Recurring Aerial Imagery Acquisition Program

MSB Project No. 16-130

Report 2 of 5

Business Needs Analysis

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Acronyms

AGC ..... Alaska Geospatial Council
ASPRS ..... American Society of Photogrammetry and Remote Sensing
CIAP ..... Coastal Impact Assistance Program
DEM ..... Digital Elevation Model
DOQQ ..... Digital Orthophoto Quadrangle
DTM ..... Digital Terrain Model
FEMA ..... Federal Emergency Management Agency
GIS ..... Geographic Information System
GSD ..... Ground Sample Distance
IFTN ..... Imagery For the Nation
KE ..... Kinney Engineering
KFA ..... Kentucky From Above
LiDAR ..... Light Imaging, Detection, and Ranging
MEA ..... Matanuska Electric Association
MOU ..... Memorandum of Understanding
MSB ..... Matanuska- Susitna Borough
MTA ..... Matanuska Telephone Association
NAIP ..... National Agriculture Imagery Program
NASA ..... National Aeronautics and Space Administration
NRCS ..... Natural Resource Conservation Service
QA ..... Quality Assurance
QBS ..... Qualifications Based Selection
QC ..... Quality Control
RFQ ..... Request for Qualifications
RFP ..... Request for Proposal
RGB ..... Red, Green, Blue
UAS ..... Unmanned Aerial Surveillance
USGS ..... United States Geological Survey
URISA ..... Urban and Regional Information Systems Association
WMS ..... Web Mapping Services

Executive Summary

The intent of the Matanuska-Susitna Borough Recurring Aerial Imagery Program is to provide aerial imagery on a recurring basis and in the most cost effective manner possible. The purpose of the business needs analysis is to determine the imagery needs and requirements of internal and external customers. The information in this report is derived from 93 survey responses; including 64 from MSB staff, 25 from other organizations, and 4 from anonymous sources. This report identifies how imagery is used in the MSB, summarizes the user's need for imagery (aka Use Cases), and defines acquisition requirements based on those Use Cases.

Key Findings

- 96% of those surveyed use aerial imagery as part of their work.
- The survey identified the following Use Cases; see Table 4 for more information:
    - Public Safety
    - Property Appraisal
    - Public Works
    - Capital Improvements (includes Transportation)
    - Land Management
    - Planning and Development Services
    - Facilities Management
    - Utilities
- Respondents to the survey identified the following features that users said they most need to see in imagery, in order of interest:
    - Transportation Infrastructure (roads, bridges, surface, etc.)
    - Buildings (measurable footprints, etc.)
    - Property Features (fences, outbuildings, driveways, etc.)
    - Rivers and Lakes (banks of rivers, lakes, coastlines, etc.)
    - Above Ground Utilities (poles, fire hydrants, boxes, etc.)
    - Land Development (timber harvest sites, urbanization, etc.)
    - Land Cover (agricultural, forest, urban, etc.)
    - Recreational Sites (playgrounds, pavilions, trails, docks, etc.)
    - Wetlands and Vegetation (wetland types, shrub, forested, etc.)
    - Resource Extraction Sites (gravel, coal, minerals, etc.)
- Post-survey interviews, of both internal and/or external stakeholders, revealed additional Use Cases and features of interest:
    - Identification of potential facility lease sites
    - Emergency dispatch (part of computer aided dispatch system)
    - Impervious surface mapping
    - Storm water management
    - Building and structure dimensions
    - Site verification associated with platting and land use
    - Permitting activities, for example landfill site reporting

- Most respondents who said the most recent imagery (flown in 2011) does not meet their needs, indicated that it was because it is not current enough.
- Nearly half of the respondents would like imagery refreshed on at least a three to five-year cycle.
- Most Use Cases, indicate that survey controlled, orthoimagery with 6-inch to 1-foot pixel resolution, is needed.
- Some Use Cases for particular departments (e.g. Public Works and Capital Projects), indicate that 3-inch pixel resolution imagery may be needed for identification of above ground utilities and small sized assets (e.g. light poles, fire hydrants, culverts, etc.).
- Areas of interest for future imagery acquisition were defined and prioritized based on survey input. The core area has been identified as the most requested area. Please see Figure 7 and Table 2 for more information.
- Most respondents would like digital imagery to be easily accessible. They also need a format that is usable with their software which includes GIS (e.g. ArcMap), computer aided drafting (e.g. AutoCAD), computer aided dispatch (e.g. InterAct, TriTech, etc.), and others. Several key stakeholders have requested special formatting of the end-products, such as imagery cropped for use in their software.

Recommendations

- Further refine the Use Cases identified during this study with additional interviews with key stakeholders. More information can build robust imagery user profiles and use scenarios that will further define imagery requirements.
- Leverage the Use Cases as marketing tools to help acquire funding.
- Use a hybrid approach regarding imagery acquisition to meet the range of mapping scales needed. This would involve acquiring imagery at different resolutions to meet the mapping requirements described in this report. Report 4 will address imagery options and Report 5 will describe a plan that utilizes a hybrid approach.
- End products should be made available in Geotiff format (usable in ArcMap, AutoCAD) and MrSid format (usable in ArcMap, and Computer Aided Drafting and Dispatch software).

1 Introduction

This report summarizes the results of a business requirements analysis of aerial imagery for the Matanuska-Susitna Borough. This report is the second of five reports being developed as part of the MSB Recurring Aerial Imagery Acquisition Program. The other reports address other recurring imagery programs, funding opportunities, technical options for imagery, and a program plan. Business needs analysis also helps ensure decision-makers that the proposed initiative has been evaluated with regard to the potential return on investment, and that the proposed initiative should be acted upon.

In the Borough, aerial imagery has become an essential tool in many levels of government. Imagery is used for asset management, public safety and emergency dispatch, flood mitigation, planning and development, facility site selection, property assessment, and many other functions. For the purposes of this report, aerial imagery products include satellite imagery, orthophotography, oblique and orthogonal imagery, and unmanned aerial systems (UAS), also known as drone acquired imagery.

The objective of this business needs analysis is to determine the imagery needs and requirements within the Borough, through the use of surveys and interviews. This information is used to identify user requirements and develop a business case for imagery acquisition. Stakeholders use digital imagery for a wide variety of purposes and may have different goals. Therefore, an analysis of current and future requirements helps determine specifications that best fit the needs of all involved stakeholders.

Borough stakeholders that use aerial imagery are diverse, and include internal and external users. For the purposes of this report, internal users are Borough staff, and external users include a variety of organizations including utilities, state and federal agencies, non-profit groups, and others. Use Cases are summarized and presented in Section 4.

The success of a business needs analysis depends on user and stakeholder input. Therefore, an effort in this project was on developing a meaningful survey and database of needs information, requirements, and specifications. The purpose of the business analysis is to identify how imagery is being used, what the needs are, and how imagery acquisition can be implemented more effectively.

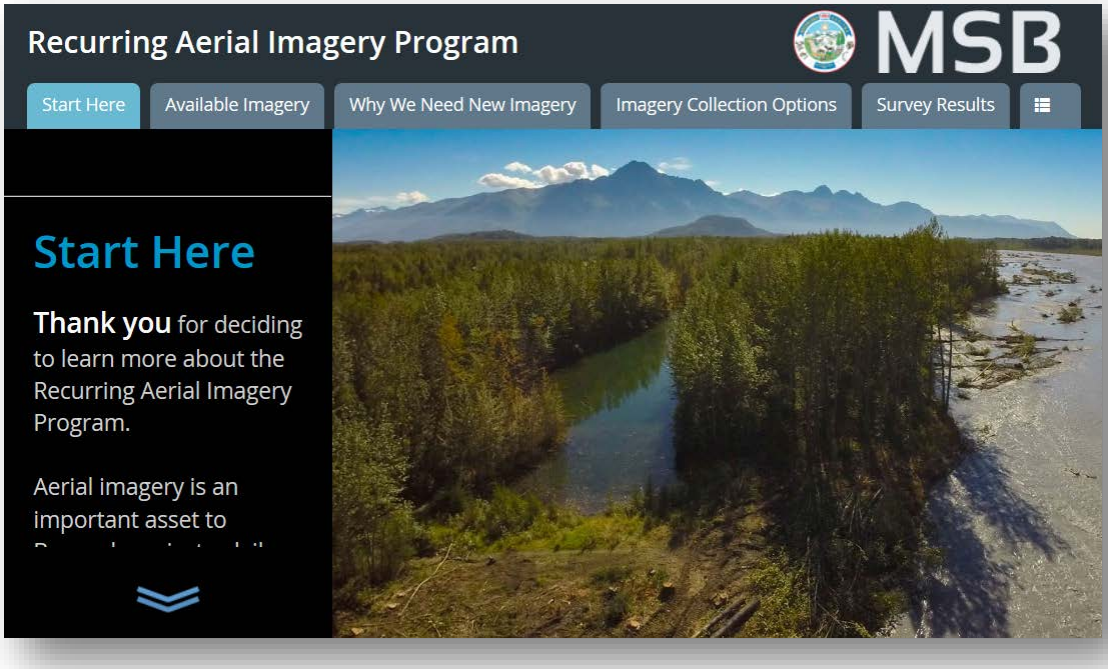
This study is the result of a collaborative effort between the MSB IT (GIS and other) staff and contractor; and survey and other data collected as part of this study is due in large part to the work and contributions of MSB staff.

2 Research Methods

The business needs analysis is divided into four separate tasks:

- **Development of Survey Methods:** A survey questionnaire was developed and imagery stakeholders were identified as part of this task. An online survey tool, Esri Survey 123, was chosen to gather survey data and an interactive map was created to capture area of interest information.
- **Development of a Project Website:** The project webpage was developed using the Esri Story Map tools. It provides access to project information, imagery options, a technical FAQ document, and links to the online survey tools. Figure 1 shows the Story Map.
- **Interviews and Survey Implementation:** Internal department meetings were held to present the project to key users, allowing the participants to share their business processes and ask questions, and conduct the survey with assistance from the project team. A public meeting was held to introduce the project, encourage survey participation, and gather input from external users. Educational materials were developed for internal and external users. An email with a link to the online survey was sent to all Borough employees and many external organizations to help capture user needs.
- **Survey Results and Imagery Requirements:** The results of the survey were analyzed, which led to development of imagery requirements and Use Cases. The results are presented in this report.

Figure 1. Project Story Map



3 Results of Analysis

An online survey was made available, from September 13-30, 2016. It was accessible through the project webpage and emailed to all Borough employees and numerous external organizations. The survey questionnaire is shown in Appendix D. Coupled with the survey, interviews and meetings were held with internal MSB staff and external stakeholders to gather the following information:

- How aerial imagery is currently used in the Borough,
- Which features users are currently using or want to use imagery to map and identify,
- Acquisition preferences including area of interest, priority areas, imagery type and resolution, and accuracy requirements, and
- Desired end products.

Questions regarding funding were part of a separate funding survey that was directed to internal staff as well as selected external stakeholders. Responses from the funding survey and funding information is addressed in the Funding Opportunities and Options Report.

The Use Cases derived from the Business Needs Analysis are presented in Section 4.

3.1 Stakeholders

Internal Stakeholders

Eight MSB departments participated in the business needs process. See Appendix A for a list of internal stakeholders who were invited to participate in the meetings and subsequent post-meeting interviews. Survey results and user group interviews were used to develop imagery Use Cases in Section 4 below.

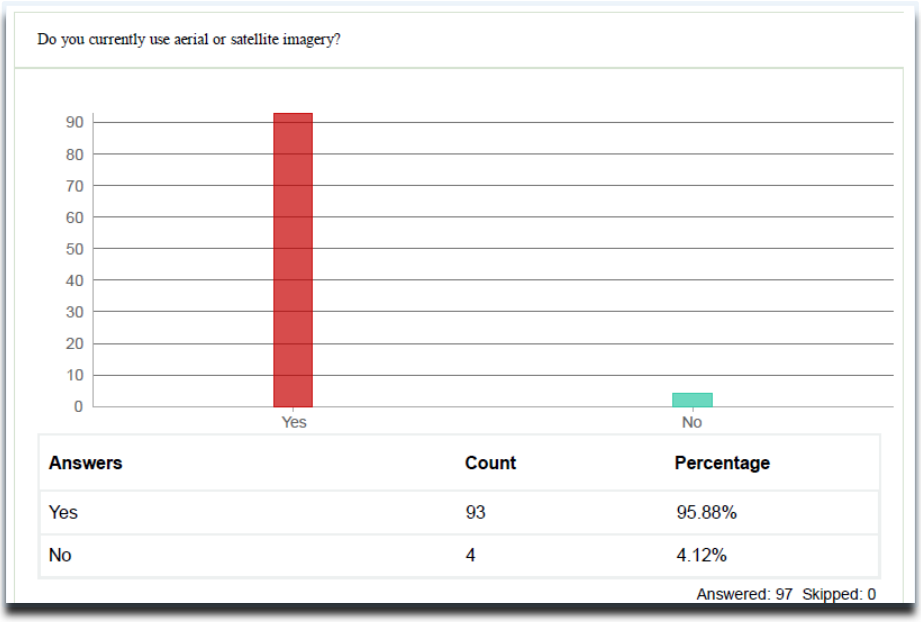
External Stakeholders

External stakeholders consist of federal and state government agencies, local area cities, and non-profit groups. A public meeting on September 23, 2016 held at the MSB office was attended by several external organization representatives. Over 200 people were individually invited from organizations and agencies interested in Borough imagery. Interviews were conducted separately with the participants; see Appendix B for a list of these stakeholders.

3.2 Imagery Usage

The first two questions in the survey asked whether or not a respondent used imagery and how frequently. Figure 2 shows that over 90 percent of the respondents use aerial imagery. Figure 3 shows that they use it frequently.

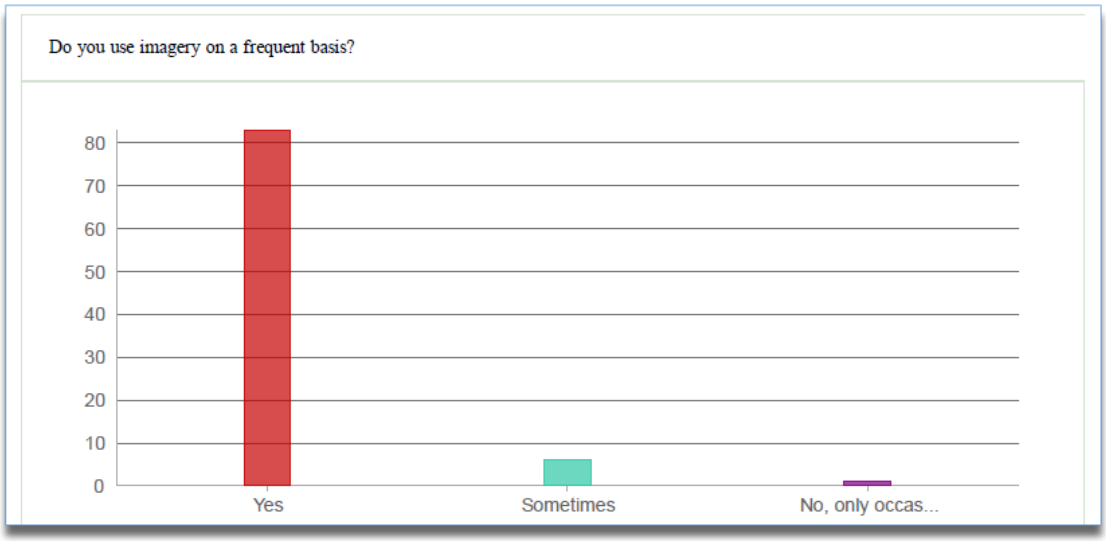
Figure 2. Percentage of Borough Imagery Users



Answers	Count	Percentage
Yes	93	95.88%
No	4	4.12%

Answered: 97 Skipped: 0

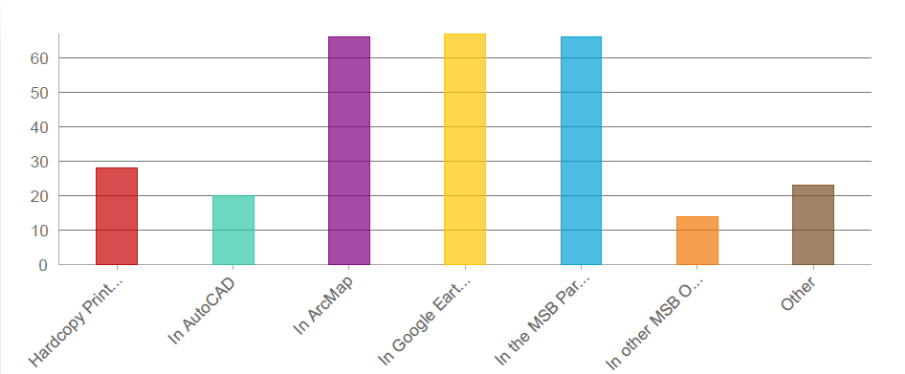
Figure 3. Frequency of Imagery Use



3.3 Accessing Imagery

The survey revealed that most respondents view Borough imagery through the online MSB Parcel Viewer and/or ArcMap software. A large number of respondents also view imagery in Google Earth, which is typically acquired from local agencies or through separate acquisition contracts. Viewing imagery using AutoCAD or on hard copy prints were two less frequently used options. See Figure 4.

Figure 4. Methods for Viewing Imagery



Answers	Count	Percentage
Hardcopy Prints	28	28.87%
In AutoCAD	20	20.62%
In ArcMap	66	68.04%
In Google Earth	67	69.07%
In the MSB Parcel Viewer	66	68.04%
In other MSB Online Viewers, which ones?	14	14.43%
Other	23	23.71%

MSB staff typically use aerial imagery that is stored on the Borough network. Whereas external users typically acquire imagery from the MSB and house it on their own computer network. Though not captured in the survey, online imagery services provided by the MBS, Geographic Information Network of Alaska (GINA), and other organizations are also used. Imagery services will likely become the industry standard for distributing imagery in the near future.

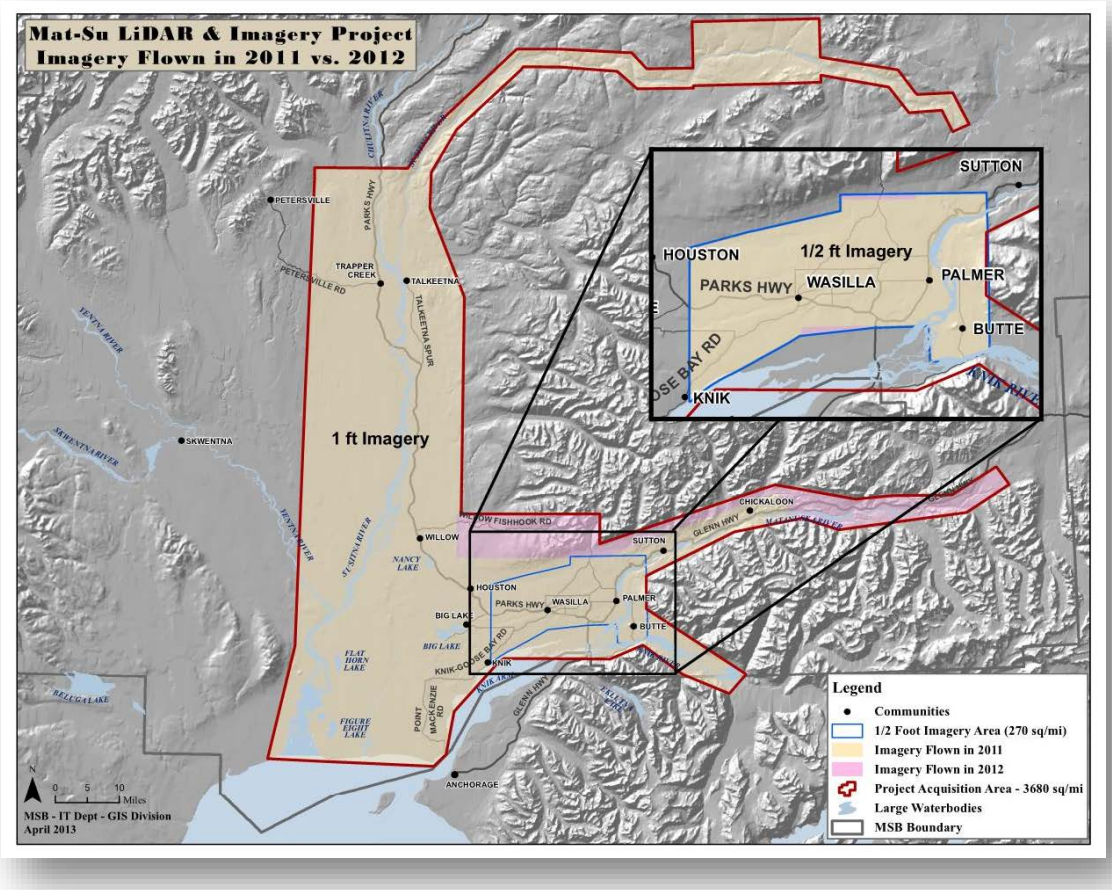
3.4 Imagery Currency

The most commonly used imagery, supplied by the Borough, is shown in Table 1 and the most recent acquisition (2011/2012) is shown in Figure 5.

Table 1. Existing Borough Supplied Imagery

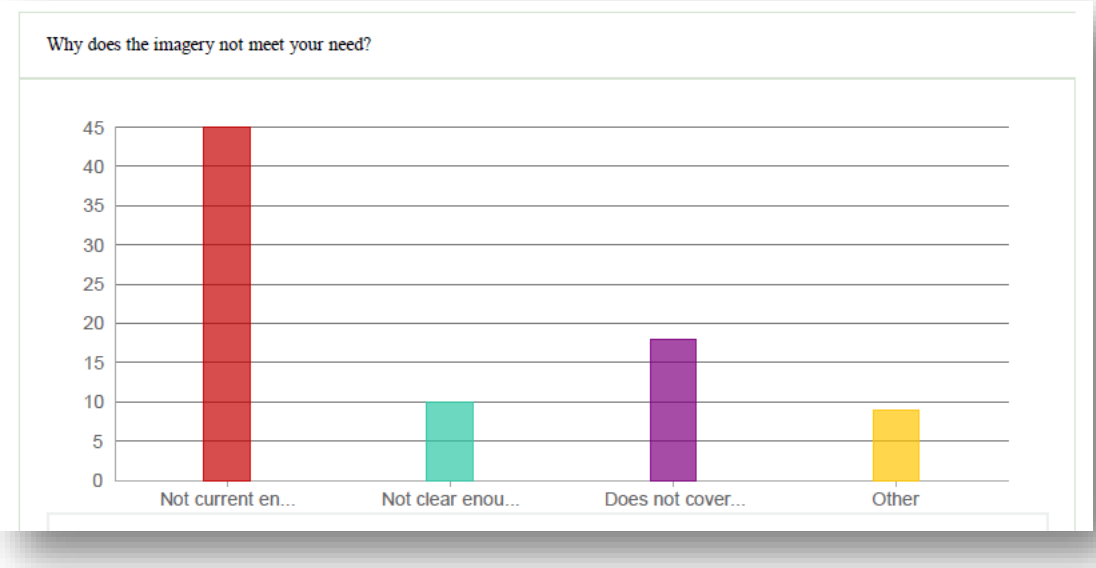
Year acquired	Resolution	Coverage
2011/2012	1-foot pixel and 6-inch pixel in core area	Most road accessible areas in the MSB (doesn't include remote areas) – See Figure 5
2004/2005	1 meter pixel	Most of the road accessible MSB (doesn't include remote areas)
1939-2015	Various scales and resolutions	Small areas scattered throughout the MSB; mostly in the core area.

Figure 5. 2011/2012 Imagery Acquisition



Availability of refreshed or current aerial imagery is important to users. Survey results showed that most users feel that the most recent imagery (2011/12) is not current enough; see Figure 6.

Figure 6. MSB Imagery Needs



3.5 Mandated Imagery Uses

Another question asked was, "Do you have a mandated/required business need that could be satisfied by imagery?". Nearly 50% of the respondents said yes.

Mandated internal uses included property appraisal/assessment, permit processing, compliance issue research, drinking water safety protocols, stormwater management, resource management, safety plans, emergency response efforts, disaster planning, wetlands management, grant reporting, project planning and design efforts, etc.

Solid Waste stated, "*We MUST validate the amount of waste in place over the last month. This must be a certified survey or piece of imagery. We also need a high resolution photo every 2 years as a requirement of our operating permit under ADEC.*"

External users also cited a number of critical uses. The Wasilla dispatch center uses imagery daily in their business for emergency response and other activities. Enstar Natural Gas Company, Matanuska Electric Association, and Matanuska Telephone Association all use Borough supplied imagery to map assets. The Nature Conservancy finds imagery very important for their conservation efforts in the Mat-Su.

It should also be noted that during research for the *Report on Successful Recurring Imagery Acquisition Programs*, it became evident that increased use of imagery in daily workflows ultimately increases the demand for regularly updated imagery.

3.6 Preferences for Future Imagery Acquisitions

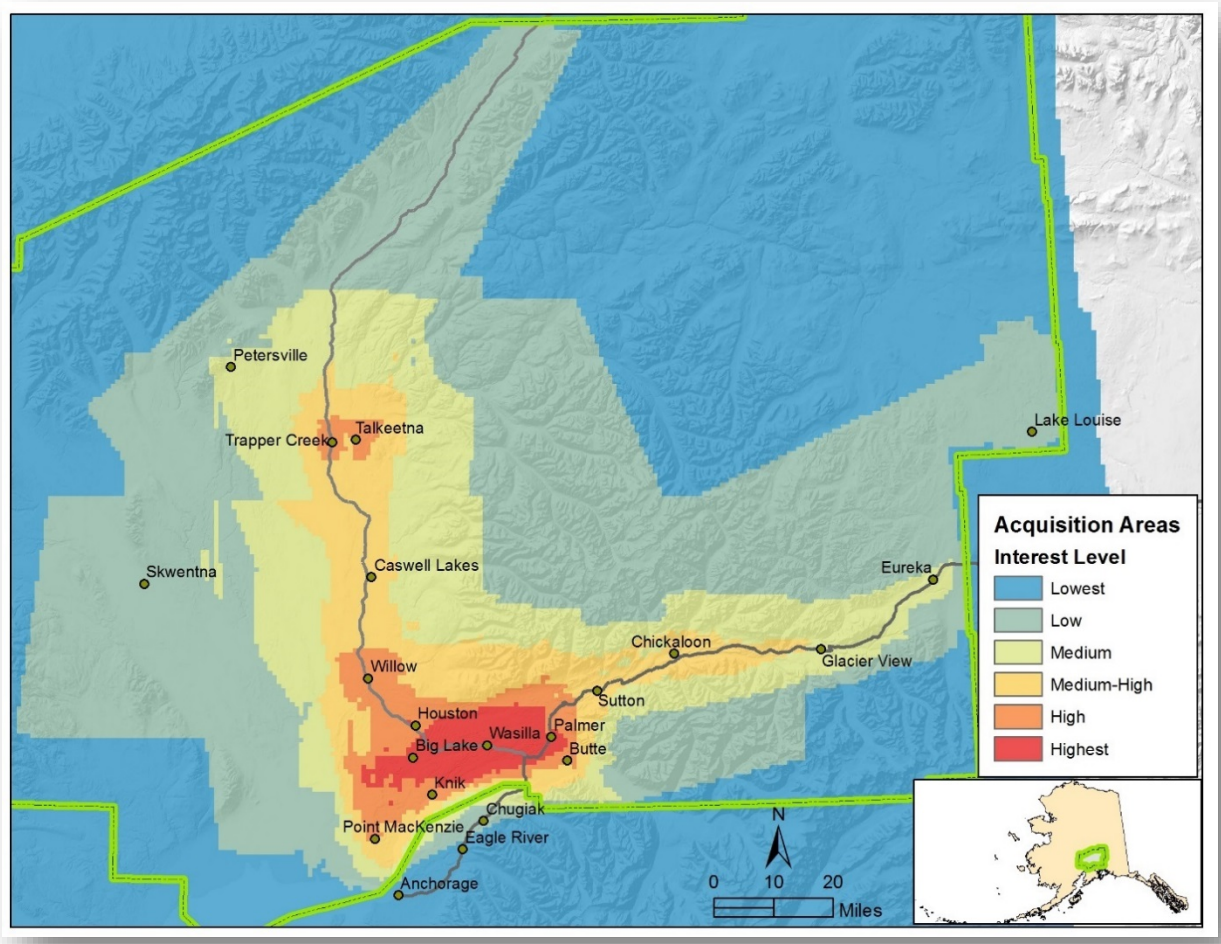
Imagery is not a "one shoe fits all" solution. When acquiring imagery, it is important to understand areas of interest, resolution requirements, and the required refresh rate.

3.6.1 Areas of Interest

Survey participants were provided access to an Esri online application, that enabled them to draw areas of interest on a map, share their contact information, explain why a particular area was important to them, and provide any other comments.

The drawn areas of interest, were analyzed using a GIS overlay technique, which identified number of areas drawn in any given location. This resulted in a map showing areas from highest to lowest level of interest; see Figure 7.

Figure 7. Imagery Areas of Interest based on AOI Drawings



The written survey also listed the areas shown below in Table 2 and asked respondents to indicate all areas they were interested in. Table 2 shows the percentage of respondents interested in each area. Respondents who chose "Other" most often described the choice as, "All Borough" or "All Road Accessible".

There is a correlation between Table 2 and Figure 7. For example, the Core area is the highest area of interest in both sets of results. The Glenn and Parks Highway corridors show as areas of high to medium interest in Figure 7 and this is also reflected by the 64 to 71 percent interest in the Talkeetna, Willow, and Houston areas.

Table 2. Acquisition Areas of Interest based on Tabular Survey

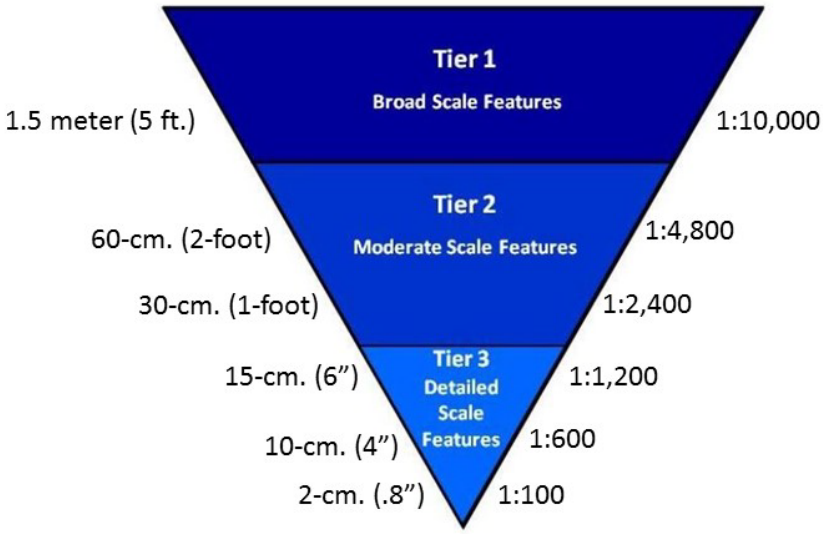
Area of Interest	Percentage Interested	Interest Level on Map
Core Area (Wasilla – Palmer)	83	highest
Houston/Big Lake/Meadow Lakes	71	high
Knik Goose Bay/Point MacKenzie	71	high
Willow/Caswell Lakes	68	high to medium-high
Talkeetna/Trapper Creek	64	high to medium-high
Lazy Mountain/Butte/Knik River	61	high to medium-high
Sutton/Moose Creek	56	medium-high
Government Peak/Hatcher Pass	46	medium-high
Chickaloon/Glacier View/Eureka	45	medium-high to medium
North Parks Highway (north of Trapper Creek)	44	medium to low
Lake Louise	32	low
Skwentna	31	low
Other	36	lowest

3.6.2 Resolution Requirements

One of the best ways to identify the resolution needed for imagery is to understand what features need to be clearly visible in the imagery then compare those features to the three tier levels, shown in Figure 8. Each tier helps define what resolution of imagery is needed for different feature types.

For example, users needing to see or map land cover (agricultural, forest, urban, etc.) require Tier 1 level mapping scale, since these types of features typically do not need exact measurements. Whereas, users who need to see, map or measure highly detailed features (pavement types, utility poles, fence lines, etc.) require Tier 3 level mapping scale.

Figure 8. Tier Levels of Mapping Scale



Survey respondents were asked, *"What types of features would you be most interested in seeing in imagery?"*Table 3 below is a summary of survey results, in order of respondent level of need, and the tier that each of these feature types fall into.

Table 3 below summarizes feature types with regard to the national standards for the scales and resolutions needed to adequately map each feature type. Since higher resolution imagery is more expensive, it will require higher levels of funding. If the funding is unavailable, it is possible to use a "second best" level of resolution with the understanding that some of the features may not be visible and as a result may not be able to be precisely mapped.

Table 3. Features, Resolution and Uses Cases in the MSB[1]

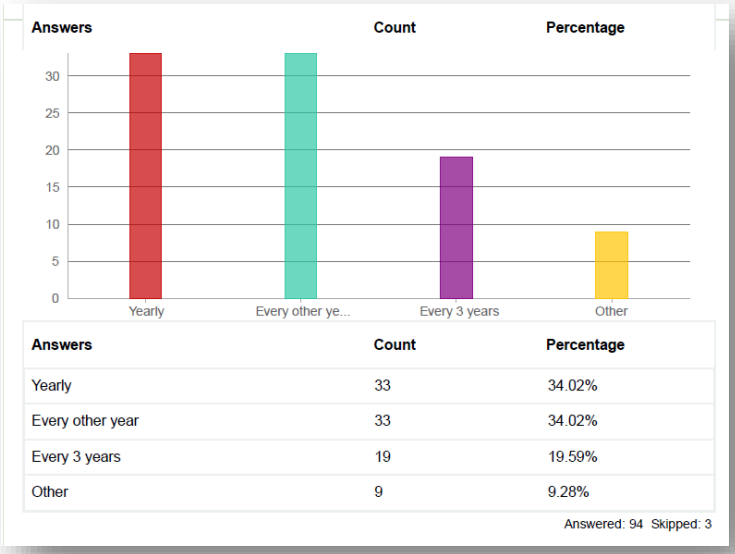
Features	Percent Interested	Tier Level	Resolution Scale	Use Cases
Transportation Infrastructure (roads, bridges, surface, etc.)	81	3	3-6" pixel 1:200 to 1:600	Property Appraisal Public Works Public Safety
Buildings (measurable footprints, etc.)	81	3	3-6" pixel 1:200 to 1:600	Property Appraisal Public Works Public Safety
Property Features (fences, outbuildings, driveways, etc.)	76	3	3-6" pixel 1:200 to 1:600	Property Appraisal Public Works Public Safety
Rivers and Lakes (banks of rivers, lakes, coastlines, etc.)	72	2	1-foot pixel 1:1,200	Land Management
Above Ground Utilities (poles, fire hydrants, boxes, etc.)	64	3	3-6" pixel 1:200 to 1:600	Utilities Public Safety Public Works
Land Development (timber harvest sites, urbanization, etc.)	61	2	1-2 foot pixel 1:1,200 to 1:2,400	Land Management Public Works Planning
Land Cover (agricultural, forest, urban, etc.)	52	2	1-2 foot pixel 1:1,200 to 1:2,400	Planning Land Management
Recreational Sites (playgrounds, pavilions, trails, docks, etc.)	49	2	1-foot pixel 1:1,200	Public Safety Land Management
Wetlands and Vegetation (wetland types, shrub, forested, etc.)	46	2	1-2 foot pixel 1:1,200 to 1:2,400	Planning Land Management
Resource Extraction Sites (gravel, coal, minerals, etc.)	43	2	1-2 foot pixel 1:1,200 to 1:2,400	Planning Land Management

[1] See US Army Corps of Engineers, Manual EM 1110-1-1000, 2015 (pp.3-8) for reference on typical feature mapping scales.

3.6.3 Imagery Refresh

The preferred refresh cycle for imagery acquisition varies among the survey respondents, depending on their level of interest in a particular region. For areas with a high level of interest, an annual or biennial refresh is preferred. For areas with a lower level of interest, a 3-year refresh of the imagery would be sufficient. See Figures 9 and 10 below.

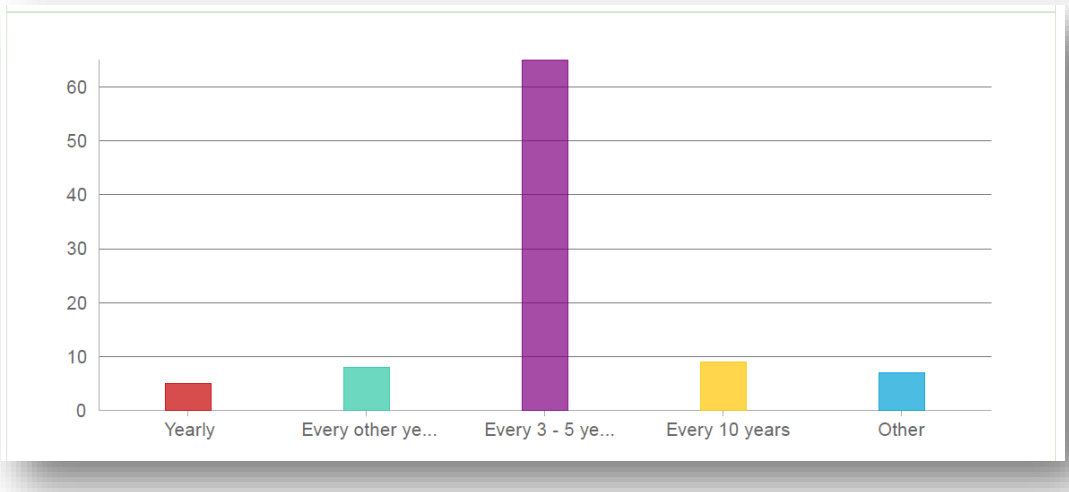
Figure 9. Refresh Frequency for High Interest Areas



Answers	Count	Percentage
Yearly	33	34.02%
Every other year	33	34.02%
Every 3 years	19	19.59%
Other	9	9.28%

Answered: 94 Skipped: 3

Figure 10. Refresh Frequency for Lower Interest Areas



4 Use Cases

For this report, Use Cases are used to organize user needs and to identify adequate imagery specifications (e.g. pixel resolution, seasonal constraints, frequency, accuracy, etc.).

A typical Use Case consists of a primary use scenario, and one or more secondary use scenarios. For example, a primary use of imagery might be to map a public works roads inventory and an alternate use scenario might be mapping and management of public works assets. The intent is not to provide complete detail at this point, but to provide a framework where the detail can be added as use cases are more fully developed.

The Use Cases identified for this program are summarized in Table 4.

Each element in Table 4 is described below:

- **Use Case**: A primary purpose of a use case is to describe how aerial imagery is used by MSB internal customers and partners, and group these uses where possible into categories that represent the main uses of imagery in the Borough.
- **Use Scenarios**: Outlines typical scenarios for why imagery is needed and how it is typically used. Primary scenarios are those that occur on a daily basis; and alternate scenarios are those that occur less frequently, but are important. Survey response data was used to develop these scenarios.
- **Mapping Scale Requirement:** Identifies the mapping scale, or range of scales, needed for a particular scenario or group of scenarios.
- **Imagery Requirements**: This element addresses imagery resolution and refresh cycle. Use scenarios and associated features, gleaned from the survey, have been correlated with resolution. While these are referenced to national standards and ideally are what should be acquired, funding realities may force other options. Refresh preferences are based on from survey response data and interviews.

Table 4. Use Cases

Use Case	Use Scenarios	Mapping Scale Requirement	Imagery Requirements
Public Safety	Emergency services management Fire (urban and wildfire) Emergency dispatch Law related investigation Pre-planning Recovery data collection	1:200 to 1:600 (core area) 1:1,200 (non-core area)	Resolution: 3-6” pixel for core area; 1 ft. pixel for areas outside core area. Refresh: prefer annual for core area; 3-5 years outside core area.
Property Appraisal	Property assessment Building and structures inventory Parcel delineation Building measurements	1:200 to 1:600 (core area) 1:1,200 (non-core area)	Resolution: 3-6” pixel for core area; 1ft. pixel suitable outside core area. Refresh: prefer annual, 2-3 years is satisfactory.
Public Works	Roads inventory mapping Asset management Right of Way delineation Project plan and profile sheets Solid waste	1:200 to 1:600	Resolution: 3-6” pixel Refresh: prefer annual, 2-3 years is satisfactory.
Capital Improvements (includes Transportation)	Evaluation of facility sites such as schools, fire stations, recreation centers, landfills, etc. Evaluation of road improvements such as new road and trail alignments Evaluations of existing conditions for Borough properties	1:600 to 1:2,400	Resolution: 6” pixel for core area; 1-2 ft. pixel for areas outside core area. Refresh: prefer annual for core area; 3-5 years outside core area.
Land Management	Flood mitigation and monitoring Identifying unmapped trails across MSB lands Vegetative analysis for forestry/timber/gravel extraction applications Landscape analysis for wetland mapping and evaluation of impervious surfaces Damage assessments related to land alterations Mapping for land sales, site selection, and trail maps	1:600 to 1:2,400	Resolution: 6” pixel for core area; 1-2 ft. pixel for areas outside core area. Refresh: prefer annual for core area; 3-5 years outside core area.
Planning and Development Services	Land use analysis Roads and infrastructure planning Long range planning Permitting	1:1,200 to 1:2,400	Resolution: 1-2 ft. pixel; Refresh: prefer annual for core area; 3-5 years outside core area.
Facilities Management	Port Potential lease sites Rail sidings, gravel development	1:200 to 1:600	Resolution: 3-6” pixel Refresh: prefer annual, 2-3 years is satisfactory.
Utilities	Electrical Natural Gas Telephone	1:200 to 1:600	Resolution: 3-6” pixel Refresh: 2-3 year cycle for major utilities; solid waste (central landfill) requires monthly imagery reporting.

5 Resources

MSB Recurring Imagery Project Story Map

http://msb.maps.arcgis.com/apps/MapSeries/index.html?appid=dc6160bacfa446ce8eacb40101798334

Esri Basemap information:

http://solutions.arcgis.com/local-government/entire-organization/basemaps/

Surdex Corporation, “Resolution Comparison,”

https://www.surdex.net/imagery/sample-imagery-comparison/

6 References

ASPRS, 2014, ASPRS Positional Accuracy Standards for Digital Geospatial Data, Edition 1, Version 1, November 2014.

Mitchell, R. K., B. R. Agle, and D.J. Wood. (1997). "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts." Academy of Management Review 22(4): 853 - 888.

NSGIC, 2008, Digital Imagery for the Nation, a briefing paper summarizing the Imagery for the Nation (IFTN) analysis and survey, published March 4, 2008.

Ornstein, M.D, 1998, "Survey Research." Current Sociology 46(4): iii-136.

US Army Corps of Engineers, 2002. Engineering and Design Photogrammetric Mapping. Engineer Manual No. 1110-1000.

US Army Corps of Engineers, 2015. Photogrammetric and LiDAR Mapping, Engineer Manual No. 1110-1000. NOTE: This is the updated version of the 2002 10-1000 Manual (see above). 30 April 2015

USGS, 2014, Digital Orthoimagery Base Specification V1.0, Chapter 5 of Section B, U.S. Geological Survey Standards, Book 11, Collection and Delineation of Spatial Data, Techniques and Methods 11–B5

Appendix A: Internal Team Interview Groups

Department	Name	Title
Administration	Rachael Richardson	Division Administrative Specialist
	Therese Dolan	Division Administrative Specialist
	Brenda Henry	Assistant Clerk
	Brian Heaslet	Health & Safety Manager
	James Wilson	Internal Auditor
	Darla Erskine	Animal Care & Regulation Officer
	Patty Sullivan	Public Affairs Director
	Marc Van Dongen	Port Director
Capital Projects	Jude Bilafer	Capital Projects Director
	Jeff Walden	Construction Project Manager/Lead
	Brad Sworts	Pre-Design & Engineering Manager
	Mike Campfield	Environmental Engineer
	Tracy McDaniel	ROW Acquisition Coordinator
	Sheila Armstrong	ROW Acquisition Officer
Community Development	Eric Phillips	Community Development Director
	Glenda Smith	Real Estate Property Analyst
	Lisa Gray	Land Disposal & Foreclosure Specialist
	Emerson Krueger	Land Management Specialist
	George Hoden	Land Management Specialist
	Nancy Cameron	Land Management Agent
	Ray Nix	Resource Manager
	Hugh Leslie	Recreational & Library Services Manager
Emergency Services	Bill Gamble	Emergency Services Director
	Casey Cooke	Emergency Manager
	Richard Boothby	Fire Code Official
	James Steel	Fire Chief
	Scott Williamson	EMS Chief
	Mark Baker	Fire Code Official
	Michelle Wagner	Permitting Technician
	Tara Wade	Fire Service Area Assistant

Department	Name	Title
Finance	Cheyenne Heindel	Acting Finance Director
	Brad Pickett	Assessor
	Art Godin	Chief Appraiser
	Brenda	Senior Appraiser
	Michelle Thaman	Assessment Assistant
	Nicole Wilkins	Property Conveyance Specialist
	Marcia vonEhr	Document Specialist
Information Technology	Eric Wyatt	IT Director
	Susan Howard	GIS Manager
	Eric Goudey	GIS Manager
	Carla Goers	GIS Specialist
	Kenny Kleewein	GIS Specialist
	Heather Kelley	GIS Specialist
	Leah Jones	GIS Specialist
	Susie Gibson	GIS Cadastral Specialist
	Will Sands	GIS Technician Assistant
	Owen Dicks	GIS Field Technician Assistant
	Trevor Brown	GIS Technician Assistant
	Jack Horner	Web Architect
	Mark Baker	Telecommunications Technology Manager
	Dan Cappel	Operations Manager
Planning	Eileen Probasco	Planning Director
	Michelle Olsen	Permitting Technician
	Sara Jansen	Planner II
	Fred Wagner	Platting Officer
	Alex Strawn	Development Services Manager
	Vickielee Fenster	Planner II
Public Works	Terry Dolan	Public Works Director
	Jim Jenson	O&M Division Manager
	Alex Senta	Civil Construction Project Manager
	Anne Dollard	Road Asset Management Specialist
	Doug Wright	Maintenance Specialist
	Jamie Taylor	Central Landfill Division Manager
	Terry Burger	Central Landfill Supervisor Of Operations
	Ivy Spencer	Clean Up Coordinator

Appendix B: External Team Survey List

Organization	Name	Title
City of Wasilla	Tina Crawford	Planning Office
	Tahirih Revet	Planning Clerk
	Gene Belden	Chief of Police
	Terry Gregory	Network Support Specialist
	Joel Butcher	Computer Aided Dispatch (MATCOM)
City of Palmer	Sandra Garley	Community Development Director
	Lance Ketterling	Chief of Police
Matanuska Electric Association	Gary Kuhn	Chief of Engineering
	Stan Halfacre	CIO
	John Royce	GIS
Matanuska Telephone Association	Sierra Alcantra	Planner
Enstar Natural Gas Company	Erick Johnson	GIS Specialist
Alaska Railroad	Aaron Butter	GIS Analyst
State of AK AGC	Anne Johnson	Geographic Information Officer
State of AK ADEC	Charley Palmer	Hydrologist III
USDA NRCS	Sidney Thielke	GIS Coordinator
USGS Alaska Science Center	Brian Wright	Alaska Liason
The Nature Conservancy	Jim DePasquale	Spatial Analyst
Kenai Watershed Forum	Mike Gracz	Wetland Program Manager

Organization	Name	Title
Mat-Su Trails and Parks Foundation	Stuart Leidner	Interim Executive Director
Engineering, Design, and Survey Firms	R&M Consultants HDL Engineering Kinney Engineering LLC RECON LLC SurvBase LLC	Various Respondents

Appendix C: Definition of Technical Terms

Aerial photography: A series of photographic images of the ground, taken at regular intervals from an airborne craft, such as an airplane.

American Society of Photogrammetry and Remote Sensing (ASPRS): A scientific association of specialists in the arts of imagery exploitation and photographic cartography.

Color Infrared imagery: Color infrared (CIR) imagery includes a band of near infrared (NIR) information. NIR wavelengths are slightly longer than red, and they are outside of the range visible to the human eye. They are frequently collected as part of an aerial imagery collection and delivered as a fourth band of spectral information (in addition to red, green, and blue). Color infrared images (aka false color) are especially useful because the internal cell structure of healthy plants reflects near infrared wavelengths. As a result, it is frequently used to monitor plant health for agricultural, natural resources, and environmental purposes. Conventionally, a digital CIR image is set up to display the infrared band data with a red tone. Red wavelengths are set to appear green, and green wavelengths are set to appear blue. Blue wavelengths are not displayed.

Digital Elevation Model (DEM): 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.

Digital Terrain Model (DTM): A vector dataset composed of 3D breaklines and regularly spaced 3D mass points, typically created through stereo photogrammetry, that characterize the shape of the bare-earth terrain. Breaklines more precisely delineate linear features whose shape and location would otherwise be lost. A DTM is not a surface model; its component elements are discrete and not continuous; a TIN or DEM surface must be derived from the DTM.

Image Resolution: Describes the linear size that an image pixel or raster cell represents on the ground. Common resolutions are 3 inch, 6 inch, 1 foot, 1 meter, etc. Typically represents the native resolution of the imagery. Another similar expression of resolution is ground sample distance (see below).

Geographic Information Systems (GIS): A GIS manages spatial and tabular data in one software system; and provides tools to store, retrieve, manage, display, and analyze various types of tabular and geospatial data including aerial imagery, LiDAR, and vector data.

Ground Sample Distance (GSD): The distance between two consecutive pixel centers measured on the ground. The bigger the value of the image GSD, the lower the spatial resolution of the image and the less visible details. GSD and pixel are often used interchangeably.

Light Imaging, Detection, And Ranging (LiDAR): An technology that uses a sensor to measure distance to a reflecting object by emitting timed pulses of light and measuring the time difference between the emission of a laser pulse and the reception of the pulse's reflection(s). The measured time interval for each reflection is converted to distance, which when combined

with position and attitude information from GPS, IMU, and the instrument itself, allows the derivation of the 3D-point location of the reflecting target's location.

National Agriculture Imagery Program (NAIP): A program to acquire aerial imagery at one-meter pixel resolution during the agricultural growing seasons, mostly in the continental U.S.

Orthophotographs: Aerial photographs geometrically corrected to create uniform scale and to remove displacements caused by terrain relief, sensor distortion, and camera tilt.

Orthoimagery: Typically, aerial imagery used for mapping consists of a rectified aerial image or orthophoto (aka orthoimage). Orthoimagery is aerial imagery or photographs that have been adjusted using survey ground control points and vertical topography, for example a digital elevation model, to ensure that the imagery is positionally accurate. Unlike an uncorrected aerial photograph, an orthophoto can be used to measure true distances, because it is an accurate representation of the earth's surface, having been adjusted for topographic relief, lens distortion, camera tilt, and other factors.

Pictometry™: Pictometry is the name of a patented aerial image capture process that produces imagery showing the fronts and sides of buildings and other features. Images are captured by low-flying airplanes, depicting oblique and overhead perspectives of features. special software is needed to accurately determine objects' size and position on the maps.

Point Cloud: One of the fundamental types of geospatial data (others being vector and raster), a point cloud is a large set of three dimensional points, typically from a LiDAR collection.

Raster Data: One of the fundamental types of geospatial data (others being vector and point cloud), a raster is an array of cells (or pixels) that each contain a single piece of numeric information representative of the area covered by the cell.

Remote Sensing: The technology of acquiring multi-spectral information about the earth's surface and atmosphere using sensors mounted on airborne platform (planes, helicopter) or satellites.

Satellite images: Images taken from satellites, which orbit the earth at much higher altitudes than airplanes. Satellites use a variety of methods to produce images, including infrared, water vapor, and visible image technologies. Satellite imagery resolution varies from 30- centimeter pixel to 5 meter plus pixel in the commercial market.

Vector Data: One of the fundamental types of geospatial data (others being raster and point cloud), vectors include a variety of data structures that are geometrically described by x and y coordinates, and potentially z values. Vector data subtypes include points, lines, and polygons.

Appendix D: Survey Questionnaire