRACTOR must fully justify any requirement for additional control to the PPGA. Upon completion of new survey control, a digital survey report shall be produced by CONTRACTOR and delivered to the PPGA project manager for approval. The accuracy of any new control surveys shall meet or exceed the accuracy requirements for this project.

6.2.2 Sub-Area 2

Portions of Sub-Area 2 have been photographed and mapped under many previous projects and therefore most of the area has sufficient control to ensure proper adjustment of new imagery. UTILITIES shall work with CONTRACTOR to provide existing control point information and for any additional control that may be needed to cover any new areas within Sub-Area 2. It is doubtful that any new control is needed within this area.

However, should new control be required in this area, CONTRACTOR shall provide all survey services. CONTRACTOR must fully justify any requirement for additional control to the PPGA. Upon completion of new survey control, a digital survey report shall be produced by CONTRACTOR and delivered to the UTILITIES project manager for approval. All surveying shall be conducted under the direct supervision of a licensed Colorado Professional Land Surveyor. The accuracy of any new control surveys shall meet or exceed the accuracy requirements for this project.

6.2.3 Sub-Area 3

Sub-Area 3 is the smallest of the sub-areas but is also the most remote. Sub-Area 3 has been photographed and mapped under many previous projects and therefore most of the area has sufficient control to ensure proper adjustment of new imagery.

Should new control be required in this area, CONTRACTOR shall provide all survey services. CONTRACTOR must fully justify any requirement for additional control to UTILITIES. Upon completion of new survey control, a digital survey report shall be produced by CONTRACTOR and delivered to UTILITIES project manager for approval. All surveying shall be conducted under the direct supervision of a licensed Colorado Professional Land Surveyor. The accuracy of any new control surveys shall meet or exceed the accuracy requirements for this project.

6.2.4 Sub-Area 4

Sub-Area 4 consists of the entirety of Teller County that is not already part of another sub-area.

Should new control be required in this area, CONTRACTOR shall provide all survey services. Upon completion of new survey control, a digital survey report shall be produced by CONTRACTOR and delivered to UTILITIES project manager for approval. All surveying shall be conducted under the direct supervision of a licensed Colorado Professional Land Surveyor. The accuracy of any new control surveys shall meet or exceed the accuracy requirements for this project.

6.3 Control Point Data

Data depicting the control points utilized for this project shall be delivered to UTILITIES in a standard ESRI shape file format and shall be in the coordinate system specified for this project. Note that all points must also include elevation (Z) coordinate information as an attribute.

6.4 Aerial Triangulation Standards

Fully analytic aerial triangulation shall be used during this project to obtain high accuracy solutions for all project areas. Second generation orientation techniques are not to be used on this project. CONTRACTOR shall ensure UTILITIES that all equipment, software, and procedures used during the Aerial Triangulation process are acceptable to meeting this requirement.

The aerial triangulation solution shall adequately control all aerial imagery to facilitate accurate ortho-rectification of the imagery. At a minimum, the positional accuracy of pass and tie points established through the aerial triangulation process shall meet or exceed each of the following conditions:

- Root-mean square error (RMSE) of the final block adjustment at all control and check points shall not exceed 1/7500 of the flight height.

- The maximum allowable error of any point shall not exceed ± 1/5000 of the flight height.

CONTRACTOR should employ checkpoints to validate the accuracy of the aerial triangulated solution. CONTRACTOR should report the results of the check to UTILITIES before proceeding

with any ortho-rectification. Should these results fail to meet project accuracy standards, UTILITIES reserves the right to halt project progress until corrective actions have been put in place to correct the situation.

6.5 Aerial Triangulation Check Points

Check points are horizontal/vertical control points that have been established by ground control procedures throughout the photo block for accuracy checking purposes. At the discretion of CONTRACTOR, checkpoints may be used to improve the aerial triangulation results. CONTRACTOR shall notify UTILITIES of the locations of any check points used within the final solution. The positional values of these points may subsequently be used in the aerial triangulation adjustment once the checks have been evaluated and approved. Independent of these check points, UTILITIES shall use its own set of checkpoints to independently validate from the CONTRACTOR deliverable product.

6.6 Aerial Triangulation Report

Upon completion of all aerial triangulation work or for any required sub-block adjustments, CONTRACTOR shall deliver two separate reports for the PPGA to review. The first report shall be an overview report of flight, control, and exposure information, and shall include, but shall not be limited to, the following items:

- Control and flight line indexes
- Exposure stations
- Control points (properly labeled)

The second report shall be an Aerial Triangulation report outlining the results of the AT process.

This report shall include, but shall not be limited to, the following items:

- All geometric closure errors for survey control points
- Computed coordinates of all control, pass, and check point locations
- Identification of all points to include:
    - Points that were included in the AT solution.
    - Points that were discarded from the AT solution.
    - Explanation of why points were discarded.
    - Weighting factors applied to all points used in the AT solution.

Reports shall also include, at a minimum, a brief narrative that describes the overall AT process including equipment used, procedures, software, RMSE summaries, bundle adjustment solution results, and geometric closure errors. Also included should be significant issues (misfits) encountered at control points and the steps taken to analyze the problem and solutions to rectifying these discrepancies.

7.0 Digital Imagery Requirements

7.1. Delivery Areas

Orthophotos shall be delivered for each Sub-Area of this project, as described in Section 3 of this Statement of Work. Delivery areas are delineated in Appendix B-2. Delivery area order shall not be changed without the consent of UTILITIES.

7.2 Raw Imagery Review

UTILITIES expects the collection of Raw imagery to meet all specifications in this scope regarding clouds, shadows, snow, etc. However, as a simple check of the raw imagery, CONTRACTOR will provide samples of raw imagery for each delivery area for UTILITIES to review. Parties will work out the details of data delivery prior to data collection.

7.3 Orthophotos

CONTRACTOR will process raw imagery at the highest bit depth possible to achieve optimum effectiveness. Orthophotos shall be delivered in the following formats listed below.

- 8-bit, 4 Band (Red, Green, Blue, Near-Infrared)
- GeoTiff, TFW

7.4 Image Quality

Orthophotos shall not contain defects such as missing pixels, pixel color anomalies, excessive color bleed, etc. CONTRACTOR is expected to correct any distortions caused by elevated or depressed structures such as bridges, railroad beds, overpasses, or steep terrain. Any images that are delivered to UTILITIES with these types of anomalies shall be rejected. In addition, visible image seams or sutures within a digital orthophoto shall also be rejected, including any with edge or feather effects. Furthermore, orthoimagery with evidence of imagery manipulation, such as copy/paste of pixels, shall be rejected by UTILITIES.

7.5 Image Mosaic Tiles

Creating image mosaic tiles is an essential part of producing a digital orthoimagery. The methods used to mosaic imagery are critical to the final product produced. Where digital mosaic orthoimages are created, it is essential that proper color, contrast, and brightness be maintained across such areas so that visual effects are essentially eliminated. All radiometric correction processes must result in minimal radiometric seams within or between flight lines. Images must also be well edge matched such that tonal values are consistent across edges. Finally, CONTRACTOR should use advanced color balancing techniques to create an output dataset that has a seamless context across the entire project.

7.6 Data Structure

Digital orthoimagery data shall be delivered in a TIFF format with associated world (TFW) files. Files shall be named and sized (4000' x 4000') according to the tile layout provided by UTILITIES. Data should be transferred to UTILITIES using portable disk technology. If applicable, CONTRACTOR shall perform anti-virus software checking of all portable disks prior to any delivery to UTILITIES.

7.7 Quality Acceptance / Acceptance Standards

CONTRACTOR shall provide orientation to its employees assigned to this project so that all employees clearly understand the requirements and deliverable specifications of the project. CONTRACTOR shall also perform quality assurance checks of the data prior to delivery of the data to UTILITIES and shall provide evidence of such quality assurance checks by delivering feedback regarding each delivery. In addition to that undertaken by CONTRACTOR, UTILITIES shall perform its own quality acceptance check. Acceptability of deliveries of data shall occur when all digital files and digital orthophotos delivered meet all project requirements regarding file structure and conformity as per UTILITIES review. ***UTILITIES shall provide feedback on all orthoimagery deliverables within 21 days of receipt of data.***

7.8 Project Wide Mosaic

Upon completion and acceptance of orthoimagery tiles and completion of sub-areas, CONTRACTOR is to produce project wide mosaic datasets for the areas and formats listed below.

- One JP2 file covering SA1 (City of Colorado Springs area)
- One JP2 file covering SA1-SA3 (El Paso County Area)
- One JP2 file covering SA Area 4 and extended areas comprising all of Teller County boundary (Teller County)
- One JP2 file covering SA Areas 1-4 (Entire Project Area)

Compression parameters shall be discussed and agreed upon prior to delivery.

7.9 Labor Resources

UTILITIES will allow the major production work of Orthophoto production to be performed by CONTRACTOR subcontractors. However, UTILITIES ***requires*** that all final quality control steps be completed by CONTRACTOR within the United States by CONTRACTOR employees located at that site. Should CONTRACTOR need additional production resources from outside vendors or other CONTRACTOR offices to adhere to the project schedule, the PPGA must be notified and approve such changes prior to implementation.

8.0 Optional Products

8.1 Digital Stereo Pair Requirements

Digital stereo pairs are a required deliverable for the area outlined below and covers approximately 463 square miles. Stereo pair delineations can be found in Appendix B-3. All digital stereo pairs for delivery shall be provided such that the images are compatible with ESRI ArcPRO version 3.1.

As part of this delivery, the following information related to the stereo models shall also be included with the delivery to the UTILITIES:

- Photo Position – photo center x,y,z, with Z being the above ground average
- Omega, Phi, Kappa values
- Camera Calibration
- Photo Direction
- 6 Interior orientation coefficients
- 6 exterior orientation parameters

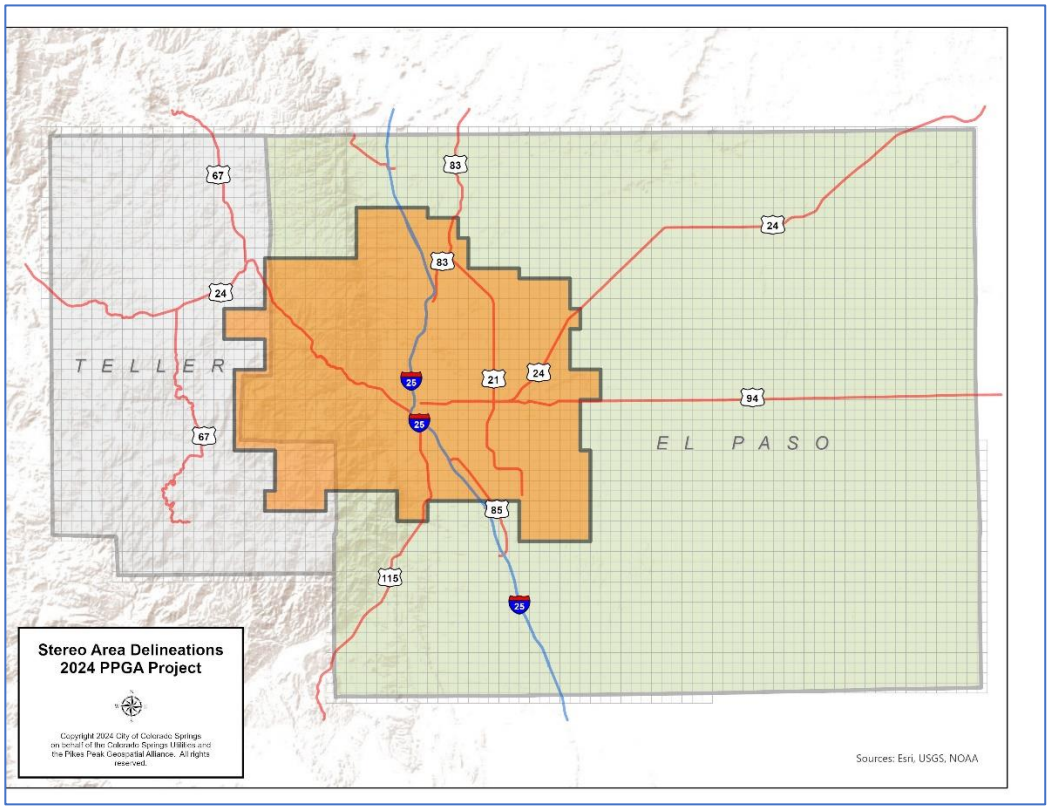

Figure 3 - Deliverable Stereo Coverage Extents

9.0 Warranty

The PPGA requires that CONTRACTOR warrant the deliverable products and to repair, replace, or correct any deliverable product for a ***two-year period*** following final acceptance of the data by the PPGA for any deliverable product that is defective, deviates from industry standards, or fails to meet all prescribed specifications set forth in this scope of work.

The PPGA retains the sole right to determine CONTRACTOR'S adherence to all specifications. If in the sole discretion of the PPGA, it determines that CONTRACTOR has seriously breached specifications, the PPGA may require CONTRACTOR to suspend production of additional work services until such time as CONTRACTOR can demonstrate that the problem has been remedied to the satisfaction of the PPGA. The PPGA may adjust the deliverable milestones of the project if necessary.

10.0 Deliverable Products and Acceptance

10.1. Deliverables

Deliverable products include information being exchanged from CONTRACTOR to the UTILITIES. The following matrix shows deliverable data from CONTRACTOR to UTILITIES and the PPGA as described in the scope of work.

Item	Section
Project Schedule	3.2, 10.0
Digital Elevation Model	4.6.4, 4.7.4
Camera Calibration Report	5.1
Flight Plan / Flight Index	5.4, 5.13
Ft Carson Approval	5.4
Aircraft FAA Documentation	5.6
Photo Point Index	5.15
Ground Control Points	6.1
Survey Control Reports	6.2
Control Point Data File	6.3
Aerial Triangulation Report / Check Points	6.4, 6.5, 6.6
Raw Imagery Review	7.2
Digital Orthoimagery Delivery	7.3
Data Review / Feedback	7.7
Project Area Mosaic Files	7.5, 7.8
Digital Stereo Pairs	8.0
Data Acceptance	9.2
Warranty	12.0

10.2. Project Deliverable Acceptance

All products must meet the specifications agreed to in the resultant contract. All deliverable products shall be reviewed by UTILITIES to determine whether the products are acceptable.

An acceptance program shall be executed based on a thorough review of the prototype delivery and the proper completion of the above deliverables. The prototype calls for the early delivery of four (4) separate locations (representing each Sub-Area) that contain four (4) contiguous tiles each.

UTILITIES shall use all specification and requirement criteria outlined in this document and accompanying appendices to determine acceptance and rejection of all identified deliverables.

After acceptance checking, products shall be either:

1. **ACCEPTED** - Products that meet specifications and contain no errors, or so few errors as to be

acceptable to UTILITIES, shall be formally indicated as ACCEPTED. UTILITIES shall notify CONTRACTOR of the products accepted. Payment for work completed shall not be made until the products are accepted by UTILITIES.

2. **REJECTED** - This means that the number and character of the errors detected by UTILITIES are such that the products are returned to CONTRACTOR. UTILITIES shall formally notify the CONTRACTOR of the REJECTED status of the products. CONTRACTOR must edit and correct the products for resubmittal to UTILITIES for its quality control edit. If, at the sole discretion of UTILITIES, there are an undue number of rejected products, the UTILITIES may require CONTRACTOR to suspend production until the problems contributing to the rejections are identified and corrected.

Execution of the correction procedure shall not affect the overall production schedule.

11.0 Schedule

The following table outlines the major schedule milestones for the 2024 orthoimagery project. UTILITIES understands that poor weather and undesirable ground conditions could lead to delays in aerial acquisition. However poor planning, resource issues, or other items caused by poor performance by CONTRACTOR are not appropriate reasons for schedule changes. Initial schedule dates cannot be changed without prior written approval of UTILITIES. Note, that it is the intention of UTILITIES to complete major production by December 31, 2024, with project completion by February 28, 2025.

Currently, this schedule is a simplified preliminary schedule and will be mutually reviewed and revised during the project kickoff phase such that dates for the initial delivery, PPGA quality review, corrections, and final acceptance can be defined.

CONTRACTOR and UTILITIES agree to start the project as soon as possible while ensuring that all flight parameters for leaf-off conditions, sun angle, and snow/cloud coverage can be met, with the project starting no sooner than March 15, 2024. Note that notice to proceed cannot be provided until all PPGA parties have approved the MOU. The dates below may change and should be considered achievement goals.

Notice to proceed	March 1, 2024
Begin Aerial flights	March 15, 2024
Conclude Aerial flights	July 31, 2024
Conclude Initial Ortho Production	December 1, 2024
Acceptance of all Ortho tiles	January 15, 2025
Conclude Mosaic Production	February 15, 2025
Final Acceptance of all data, Project Complete	March 15, 2025

12.0 Performance Requirements

The UTILITIES and CONTRACTOR recognize that time is of the essence concerning this agreement and that the UTILITIES shall suffer financial loss if the services provided by CONTRACTOR are not completed within the times specified in the schedules outlined in this scope, including any extensions thereof. UTILITIES and CONTRACTOR also recognize the delays, expense, and difficulties involved in proving the actual loss suffered by the UTILITIES if the services of this scope of work are not completed on time.

The PPGA reserves the right to terminate the contract with CONTRACTOR if the following project milestones or specifications do not occur according to schedule or are not met, respectively:

- Target flight windows are missed by CONTRACTOR (as noted above for each section, flight dates)
- Non-compliance of mapping specifications by CONTRACTOR
- Non-usage of specified DTM/DEM by CONTRACTOR
- Orthoimagery has been excessive manipulated by CONTRACTOR through copy/paste methods

13.0 Project Completion

Upon delivery and final acceptance of all data deliveries, the project shall be deemed complete.

At that time, the PPGA shall provide CONTRACTOR with a formal letter indicating final acceptance of the data and overall completion of the project. At that point, the data shall be considered under warranty as specified in section 9 of this document.