

# Aerial Imagery Study



Report submitted pursuant to Chapter 261, Laws of 2022

RESEARCH AND DEVELOPMENT  
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Report to the Legislature

**Director Mike Fong**

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# Executive summary

## Purpose and background

In 2022 ([Chapter 261, Laws of 2022 \(HB 1629\)](#)), the Legislature requested that the Department of Commerce (Commerce) in collaboration with the Office of the Chief Information Officer conduct an Aerial Imagery Study to assess the current uses and needs from state, local, special purpose districts, and tribal governments and provide recommendations to improve the collection and distribution of aerial imaging data. Specifically, the Legislature requested that the study include the following:

- (a) An assessment of:
  - (i) The ways in which state agencies, local governments, special purpose districts, and tribal governments currently use aerial imaging technology;
  - (ii) The ways in which state agencies, local governments, special purpose districts, and tribal governments could benefit from having access to aerial imaging technology, as determined by interviewing a sample of state, local, special purpose district, and tribal government officials to assess expectations for aerial imaging data;
  - (iii) The types of imagery currently used or needed; and
  - (iv) The frequency with which various types of imagery are currently used or needed.
- (b) Determine the minimum resolution level of aerial imaging that would best serve the majority of users statewide;
- (c) Estimate the current statewide expenditures by state, local, and tribal governments, and special purpose districts, for aerial image acquisition and organization;
- (d) Estimate the cost of procuring, once per biennium, and administering a high-quality aerial imagery program on a statewide basis;
- (e) Quantify the economies of scale between individual flights procured by individual jurisdictions as compared to the cost of procuring a single flight to obtain aerial imaging of the entire state;
- (f) Determine the best available mechanism for cost sharing between jurisdictions for the acquisition and management of aerial imagery; and
- (g) Make recommendations about current sources that provide imaging data, further steps to improve the collection of aerial imaging data, and the steps necessary to implement a comprehensive, cost-efficient, aerial imaging collection and distribution system to serve state, local, special purpose district, and tribal officials statewide through the state's existing geospatial program.

Commerce developed the Aerial Imagery Study research team, comprised of a mix of government staff and contracted consultants who operated under the selected vendor AppGeo, Inc. The research team conducted the study using various methods including:

- A survey of 435 subject matter experts from 145 local, special district, state and tribal governments

- Four workshops
- Twelve focus groups
- Numerous one-on-one interviews

## Key findings

- **The conservative estimated benefit of using aerial imagery is \$159 million per year in Washington.**
  - Aerial imagery is essential to many industries. We use aerial imagery for a wide variety of purposes from monitoring salmon habitats, land and waterway developments, and condition assessments to reducing the need for field inspections.
  - The efficiencies we gain by using aerial imagery has an aggregate benefit of \$159 million per year.
- **The current statewide aerial imagery program is cost effective but does not meet minimal technical specifications for the majority of local, special district, state, and tribal government users.**
  - The current Statewide Imagery Services Program administered by WaTech and contracted with Hexagon, costs the average county \$6,000 per year to acquire 6-inch orthoimagery (ortho). To acquire the same 6-inch ortho on the open market, a county would have to spend an average of \$45,000 per year.
  - The Statewide Imagery Services Program offers only 6-inch ortho and the characteristics of the imagery, like time of year, are not controlled.
  - The majority of survey respondents - 81% - were in favor of an expanded state-run program as long as it was at an affordable price to their government entity.
- **There is no readily available off the shelf solution to meet the minimum technical specifications that addresses the majority of local, special purpose district, state and tribal government aerial imagery uses.**
  - While there is useful imagery like the National Agricultural Imagery Program (NAIP), and some aerial imagery vendors provide regular urban flight plans, none of these options would achieve 6-inch ortho and oblique minimum technical specifications.
  - Technical specifications for high-quality aerial imagery program are 3-inch and 6-inch ortho (vertical) and oblique (at an angle) photos collected when the leaves of deciduous trees are off (leaf-off) and leaves are on (leaf-on). This aerial imagery is also available in 4-band (red, green, blue, near infrared) ortho and 3-band (red, green, blue) oblique imagery.
- **Without a state-funded program, tribal, state and local governments would need to spend \$48.1 million every two years to acquire images at the necessary minimal technical specifications.**
  - In addition to 6-inch ortho, local, special purpose district, state, and tribal governments need 3-inch ortho with 4-band imagery, 3-inch oblique and 6-inch oblique imagery with 3-band imagery that is flown in different seasons when the leaves are on (leaf-on) and off (leaf-off). Three-band and 4-band imagery allow for infrared and near infrared, as well as other spectrums of light to be seen for a variety of technical needs that cannot be achieved in other ways.
- **Cost-sharing models have mixed results.**

- Cost-sharing models are currently the only way that some smaller governments can acquire aerial imagery. While \$6,000 per county is a good deal for many counties, many municipalities do not have a budget for aerial imagery.<sup>1</sup>

**Washington has the economies of scale to get the best cost per square mile of aerial imagery and control administrative costs.**

- AppGeo, Inc. utilized survey data, focus groups and one-on-one interviews to determine a high-quality aerial imagery program that would meet the minimal technical specifications for the majority of local, special district, state and tribal government users. Six percent of the high-quality aerial imagery program would go toward administrative costs, while 73% would go toward aerial imagery acquisition. The remaining 21% would be spent on spatial and image quality control, infrastructure (storage, hosting and streaming services) and software to ensure access for local, special purpose districts, state and tribal governments. The total biennial cost would be \$36.6 million.

**A high-quality aerial imagery program has a positive return on investment.**

- For every \$1 invested in aerial imagery, there is a \$7.35 return in benefits over 6 years. A simple annual cost/benefit analysis shows that for every \$1 invested in aerial imagery there is bi-annual \$8.80 benefit. To learn more about these calculations please see [Appendix C: Study methods](#).

## Recommendations overview

WaTech manages the existing Statewide Imagery Services Program and serves primarily Washington state agencies and interested counties. To expand the focus of this program so that Washington's tribes and local governments can receive imagery services is a change in focus that would increase program administration, implementation, and coordination costs. Commerce recommends that the Legislature enable an expansion of this program through the following phases:

- **A one-year startup phase in fiscal year 2025.** This includes the planning to control imagery characteristics, hiring of staff positions essential to the administration of the program (including a tribal liaison to consult with tribal governments on flight paths and collection), and beginning a new vendor selection process. [Table 3](#) contains potential startup costs.
- **In the 2025-27 biennium and each biennium thereafter, begin operating the high-quality aerial imagery program.** This program will provide both oblique and ortho at 3-inch and 6-inch resolution, which meets the majority of users' needs. This option also allows for all Washington and tribal government entities to access the imagery they need without concerns over limited budgets. This option also streamlines administrative costs, saving Washington residents' funds and re-directing government entities' administrative capacity to other pressing needs. WaTech would house and manage the expanded program. [Table 3](#) and [Table 4](#) contain potential startup costs and data acquisition estimates.

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<sup>1</sup> Based on AppGeo Survey data.

# Introduction

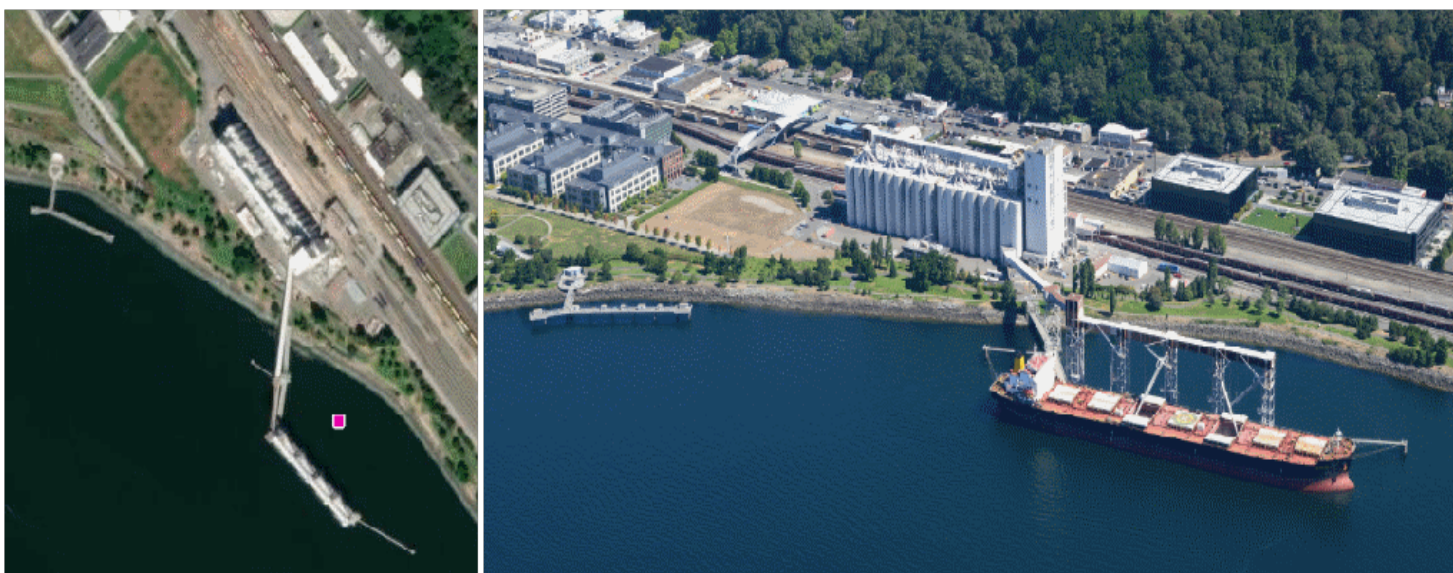
## Background

A single aerial imagery flight can take different types of imagery that crosses multiple jurisdictions and geographies. Today, state, local and special purpose districts purchase aerial imagery data independently, often resulting in multiple payments for the same data and flights. This report outlines how Washington can achieve a high-quality aerial imagery program.

## Aerial imagery terms

Orthoimagery (ortho) and oblique imagery are the two most important terms to understand in this report. Figure 1 shows the same scene as an orthoimage and an oblique image. Different camera systems collect vertical and oblique photos, so their acquisition costs are different. Oblique imagery is typically more expensive.

**Figure 1: Comparison of an ortho (left) and an oblique image (right)**



Source: Washington Department of Ecology Coastal Mapper

Every functional use requires up-to-date imagery, typically no more than 2 years old. Older imagery is used to determine changes and establish trends (e.g., erosion and sedimentation, and changes in buildings). A successful program must gather new imagery and make historical imagery available too. Indeed, some regulatory and professional requirements set standards for the age of useful imagery.

The next most important factor to understand in this report is ground separation distance (GSD). GSDs are measured in resolutions, which is the dimension of pixels. GSDs range from 1-inch to 1-meter. 1-inch is the most detailed, while 1-meter is the least detailed. Smaller GSD values reveal more detail but are more expensive to collect, process, and store. Many governments cannot afford high resolution aerial imagery, so they opt for lower resolution aerial imagery (including free imagery from sources such as Google Maps and Microsoft Bing). Figure 2 shows the difference in clarity between a 12-inch ortho and a 3-inch ortho.



**Figure 2. 12-Inch and 3-inch ortho imagery**



Two Images from MapGeo: <https://carsoncitynv.mapgeo.io>

There are many additional terms that this report references. Table 1 lists key terms that the reader may reference.

**Table 1: Aerial imagery key terms**

Term	Description	Synonyms
<b>Aerial imagery software (user)</b>	Software that makes aerial imagery useful such as web-browser maps, GIS software, computer-aided dispatch (CAD), mass appraisal (CAMA). Oblique software is often a separate computer program because oblique imagery is often stored in specific, optimized, formats that require special code. Oblique software can also allow rotating three-dimensional views and measurements such as height, depth, and vertical surface areas. Oblique software may integrate with other software.	Software, Oblique software, various product names
<b>Corrected orthoimagery</b>	Colors are balanced and standardized, seam lines removed, vertical relief artifacts are removed to create a purely vertical view everywhere.	Product names: TrueTouch, True Ortho
<b>Derived products</b>	Data and products created using aerial imagery. These include maps of many phenomena (buildings, vegetation, land cover, infrastructure, etc.) and changes detected by comparing different generations of derived products.	Land cover, land use, impermeable surfaces, infrastructure, building footprints, change detection
<b>Ground separation</b>	The dimensions of an image pixel on the earth. Typical values are 1m, 0.5m, 12", 9", 6", 3".	Resolution

Term	Description	Synonyms
<b>distance (GSD)</b>		
<b>Ground visibility</b>	Whether the actual ground surface is visible. Common causes of poor visibility are atmospheric (clouds, fog, mist, smoke, dust) or surface (water, snow, objects) and vegetation.	
<b>Image bands</b>	The light wavelengths collected by a camera. Typical bands are red, green, blue, and near infrared.	RGB, IR, Near IR, 4-band, 3-band
<b>Image services</b>	Online digital services that provide images (ortho or oblique) to some sort of user client software (web-browser map, GIS software, computer-aided dispatch (CAD), mass appraisal (CAMA)).	Cloud-based, streaming, on-line, web service, WMS
<b>Leaf-on / Leaf-off</b>	Leaf-on is when deciduous and annual vegetation has leaves; Leaf-off is when deciduous and annual vegetation has dropped its leaves. Leaf-off is typically late fall to early spring (western Washington) or mid-spring (eastern Washington).	Leafless, leaf on, leaf off
<b>Lidar</b>	Lidar stands for "light imaging detection and ranging". This technology is often confused with aerial imagery because collection is often done from aircraft and the products are frequently used together. Lidar provides a large "cloud" of 3-dimensional points used to model the surface and other things on the surface. This study does not include Lidar collection or use.	
<b>Near infrared</b>	Near infrared wavelengths are reflected (illuminate) vegetation and other heat-absorbing or heat-reflecting surfaces.	IR, Near IR
<b>Oblique photo</b>	Air photo taken with the camera axis at a 35 to 50 degree angle to the surface of the earth.	Sideways, 2-way, 4-way
<b>Orthoimagery</b>	Vertical photos seamed together and spatially corrected to varying degrees of accuracy.	Orthogonal, ortho, orthos, vertical, top-down
<b>Planimetric orthoimagery</b>	Orthoimagery corrected to a known accuracy standard using surveyed ground control points.	Product names: Certified, Controlled
<b>Storage</b>	The digital storage requirements for aerial imagery. Storage needs are dictated by the number of bits in each image and by the GSD (see above). Decreasing the GSD by 50% (e.g., 6" to 3")	

Term	Description	Synonyms
	results in a 200% increase in storage (e.g., 50tb to 200tb).	
<b>Sun angle</b>	The angle of the sun to the surface of the earth. Highest angles occur at daily solar noon and seasonally at the summer solstice. Low sun angles produce larger and deeper shadows.	
<b>Vertical photo</b>	Air photo taken with the camera axis perpendicular to the surface of the earth.	Top-down

# Recommendations

Commerce recommends that the Legislature expand the existing Statewide Imagery Services Program, known as the high-quality state aerial imagery program. As Table 2 illustrates, the high-quality statewide aerial imagery program is the only option that meets all criteria that the Legislature, state agencies, local governments and tribal governments identified. We consulted with the current WaTech aerial imagery program manager on these recommendations.

**Table 2. Aerial imagery options comparison**

Option	Equal access	Standardized coverage of state	Low administration cost to users	Meets regulatory standards (e.g. IAAO)	Cost per biennium
High-quality statewide aerial imagery program	Yes	Yes	Yes	Yes	\$36M
High-quality state program minus 3-inch obliques in public mountainous areas	Yes	No	Yes	Yes	\$28M
State funded 6-inch with 3-inch Buy-Up	Yes	6 inch only, higher resolution requires buy-up	Buy-up 3-inch administrative costs	Yes	\$23M
State funded 6-inch minus mountainous areas	Yes	No	Buy-up 3-inch administrative costs	Yes	\$15M
Statewide 6-inch with 3-inch buy up (no obliques)	Yes	No	Buy-up (all obliques and 3-inch orthos) and administrative costs	No	\$3M
Current program with full state funding	Use under license only	No	No	No	\$1M

## Startup phase beginning in fiscal year 2025

The startup phase would focus on the planning to control imagery characteristics, hiring staff that are essential to the administration of the program and initiating a new vendor selection process. WaTech would continue to house and manage the expanded program. [Table 3](#) outlines potential estimated startup costs. Actual FTE costs may vary depending on the specific job classifications to be filled, when those staff are hired, and the timing of staff onboarding. The high-quality aerial imagery program would have four new staff positions to administer all of the technical specifications and needs of the program, including community coordination, and outreach and engagement.

**Table 3. Potential project startup costs of high-quality aerial imagery program**

Costs	Project startup: FY 2025 - supplemental
Ortho & oblique imagery acquisition	\$0
FTE (4), salary, benefits, and standard agency goods, services, and space and utilities costs	\$940,000
External technical support	\$100,000
Creation & maintenance of statewide control network	\$1,325,000
Spatial and image quality control	\$100,000
Infrastructure (Storage, hosting, and streaming services)	\$32,400
Software (support viewing, distribution)*	
<b>Total startup cost</b>	<b>\$2,497,400</b>

\*There are no software costs for the first year since there is no imagery collected in the first year.

### Statewide control network

Before any aerial imagery can be collected, there is a one-time cost for the initial setup of a statewide control network. A control network ensures the spatial accuracy of the imagery is captured and would initiate the acquisition of aerial imagery viewing software. The staff mentioned earlier would be managing this critical step.

### Recommended staff:

- Aerial Imagery Program Manager (1 FTE) manages the solicitation and contract activities of the high-quality state aerial imagery program and manages the high-quality state aerial imagery program team. Estimates based on an IT Business Analyst - Senior Manager position (\$177,000 salary and benefits plus agency expenses).
- Support Engineer (1 FTE) administers the infrastructure and distribution (storage, data downloads, online services, web maps) and software needs of aerial imagery to all local, special purpose district, state and tribal governments support and work with existing DNR staff who also provide technical assistance. Estimates based on an IT Data Management - Manager position (\$177,000 salary and benefits plus agency expenses).
- Tribal Coordinator (1 FTE) will coordinate with federally recognized tribes to ensure the state is meeting obligations to tribal governments. Specific work can include, but is not limited to creating processes for the co-administration of aerial imagery with the state as it pertains to the reserved rights of each federally recognized tribe and coordination with the rest of the program staff to ensure consistent and equitable treatment of all users of aerial imagery. Estimates based on an IT Data Management - Manager position (\$177,000 salary and benefits plus agency expenses).
- Community Relations Coordinator (1 FTE) will raise awareness about the high-quality aerial imagery program and coordinate with program staff to ensure that local and special purpose district staff have

equitable access to the high-quality state aerial imagery program. Estimates based on a Management Analyst 5 position (\$131,000 salary and benefits plus agency expenses).

It is assumed that onboarding of staff may occur at different times of the fiscal year, and actual job classifications may vary based on the administering agency's needs. Each factor would have an effect on these cost estimates.

**Beginning in the 2025-27 biennium and each biennium thereafter, WaTech could begin operating the high-quality aerial imagery program.**

Similar to the state of Kentucky's aerial imagery program, the high-quality statewide aerial imagery program will provide both oblique and ortho at the 3-inch and 6-inch resolution, which meets the majority of Washington users' needs. This option also allows for all Washington and tribal government entities to access the imagery they need without concerns over limited budgets. This option also streamlines administrative costs, saving Washington residents' funds and re-directing government entities' administrative capacity to other pressing needs.

[Table 4](#) provides an estimate of program administration, implementation and data acquisition costs for illustrative purposes. It also illustrates that the first flight cycle represents a first biennial budget of \$33 million because the full infrastructure costs would not be incurred until the following biennium. The second flight cycle is an accurate depiction of the biennial costs for the high-quality aerial imagery program.

**Table 4. Potential costs of high-quality aerial imagery program over two biennia**

Costs	1st flight cycle 2025-2027 biennium	2nd flight cycle 2027-2029 biennium
Ortho & oblique imagery acquisition	\$26,479,825	\$26,479,825
FTE (4)	\$2,000,000	\$2,000,000
External technical support	\$200,000	\$200,000
Creation and maintenance of statewide control network	\$26,500	\$26,500
Spatial and image quality control	\$1,712,500	\$1,712,500
Infrastructure (Storage, hosting, and streaming services)*	\$1,958,400*	\$5,875,200
Software (support viewing, distribution)	\$850,000	\$340,000
<b>Total subsequent biennium cost</b>	<b>\$33,227,225</b>	<b>\$36,634,025</b>

\* There are minimal storage, hosting, and streaming costs for the first year.

A custom contract with a national aerial imagery vendor will be needed. National aerial imagery vendors are listed in alphabetical order and include but are not limited to Eagleview, Sanborn, NearMap, and NV5. At a minimum, the aerial imagery should be collected on a biennial cycle with fresh aerial imagery data published every 2 years across the entire state according to [Figure 5](#). The expectation is that the vendor would be the primary contractor and subcontract out parts of the technical requirements.

Technical requirements include:

- 6-inch GSD ortho, nominal 6-inch oblique images over 84% of the state<sup>2</sup>
- 3-inch GSD ortho, nominal 3-inch oblique images over 16% of the state<sup>3</sup>
- 4-band (red, green, blue, near infrared) ortho
- 3-band (red, green, blue) oblique imagery
- Leaf-off imagery
- Spatial and quality control sufficient for planimetric mapping purposes in all populated areas, appropriate to the GSD of the ortho.
- Spatial and quality control sufficient for general mapping purposes in all other areas.
- Stereo pairs of ortho are provided to the Department of Natural Resources for their photogrammetry use
- Offers oblique viewing tools or is compatible with oblique viewing tools for measurement, calculations, etc.
- Compatible with common government software systems: GIS, CAMA, CAD.

The program will cover the entire state at either 3-inch GSD or 6-inch GSD (Figure 5). Urban growth areas and corridors require higher resolution at 3-inch GSD. All other parts of the state are collected at 6-inch GSD. For ortho, the 6-inch GSD coverage is the same as the current WaTech Statewide Imagery Program, with the notable difference that WaTech would have control over imagery characteristics. Providing more detailed 3-inch imagery in urban areas supports government needs for planimetric mapping of infrastructure, assessments, planning, and other intensive uses. An entity could optionally purchase the 3-inch GSD imagery through the buy-up options.

- State funding assures equal accessibility for all Washington government entities and tribal governments:
  - It does not require subscription and removes accessibility barriers that smaller government entities currently experience.
  - It is distributed through mechanisms that are available to all.
- The high-quality state program should also offer buy-up program for derived products or enhanced imagery.
  - Vendor offers additional products commonly of interest to government sectors (e.g., change detection).
  - Government entities can buy more detailed imagery (smaller GSD, higher resolution oblique images) at reduced rates, so long as the more detailed imagery is shared as part of the program.

## Implementation of the high-quality statewide aerial imagery program

- 1) Decide on which option to pursue.
- 2) Establish stable funding.
- 3) Year 0 (Fiscal Year 2025): plan and design the aerial imagery collection technical effort as needed (depends on alternative selected)
  - Spatial control through ground survey network
  - Flight planning

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<sup>2</sup> 84% of Washington is suburban or rural and does not require as high of a resolution of ortho and oblique imagery.

<sup>3</sup> 16% of Washington's land area is in an urban growth area and has high-density structures, which require higher resolution of ortho and oblique imagery.

- 4) Year 0 (Fiscal Year 2025): design any solicitation needed for the aerial imagery program
  - Establish an industry review process to hone the requirements to be realistic, feasible, biddable
  - Release toward the end of Year 0
  - Select vendor
- 5) Year 1 (Fiscal Year 2026): collect first cycle of aerial imagery
  - Process and deliver
- 6) Year 1 (Fiscal Year 2026): promote aerial imagery usage
  - Coordination with tribal governments
  - Coordination with local governments
  - Training and education resources
- 7) Year 1 (Fiscal Year 2026): solicit buy-up requests
  - Coordinate with vendor if part of acquisition process
- 8) Year 2 (Fiscal Year 2027): vendor buy-up fulfillment
- 9) Year 2 (Fiscal Year 2027): continue coordinating, training, and education to get maximum value from imagery
- 10) Years 3 (Fiscal Years 2027 and 2028) and forward: repeat the Year 1 and 2 collection, buy-up, distribution cycles on biennial basis



# Methodology

In order to conduct the aerial imagery study, the research team engaged with subject matter experts broadly and in-depth. The research team organized four virtual workshops, a statewide electronic survey and 12 focus groups.

Broad engagement occurred across state and local levels of government and across the entire state, including 34 counties, 61 municipalities, 16 special purpose districts, six school districts, and 26 tribal governments. These numbers reflect the total engagement with each government type across the workshops, survey and focus groups.

The survey and focus groups allowed for in-depth analysis efforts to better understand the different uses and needs of aerial imagery by different staff levels within each government sector. AppGeo conducted a survey with 435 government officials and staff respondents. The total survey respondents included 113 county staff, 83 municipality staff, 16 special purpose district staff, 125 state agency staff, 21 tribal government staff, and 71 other individuals. A question on the survey asked if participants wanted to volunteer to participate in a focus group.

Each focus group included subject matter experts with similar and relatable experiences to discuss their specific aerial imagery uses, needs and challenges. We convened the following 12 focus groups:

- 13 GIS Managers
- 3 Planners
- 4 Environment/Natural Resource Managers
- 2 Infrastructure: asset and Engineer Managers
- 5 Transportation subject matter experts
- 4 Public Safety subject matter experts
- 2 Emergency Preparedness staff
- 4 Assessors from the west side of Washington
- 4 Assessors from the east side of Washington
- 2 focus groups for tribal government staff with a total of 6 subject matter experts
- 1 focus group for the existing Statewide Imagery Services Program run by WaTech.

For each focus group, AppGeo sent invitations to an average of 10 individuals whose survey response indicated interest in joining. For subject matter experts who wanted to attend a scheduled focus group, but could not make the meeting due to a time conflict, the research team followed up with one-on-one interviews.

For more details about methodology, please refer to [Appendix C: Study Methods](#).

# Findings

## Current aerial imagery uses and benefits in Washington

Washington and tribal governments use aerial imagery in a wide variety of ways. Table 5 shows some of the uses and the types of aerial imagery most valuable for each. Between workshops, the survey, focus groups, and interviews, it was determined that both 3-inch and 6-inch ortho and oblique imagery are considered the most useful overall. As a reminder, the smaller the inch size, the more detailed the image. Six-inch imagery is better than 12-inch and would fulfill the need of any user who has a minimum technical resolution that is higher than 6 inches.

**Table 5. Current uses and benefits of aerial imagery**

Functional need	Government sector	Benefits	Imagery type
<b>Air quality monitoring</b>	State, local, tribal, special purpose district	Timely public hazard notification & education	1' to 3' ortho
<b>Assessing property value</b>	Local, tribal	Improved assessment equity; More efficient inspections; improved safety	3-6" ortho / obliques
<b>Disaster recovery</b>	State, local, tribal, special purpose district	Assess damage and focus mitigation efforts, speed conveying resources to affected communities and individuals	6" - 12" ortho / obliques
<b>Economic development</b>	State, local, tribal, special purpose district	Improved property targeting matching specific development criteria; Improved property management	3-6" ortho / obliques
<b>Emergency management</b>	State, local, tribal, special purpose district	Improved hazardous materials and wildfire risk assessment and preparedness; More efficient disaster response; Improved post disaster assessment and mitigation	3-6" ortho / obliques
<b>Forestry and forest management</b>	State, local, tribal	Improved timber harvest assessments, forest health assessments, & wildfire risk assessments; Improved post wildfire recovery management	6" - 12" ortho
<b>Law enforcement</b>	State, local, tribal	Improved crime mapping, public notification, emergency services routing, 911 location verification	6" - 12" ortho
<b>Long-term planning</b>	State, local, tribal, special purpose district	Improved comprehensive planning, economic development, public discourse	6" - 12" ortho
<b>Near-term planning</b>	State, local, tribal, special purpose district	Improved planning and public discourse	6" - 12" ortho / obliques
<b>Public health</b>	State, local, tribal, special purpose district	Improved disease mapping; improved public outreach	6" - 12" ortho
<b>Public safety (fire and police actions)</b>	Local, tribal	Ability to see incident context (safe entry modes, nearby hazards); Common operating picture for incident command	6" - 12" ortho / obliques
<b>Shoreline management</b>	State, local, tribal, special purpose district	Improved coastal & shoreline erosion, monitoring & assessment; Improved coastal development monitoring of unpermitted uses; Improved recreational use management and recreational facility management	6-12" ortho / obliques

Functional need	Government sector	Benefits	Imagery type
Site selection	State, local, tribal, special purpose district	Improved site prospecting and planning	6-12" ortho / obliques
Transportation infrastructure	State, local, tribal, special purpose district	Improved traffic management; Improved infrastructure mapping & facility management; improved safety assessment	3-6" ortho / obliques
Utility infrastructure (power, water, sewer)	Local, tribal, special purpose district	Time-savings in fieldwork, efficiency in management, safety through reduced field time	3-6" ortho / obliques

Overall, aerial imagery plays a central role in many aspects of contemporary government at the state, tribal, and local levels. The most common form of large-area imagery has been ortho (vertical imagery). Local, special purpose district, state, and tribal governments use ortho for many planning and management purposes. One of the most helpful uses is looking at changes of landscapes over time. Aerial imagery companies have software that detects changes very quickly, which can save a lot of staff time in monitoring and managing landscapes.

Oblique imagery is very important for government uses. Oblique imagery is now much more available due to the use of digital systems. Contemporary oblique aerial imagery collections, used with appropriate software, allow detailed rotating views (fly-arounds) of a single location, enhanced measurement capabilities, and can convey more information to the casual user than ortho does. For example, property assessment increasingly makes use of oblique aerial imagery, which is a practice promoted by the [International Association of Assessing Officers](#) and current [Washington regulations](#). Shoreline management also relies on oblique imagery because vertical photography does not convey near-shore topography or setting as shown in Figure 1. Local, special purpose districts, state and tribal governments all rely on aerial imagery for disaster recovery. Aerial imagery taken prior to a disaster is used to assess damage and focus mitigation efforts to convey resources to affected communities and individuals. Aerial imagery is also commonly used for economic development, assessing property values, comprehensive planning and public health, saving staff time and administrative costs that result from in-person assessments, surveying and planning.

## Current sources that provide aerial imagery data

Government sectors in Washington acquire aerial imagery in two principal ways. First, WaTech runs the Statewide Imagery Services Program. Second, many government agencies independently purchase aerial imagery. This study also found that some governments acquire imagery directly over small areas using camera-equipped drones – a useful tool but one that does not scale to a statewide, high-quality aerial imagery program.

### Statewide program

The current WaTech Statewide Imagery Services Program was established in 2017 at the request of the State E911 Office and the Washington Association of County Officials (WACO). The Statewide Imagery Services Program is a subscription-based program with Hexagon as the imagery services provider. Government entities can subscribe to the data for licensed uses on an annual payment basis at a moderate cost. The available aerial imagery is limited to the 6-inch GSD orthophotos throughout the state. The state program and Hexagon contract is managed by a single staff person at WaTech who administers many other efforts.

WaTech’s current imagery contract that provides access to Hexagon’s subscription services is through Ascent GIS, a Hexagon reseller. WaTech’s three-year contract with Ascent GIS guarantees access to Hexagon’s six-

inch resolution imagery for all of Washington. In addition, the Ascent GIS contract guarantees that Hexagon’s statewide imagery for Washington will be refreshed twice within each three-year contract cycle. Hexagon provides access to imagery via online streaming services and WaTech delivers of the imagery to subscribers on physical media. WaTech provides online streaming services for all Washington agencies and departments. WaTech imagery is available to tribal governments through the Northwest Indian Fisheries Commission, rather than on a per-government subscription basis. For all other governmental entities, Hexagon provides online streaming services.

The current cost of the program is \$307,000 annually. Once Hexagon delivers the 6-inch orthophotos to the state program, the Department of Natural Resources (DNR) does post-processing of many images at no additional cost to subscribers; this work requires an additional 0.1 FTE annually. Some examples of the type of post-processing of the Hexagon imagery are customized image compression formats and alignment of orthophotos to match municipal or county boundaries. Table 6 provides a breakdown of the annual cost of the current WaTech Statewide Aerial Imagery Program.

**Table 6. Annual aerial imagery acquisition costs, WaTech Statewide Aerial Imagery Program (administrative costs are not included)**

Statewide imagery services program member subscriber	Annual payment
Northwest Indian Fisheries Commission	\$15,000
Emergency management, Department of the Military (WA NG911 Office)	\$65,000
State agencies (Ecology, Wildlife, DOT, DNR)	\$40,000
Others	\$187,000
<b>Total</b>	<b>\$307,000</b>

**Benefits of the current statewide program**

- **Lowest cost.** The current statewide imagery program provides 6-inch ortho at a fraction of the cost compared to what government entities would pay independently for the same quality of 6-inch ortho. The average cost to a county for the statewide imagery program is \$6,000 per year, compared to an average of \$45,000 per year for independently purchased 6-inch ortho. That is an average savings of \$39,000 per year for each county.

**Challenges the current statewide program faces**

- **No control over imagery characteristics.** Because WaTech’s contract with Hexagon is for an imagery subscription service, WaTech has no control over the imagery’s technical characteristics. For example, the date of the imagery capture determines whether trees have leaf-on or leaf-off. Leaf-on imagery is great for urban or rural forestry applications, but very poor for tax assessment purposes. Lack of control over the image characteristics means that the imagery is not as useful as it could be for local governments, special purpose districts, state agencies or tribal governments.
- **Aerial imagery provided can be incomplete.** Because government entities cannot choose the dates of when to fly, inclement weather can interfere with the collection of statewide imagery leaving areas of Washington uncollected. Aerial imagery collected along coastal locations on the Olympic peninsula often has significant cloud cover and/or fog, which makes it hard to collect imagery during the spring.

- **Duplicative imagery acquisitions.** Because there is no control over image characteristics, government entities make independent purchases of aerial imagery at the six-inch GSD orthophoto to control for leaf-on, leaf-off and weather events. This requires additional budget investments by these governments.
- **Funding instability.** Funding the current WaTech Imagery Program comes solely from government subscriptions. Therefore, if just a few of those governmental partners do not renew their subscription to the program, the whole imagery program is at risk of termination.
- **Unequal access to imagery.** Most smaller and rural government entities do not have the funds necessary to participate in the Washington subscription-based Aerial Imagery program.
- **Complex accounting and administration.** There are significant administrative costs associated with the current WaTech Statewide Imagery Services Program at both state and local levels. Examples include the generation and payment of invoices, late payment reminders, replacement and recruitment of new consortium partners, and the need to provide end-user technical support. WaTech technical support also includes coordinating the post processing of the imagery into various state plan projections and customized image compression formats. In addition, WaTech technical support includes the clipping of the post-processed imagery to consortium partners, and finally the storage and hosting of all historical imagery.

## Independent purchasing

For the purpose of this report, we define independent purchasing as aerial image purchases independent of the state program. Independent purchasing addresses many of the challenges faced by the Statewide Imagery Services Program. During the study, the research team spoke with many municipal and county staff who were part of local consortiums. These consortiums bring together funding from multiple local governments and some special purpose districts to purchase agreed upon aerial imagery. Costs can vary from year to year based on user requirements and consortium membership. We noted that while consortiums capitalize on economies of scale, the cost per mile is still much larger compared to a statewide aerial imagery program. Local, special purpose district and tribal governments still choose to participate in local consortiums because they offer a better alternative than the current option of purchasing the imagery alone.

Based on the survey data, aggregated individual purchases of aerial imagery total \$2,645,000 per year with an estimated annual direct administrative cost of \$625,000. Indirect administrative costs: legal review, purchasing review and approval, have high variability from one government entity to another and were not included. The annual aggregated independent purchases of aerial imagery by Washington and tribal government entities are in Table 7. Not all local governments and tribal governments reported their aerial imagery costs due to complex budgeting. It was not unusual for multiple survey respondents from the same government to report conflicting figures. In those instances the research team followed up with the best point of contact who could speak to costs and if the figure could not be validated it was not included in the annual aggregate. The parenthesis next to the individual purchasers column lists the number of governments the research team was able to validate. It is safe to assume that Table 7 totals report a significant undercount in the actual cost of independently purchased aerial imagery.

**Table 7. Annual aggregated reported independent purchase costs from survey, focus groups, and interviews**

Individual purchasers	Current reported annual imagery cost
Counties (13)	\$1,446,440
Municipalities (26)	\$427,042
State agencies (3)	\$499,300
School district* (2)	\$0*
Special purpose district (25)	\$152,000
Tribal governments (15)	\$66,070
Other (regional councils)	\$54,317
<b>Total</b>	<b>\$2,645,169</b>

\*No school districts reported purchasing figures.

While Table 7 shows annual reported aggregates, it does not show a biannual cost. Table 8 compares reported versus extrapolated annual administrative costs and per cycle aerial imagery acquisition costs. In order to create a comparative analysis, a baseline of aerial imagery is needed. The research team assumed that on average local governments and tribal governments want 25% oblique and 75% ortho imagery which was informed by the survey and focus groups and that acquisition of 3-inch, 6-inch, and some 9-inch were most typical. Based on these assumptions and the survey responses, individual purchasers collectively spend \$6,540,000 per year. This is still an undercount of the actual aggregate cost of aerial imagery in Washington.

Because the true cost of aerial imagery cannot be determined, an extrapolated estimate was created. The extrapolated independent purchasers estimate in Table 8 answers the question, what if each county and city were to purchase imagery independently? Counties and Cities have well-defined borders and can be quickly analyzed at a per square foot cost using the same mix of 25% oblique and 75% ortho imagery. This extrapolated cost does not account for state agencies, special purpose districts or tribal governments. The total amount for a two-year cycle is \$47,338,000. The cost is high due to \$34.5 million administrative costs over two years. Each county and city would pursue their own contracts with aerial imagery providers. During focus groups, participants from different government types were asked how much staff time they spend on administration as a percent of a FTE. Annually, 172.55 FTEs are needed to perform the administrative duties associated with aerial imagery acquisition. The salary of a single FTE varies greatly throughout the state. Focus groups helped inform a \$100,000 average FTE salary. The administrative cost assumptions listed in [Appendix C - Study Methods](#), provide greater detail. It is true that local consortiums exist to acquire aerial imagery. It is also true that these local consortiums have high rates of variable participation year to year, so no reliable figures could be acquired. It is important to remember that no state, special district or tribal governments are included in the extrapolated costs. Therefore the undercount of administrative staffing and not accounting for local consortium savings have a cancelling effect. Approximately 73% of the total extrapolated 2-year cost, \$47,338,000, are administrative costs.

**Table 8. Comparing Reported vs Extrapolated annual and per cycle cost of statewide aerial imagery under current procurement methods.**

Individual purchasers	Annual imagery cost	Annual administrative cost	Per cycle cost (2 Year)
Reported independent purchases (25% oblique, 75% ortho)	\$2,645,000	5.0 FTE (aggregate, 50 respondents at 0.1 each) at \$125,000 per FTE = \$625,000 <sup>4</sup>	\$6,540,000
Extrapolated independent purchases	\$6,414,000	172.55 FTE (aggregate 1,822 government entities) At \$100,000 = \$17,255,000 <sup>5</sup>	\$47,338,000 <sup>6</sup>

**Benefits of independent purchasing**

- **Control over image characteristics.** The primary benefits of independent imagery purchases are that state and tribal government entities can have complete control over the specifications of the imagery products being purchased and tailor them to their specific needs.
- **Control of imagery resolution.** Examples of such imagery specifications include the resolution of the imagery. Higher resolution imagery, such as 3-inch, allows the end user to efficiently perform many different tasks directly from their desk. These include visualizing, locating, inspecting, assessing and measuring a wide range of infrastructure like fire hydrants, building and shoreline setbacks, docks, and sidewalk ADA-access, which for most urban applications requires 3-inch resolution imagery.
- **Control over imagery capture time.** State and tribal government entities can choose the time of year they wish to collect imagery. Leaf-off imagery is typical in the late fall when deciduous trees lack leaves, allowing aerial imagery to see various types of infrastructure more clearly. Leaf-on imagery can also allow for an infrared band for vegetation-related analysis in urban forestry to determine the health and size of tree canopies. Leaf-on imagery can also be used to manage urban trees so they can be trimmed and not interfere with electric transmission lines during high winds. Most government entities that purchase aerial imagery independently have alternating cycles of leaf-off, leaf-on aerial imagery.
- **Ability to fiscally plan and cost-share imagery acquisition.** State, local and tribal government entities that have the budget for independent aerial imagery purchases can plan ahead and seek out local consortiums to cost-share. Many government entities, most often county governments, form imagery consortiums to help lower their imagery acquisition costs by sharing those costs with other government entities that exist within, or adjacent to their jurisdiction.
- **Ability to purchase derived imagery products.** Another significant benefit of independent imagery purchases is that it allows users to purchase ancillary products. One of the most commonly purchased derived products is “change finder” or “change detection,” where planimetrics (building footprints, roads, sidewalks) are derived directly from the imagery from two separate imagery capture cycles that have occurred at different points in time. Change detection has saved countless staff hours by automatically

<sup>4</sup> Annual encumbered staff rates for those local and tribal governments who reported staff rates associated with the purchase of independent imagery were aggregated and averaged resulting in an encumbered staff rate of \$125,000 per year. Appendix C, page eight.

<sup>5</sup> For each government sector, AppGeo assigned an administrative full-time equivalent value from 0.1 to 0.05 for staff time spent managing or administering the purchase of a flight cycle based on local, special purpose district, state agency and tribal government responses to FTE equivalents. Position pay varied. \$100,000 was considered a reasonable estimate across the state. Appendix C, page eight.

<sup>6</sup> \$47,338,000 was calculated by determining the average square mile cost of imagery then extrapolated to all entities within each sector of government. Appendix C, page eight.

finding these changes, especially in the area of parcel assessment. It has added millions of dollars of assessed value to the property tax rolls of government entities within Washington.

### Challenges of independent purchasing

- **Duplicative imagery acquisitions.** Independent imagery purchases by government entities results in the purchase of duplicative imagery over the same geography. We documented this challenge via the survey, workshops and in-person interviews. During focus groups, many participants were shocked to learn that multiple consortiums existed and were purchasing the same aerial imagery.
- **Unequal access to imagery.** Imagery purchases depend on funding, which creates haves and have-nots in every sector of government. For instance, there are more than 1,822 special purpose districts in Washington. The majority of them cannot afford imagery because of their limited fiscal resources. This is also true for numerous state agencies, counties, municipalities and tribal governments who have large geographic extents coupled with low populations and constrained tax bases.
- **Licensing restrictions and proprietary software.** Independent imagery purchases by government entities often lead to aerial imagery acquisition that cannot be shared across various levels of government. This is either due to vendor licensing restrictions (which often provide the governmental organization purchasing the imagery, a better price) or in the case of oblique imagery, the need for proprietary software in order to use the oblique imagery to view and measure buildings and structures, and perform other types of analytical tasks such as parcel assessment. Licensing restrictions and proprietary software make collaborative and consultative governing very challenging and sometimes nearly impossible.
- **Funding instability.** Funding for imagery for all levels of government that make independent imagery purchases are always vulnerable because funding can be re-prioritized for other needs. Local aerial imagery consortiums face the same funding instability if a consortium member drops out.
- **Duplicative administrative burden.** Each independent purchaser faces similar administrative costs: running a request for proposal (RFP) process, selecting a vendor, negotiating the contract and administering the program. For example, Skagit County documented how much time staff expended to manage the local aerial imagery consortium, which included municipalities, special purpose districts and some tribal governments. On average, internal GIS staff spend 279 hours or (0.13 FTE equivalent) a year performing various administrative tasks associated with acquiring imagery and maintaining the consortium. During years when an RFP is required to select a vendor, the time significantly expands to 600 hours. These 600 hours do not include any of the staff time that Skagit County's legal, purchasing, or treasurer staff spent in support of these ongoing independent imagery acquisitions.

## Benefits to having access to aerial imagery

General professional knowledge about the use of imagery in major business sectors and government operations was used to create conservative estimates of the cost value benefits of aerial imagery (compared to a high-quality aerial imagery program) in selected parts of Washington's economy and government operations. For government operations, focus group participants from state, tribal, and local government sectors and in individual follow-up interviews confirmed the accuracy of these general values.

There was general agreement from government sector stakeholders that lower quality imagery yields fewer benefits. For example, if imagery does not meet legal or professional standards for some uses, such as property assessment under the International Association of Assessing Officers and state guidelines, then the value of the imagery is lost.

AppGeo used a conservative assessment approach. First, this study included four important state industries and four areas of government operations that rely on aerial imagery to meet business needs. Second, while all costs were included, we used very modest estimates of cost value benefits. We estimated benefits as a



percentage of the total dollar value of the industry (based on Commerce estimates and state-specific industry associations) or government operations area (based on focus groups, interviews, and literature reviews). The eight industries and rationale for the percentage value used are:

- Salmon Fishery - tribal government stakeholders and state agency staff stressed the importance of aerial imagery to managing near-shore and riverine habitats to ensure the long-term health of salmon. The economic value of aerial imagery for maintaining the fishery was conservatively estimated as 1% of the total annual value.
- Forest products - this industry and the agencies that manage it rely on aerial imagery for inventory, planning and operations on both private and public lands. Near-term uses are important, but so are long-term goals of sustainable yield through excellent conservation practices. These long-term practices use aerial imagery extensively. The economic value was set at 0.1% of the total annual value.
- Agriculture - farmers and farm management agencies routinely use aerial imagery for their work. The economic value was set at 0.1% of the total annual value.
- Transportation - Washington is an important transportation nexus with shipping, rail, road, air and international ports of entry. We use aerial imagery to plan, manage, and design all types of transportation infrastructure. It is also a common background against which transportation operations are conducted (e.g., imagery in a navigation system). The economic value was set at 0.1% of the total annual value.
- Property taxes - County assessors are primary users of aerial imagery, as discussed throughout this study. Without aerial imagery, their work would be much more time-consuming and even dangerous, as they would need to visit more properties in person. Tax collection would be slower and while all taxes would ultimately be collected, local governments and the state would pay a penalty for lost revenue over time. The economic value was therefore set at 0.1% of the total annual value of property tax collected.
- Emergency planning - Emergency planning depends on current, detailed, aerial imagery for making effective response plans. Planners use aerial imagery combined with other data to forecast affected areas, pre-determine relief centers, evacuation sites, and travel corridors, and to plan and execute mitigation measures in advance of actual events. The activities of emergency planning were estimated to be about \$1 billion annually across governmental sectors. The value of aerial imagery was estimated at 1% of the activity costs.
- Disaster/Emergency response - When a disaster or emergency occurs, aerial imagery is an essential tool used by government, industry, and the public. Statewide, consistent aerial imagery allows for rapid and accurate assessment of disaster situations, saving lives and property. In recovery from disasters, aerial imagery is the most commonly used tool by insurers, planners, and support agencies. The value of aerial imagery was estimated at 1% of an estimated annual economic toll of disaster costs in Washington.

Table 9 shows the eight areas studied, their value, major value arguments, and the net annual benefit. The total annual benefit of using aerial imagery is more than \$159 million.

**Table 9. Estimated benefits of using aerial imagery in selected Washington industries and government operations**

Industry / govt. operation	Annual economic value	Est. benefit %	Est. benefit \$	Key uses
Salmon fishery	\$462M*	1.0%	\$4,620,000	ESSENTIAL to state economy and tribal governments Informs critical decisions regarding management, protection, and resource allocation Monitoring and protecting salmon habitat against land and waterway development Change detection in development of impervious surfaces which impact volume and hydraulics of the waterways Monitoring of coastal erosion and shoreline change
Forest products	\$36B*	0.1%	\$36,000,000	ESSENTIAL to all sectors of government Identification of stand types and health Improved accuracy of stand delineations Reduced need for field inspections
Agriculture	\$20.4B*	0.1%	\$20,400,000	ESSENTIAL to all sectors of government Crop identification and delineation Management practices improvement
Transportation	\$70B*	0.1%	\$70,000,000	ESSENTIAL to all sectors of government Asset management Condition assessment Stormwater management Right-of-Way delineation Encroachment monitoring Transportation planning to promote economic development, resilience, safety, energy conservation, healthy communities
Property tax assessment	\$16B**	0.1%	\$16,000,000	ESSENTIAL to local and tribal governments Significant time savings for assessor field staff in performing inspections Improved safety of assessor field staff in performing inspections Improved accuracy of assessment Scope of time savings will increase over time, as imagery and inspection standards evolve
Emergency planning	\$1B	0.2%	\$2,000,000	ESSENTIAL to all sectors of government Disaster planning prior to critical events Plan responses using current situation
Emergency management and response	\$1B	1%	\$10,000,000	Common operating picture is essential Identify dispatch, staging and deployment points Post-disaster identification of buildings and critical infrastructure Response and recovery
<b>TOTAL</b>			<b>\$159,020,000</b>	

\* Annual economic value as reported by the Washington Department of Commerce;

\*\* Annual tax revenue for Washington in 2021;

\*\*\*Annual value of goods and services moved by Washington’s transportation infrastructure;

\*\*\*\* ROI Study research included workshops, focus groups, survey responses, and responses to email inquiries.

## Intangible benefits

Aerial imagery has many intangible benefits. Two areas of special importance are the benefits provided to tribal governments, and the public perception of active, responsive government.

### Tribal governments and management of lands

**“These ancestral lands are sacred to tribes and they must be provided the tools necessary to actively and meaningfully engage in the management of them - as they have done since time immemorial.”**

Noah Oliver, Geographer/Archeologist - Confederated Tribes and Bands of the Yakama Nation

Tribal governments are sovereign nations with whom the Washington consults. Aerial imagery helps tribal governments' operations just as it does state and local governments. Because tribal governments have a relationship with the landscape from time immemorial, aerial imagery has cultural and intangible values too. Governments use aerial imagery to manage lands protected under federal treaties and management of culturally significant areas. Similar to local, special purpose district and state governments, as outlined in Table 5, aerial imaging supports tribal governments (sovereign nations) in caring for and protecting their lands with fewer staff. Ensuring that tribal governments have the tools to co-administer the aerial imagery, and sufficient information and authority when they are consulted on lands to which they have ancestral ties or reserved rights<sup>7</sup> is critical to strengthening Washington's commitment to meaningful government-to-government relationships and consultations.

### Collaborative, efficient, and responsive government

**“A county emergency manager pointed out that aerial imagery gives his county agencies the ability to locate places, figure out how to swiftly get appropriate first responders to those in need, and saves lives.”**

Emergency Manager Focus Group

Aerial imagery is a basis for government-to-government coordination, planning and response. When governments share imagery, government staff can work together in a more collaborative, efficient, and responsive way.

Oblique imagery is essential for assessors.<sup>8</sup> If oblique imagery is not available, staff must drive to locations for in-person assessments, which requires more staff, more time, more fuel, and can be more intrusive for property owners. Aerial imagery is a win-win for residents; it provides benefits of privacy and cost efficiency and government staff efficiency.

## Privacy assessment

Privacy is an important consideration when collecting any digital data. Katy Ruckle, State Chief Privacy Officer (Office of Privacy and Data Protection) recommended completing a formal privacy threshold analysis on the recommended high-quality aerial imagery program, which is the standard method used by state agencies to

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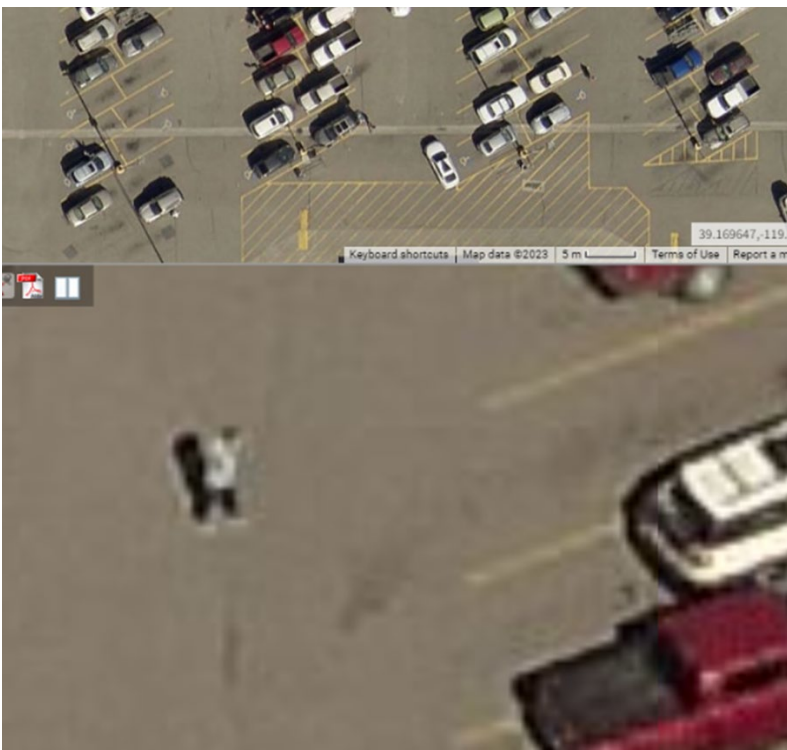
<sup>7</sup> Reserved rights are all rights not addressed by Indian treaty provisions and are presumptively reserved.

<sup>8</sup> Western and Eastern Assessor Focus group's more urban county assessors stated that they are dependent on obliques for assessing property values.

evaluate privacy concerns. The threshold analysis revealed that the high-quality aerial imagery program contained no personally identifiable information (PII), and thus a more detailed Privacy Impact Analysis was not necessary.

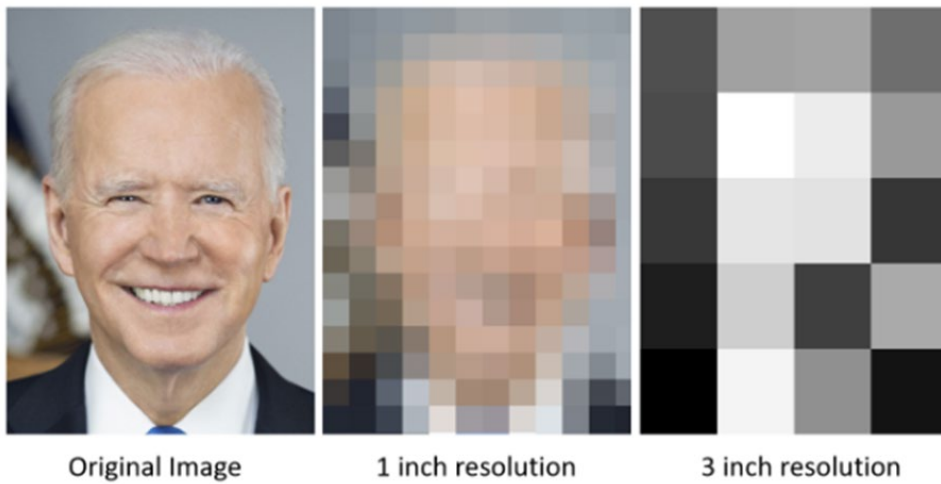
The analysis determined that a person cannot be identified by software tools such as facial recognition software using the recommended imagery because the resolution is insufficient. Figure 3 below shows an orthoimage scene at 3-inch GSD. The oblique image underneath it, taken within a few seconds of the vertical scene, shows one of the people in that scene. The individual cannot be identified in the oblique image and license plates cannot be read, because the image quality is too coarse to reveal identifiable features or writing. Figure 4 shows a detailed image as 1-inch pixels (equivalent to about 1-inch GSD in an orthoimage) and 3-inch pixels (equivalent to 3-inch GSD). As the example demonstrates, a familiar face is unrecognizable as 3-inch pixels.

**Figure 3. Example 3-inch GSD orthoimage and 3-inch oblique image of the same scene**



Imagery from <https://carsoncitynv.mapgeo.io>, accessed 3/15/2023.

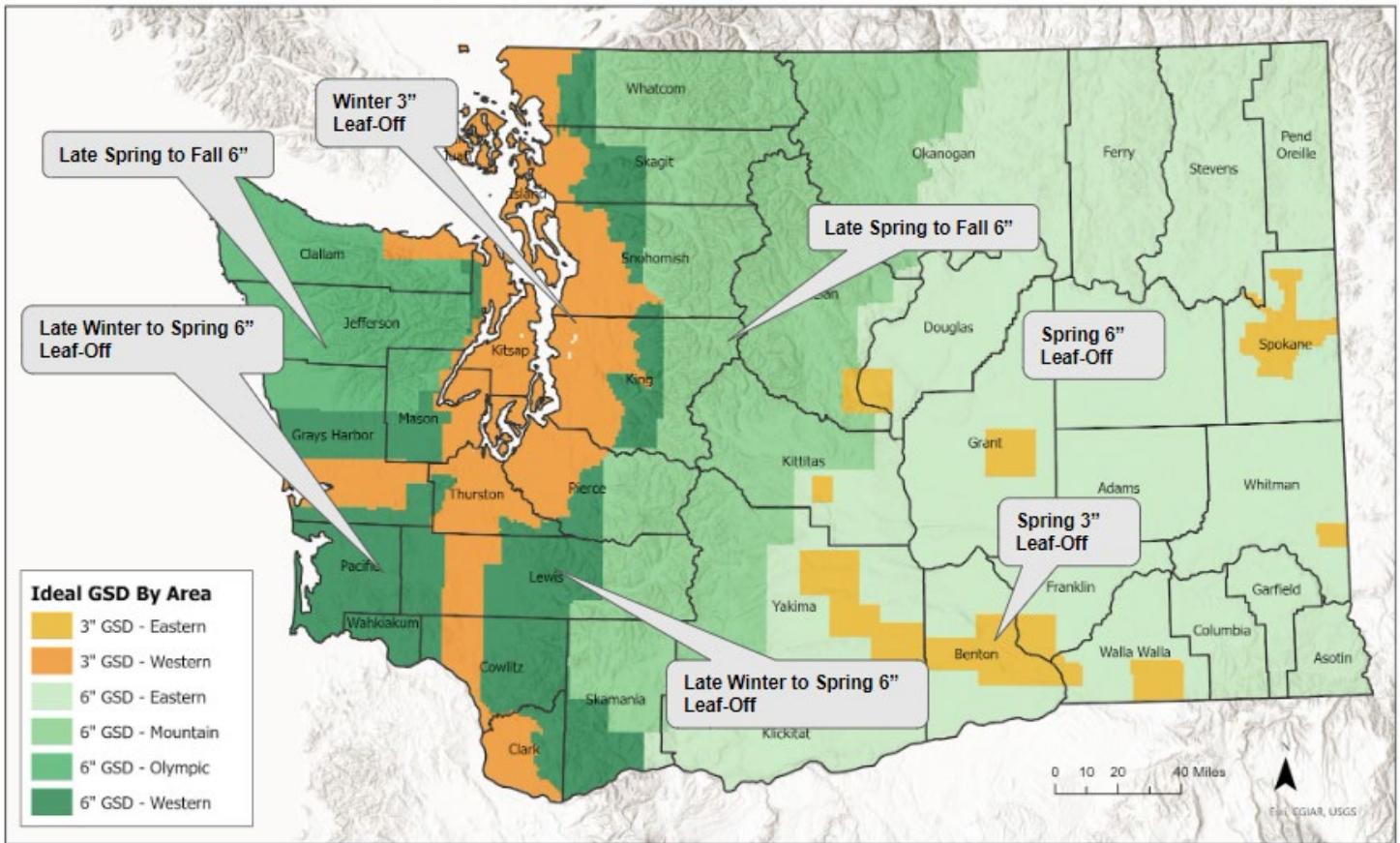
**Figure 4. Three images illustrate how pixel resolution obscures identification of individuals**



Original image from [www.whitehouse.gov](http://www.whitehouse.gov), official photograph of President Joe Biden, accessed 3/15/2023

# High-quality statewide aerial imagery program

**Figure 5. High-quality statewide aerial imagery program flight calendar and GSD ortho and oblique collection areas and timing**



**Table 10. High-quality statewide aerial imaging program flight calendar and GSD ortho and oblique collection areas and timing**

Area	3-inch	6-inch	Leaf on or off	Season
Eastern	More populated	Less populated	Leaf off	Spring
Mountain	None	All	Leaf on	Late spring to fall
Olympic	More populated	Less populated	Leaf on for 6-inch	Winter, 3-inch, late spring for 6-inch
Western	More populated	Less populated	Leaf on for 6-inch	Winter, 3-inch, late spring for 6-inch

Figure 5 shows a proposed flight calendar that the research team created, based on data provided by the survey and focus groups. Different parts of the state are flown at different times and different GSD values that require different altitudes and equipment. In order to get optimal imagery for users’ needs, careful planning should consider the natural challenges of three geographies: mountains, western valleys, and eastern plateaus, as well as the seasonality of plant growth and sun angles. Tribal consultation will also need to occur prior to confirming flight paths.

To meet the spatial accuracy needs of the majority of users in Washington and tribal governments, aerial imagery has to be collected using methods that meet defined mapping standards. Underlying these methods is a network of ground control points. These are established through carefully designed ground surveys prior to flights. The high-quality program needs to include the creation and maintenance of these control points and similar supporting data at a statewide level. An additional benefit of the high-quality statewide program is that these control points and other data can be shared with others who might use them as ground control for small area flight programs or other purposes, saving others some costs. Costs for establishing the ground surveys and control points are included in the estimated total cost of a high-quality aerial imagery program.

## Minimal technical specifications and availability needed

The Legislature directed this study to determine the frequency of image collection and the minimum resolution level of aerial imaging that would best serve the majority of users statewide. The following information is a summary of expertise collected by the survey, focus groups, and vendor interviews with knowledge of aerial imagery acquisition in Washington.

At a minimum, the aerial imagery should be collected on a biennial cycle with fresh aerial imagery data published every two years. This collection would include:

- First flight occurs in first year of the biennium and the second flight occurs in the second year of the biennium to correct for problem areas.
- Statewide imagery types and features:
  - 6-inch GSD ortho, 6-inch oblique images over 84% of the state<sup>9</sup>
  - 3-inch GSD ortho, 3-inch oblique images over 16% of the state<sup>10</sup>
  - 4-band (red, green, blue, near infrared) ortho
  - 3-band (red, green, blue) oblique imagery
  - Leaf-off imagery
  - Spatial and quality control sufficient for planimetric mapping purposes in all populated areas, appropriate to the GSD of the ortho.
  - Spatial and quality control sufficient for general mapping purposes in all other areas.
  - Stereo pairs of ortho are provided to the Department of Natural Resources for their photogrammetry use
  - Offers oblique viewing tools or is compatible with oblique viewing tools for measurement, calculations, etc.
  - Compatible with common government software systems: GIS, CAMA, CAD.
- Equal accessibility for all Washington and tribal government entities:
  - Does not require subscription and removes accessibility barriers that smaller government entities currently experience.
  - Distributed through mechanisms that are available to all.
- Optional buy-up program for derived products or enhanced imagery:

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<sup>9</sup> 6-inch aerial imagery meets the needs of 84% of Washington.

<sup>10</sup> 16% of Washington's land area is in an urban growth area and has high-density structures, which require higher resolution of ortho and oblique imagery.

- Vendor offers additional products commonly of interest to government sectors (e.g., change detection).
- Government entities can buy more detailed imagery (smaller GSD, higher resolution oblique images) at reduced rates, so long as the more detailed imagery is shared as part of the program.

The high-quality aerial imagery program includes both ortho and oblique imagery. Ortho is collected at the same time as oblique imagery (in most cases). This is different from Washington’s current statewide program and different from that in many other states. The study found that oblique imagery is very important to many government uses in Washington. In addition to the uses by assessors discussed already, state agencies will benefit from measuring trees in timberlands and seeing a different view of undeveloped areas including shorelines and river corridors; emergency responders can be safer and more effective by seeing under trees and all around buildings; engineers can do site suitability and permit studies much faster, to name just a few important uses. Wyoming and Kentucky are already moving to include oblique imagery as part of their statewide programs; Washington would join this cutting-edge group.

The program covers the entire state at either 3-inch GSD or 6-inch GSD ([Figure 5](#)). Urban growth areas and corridors require higher resolution at 3-inch GSD. All other parts of the state are collected at 6-inch GSD. For ortho, the 6-inch GSD coverage is the same as the current WaTech Statewide Imagery Program, with the notable difference that WaTech would have control over imagery characteristics. Providing more detailed 3-inch imagery in urban areas supports government needs for planimetric mapping of infrastructure, assessments, planning, and other intensive uses. An entity could optionally purchase the 3-inch GSD imagery through the buy-up options.

## Administration and management

The high-quality state program is efficient and requires administration and management. We suggest that administration and management be centralized within the state government using four FTEs:

- One FTE to manage and create a solicitation for vendors (one year prior to starting imagery acquisition), to work with the selected vendor(s) throughout their contract, and to coordinate ongoing efforts for quality control, distribution, and provide technical support for agencies and other government sectors.
- One FTE to manage the buy-up program (in which governments can get products not provided through the standard statewide program), making sure that buy-ups are coordinated and planned to maximize use of public funds.
- One FTE to serve as a liaison to tribal governments to coordinate co-administration of aerial imagery.
- One FTE to serve as a liaison and technical resource for local governments, ensuring that the state’s investment in aerial imagery is used as widely and productively as possible.
- Additionally, the program will require:
  - \$100,000 annually for external technical support.
  - \$100,000 annually in hardware and network costs for infrastructure to support sharing the imagery.

There is a substantial savings in administrative effort. Aggregated across all government sectors, freely available aerial imagery will result in a net savings to taxpayers. The current (and potential future) burdens of finding localized funds, contracting for aerial imagery, distributing the products, and building funding coalitions are eliminated.



## Cost

An important mandate in Section 2 of the proviso is:

- (d) Estimate the cost of procuring, once per biennium, and administering a high-quality aerial imagery program on a statewide basis;

AppGeo brought aerial imagery program experts with national and international certifications into the study to devise general flight plans, high-quality program requirements and cost estimates. The aerial photography experts made budget-level estimates (rather than competitive bid-level estimates) for each area shown in Figure 5 because they have different seasonal, flight, photography, and post-photography processing requirements. For example, per square-mile estimates for 6-inch GSD imagery in the Cascades and Olympic mountain ranges are \$550 per square mile, but 6-inch GSD imagery in eastern Washington is \$225 per square mile. These per-square mile values for each flight zone were then multiplied by the size of the zone to give a total oblique (with ortho included) acquisition cost for the roughly 71,000 square miles in Washington.

We also asked the aerial imagery experts to provide budget-level estimates for creating and maintaining a statewide spatial control network of surveyed points visible in aerial imagery.

Storing a statewide collection of aerial imagery involves about 1 petabyte of storage space (i.e., 1,000 terabytes, or 1,000,000 gigabytes). Costs to store, serve, and provide specialized software for oblique imagery were estimated based on commercial internet cloud rates and typical software licensing costs.

We calculated state personnel costs (four FTE, described above) using a burdened cost of \$250,000 per FTE. Lastly, we allocated \$100,000 per year for specialized external technical support that the program might need.

Table 11 shows high-quality aerial imagery program estimated costs for the initial flight cycle and for the second flight cycle (additional details are given in [Appendix C](#), Step 10). We can easily extrapolate costs for additional cycles from these figures. In the first year, 2025, program staff will establish the ground control network, design and issue the program solicitation, and determine a vendor. Aerial imagery is acquired in 2026, and is available late in that year or early in 2027, triggering the infrastructure costs shown in the table and the initial software licensing costs. The total cost between 2025 and 2027 (the completion of the first flight cycle) is approximately \$36 million. For the second flight cycle (2028-2029), the cost is similar because while data storage costs are cumulative, software costs are lower since it is just a continuation of any licensing rather than new purchases.

The general logic of the high-quality program, its detailed technical specifications, and the cost estimates were validated in extensive discussions with multiple commercial aerial imagery firms (Appendix C, Step 11). All of them considered the approximately \$36 million per flight cycle figure to be an appropriate budgeting figure for the high-quality aerial imagery program described above.

**Table 11. Estimated costs of a high-quality aerial imagery program**

Costs	Project startup FY 2025 supplemental	1st flight cycle 2025- 2027 biennium	2nd flight cycle 2027-2029 biennium
Ortho and oblique imagery acquisition	\$0	\$26,479,825	\$26,479,825
FTE (4)*	\$1,000,000	\$2,000,000	\$2,000,000
External technical support	\$100,000	\$200,000	\$200,000
Creation and maintenance of statewide control network	\$1,325,000	\$26,500	\$26,500
Spatial and image quality control	\$100,000	\$1,712,500	\$1,712,500
Infrastructure (Storage, hosting, and streaming services) *	\$32,400	\$1,958,400*	\$5,875,200
Software (support viewing, distribution)		\$850,000	\$340,000
<b>Total cost</b>	<b>\$2,557,400</b>	<b>\$33,227,225</b>	<b>\$36,634,025</b>

\* This cost reflects minimal storage costs because only one year of data is stored in the 2025-2027 biennium. The 2027-2029 Biennium Infrastructure costs represent a stable biennium cost.

## Economies of scale and cost-sharing

Is an improved statewide aerial imagery program more cost effective than continuing with the current WaTech program and having each government purchase aerial imagery independently? Section 2 of the proviso directed this study to:

- (e) Quantify the economies of scale between individual flights procured by individual jurisdictions as compared to the cost of procuring a single flight to obtain aerial imaging of the entire state;
- (f) Determine the best available mechanism for cost sharing between jurisdictions for the acquisition and management of aerial imagery;

**For every \$1 spent on aerial imagery, there are \$8.80 in benefits bi-annually.**

**For every \$1 spent on aerial imagery, there is \$7.35 return on investment over 6 years.**

Aerial Imagery Study Research Team

The estimated cost of the high-quality aerial imagery program is \$36 million per biennium. It provides the minimum resolution requirements to achieve the majority of uses identified across all local governments, special purpose districts, state agencies and tribal governments. While it is possible to share costs, the research team found many risks to implementing cost-sharing:

- If government entities or tribal governments do not buy into the state program, it may prevent better collaboration and management of lands between government entities and tribal governments, especially when addressing emergencies, natural resource management, and many other government management needs.
- Economies of scale and return on investment decrease when cost-sharing models are implemented due to higher direct and indirect administrative costs.

- Every government entity and tribal government wishing to buy-in would need to properly budget for cost-sharing.
  - State administrators would likely experience an increase in the administration of invoices and payment verification, adding a need for more staff beyond the \$36 million biannual amount.
- Cost-sharing models are inherently unstable because of the subjective nature of what is considered an affordable price, which is different for every government entity and tribal government.
    - 81% of survey respondents were in favor of a state-run program as long as it was at an affordable price to their government entities and tribal governments. Counties and municipalities currently pay a range for aerial imagery from \$250,000 to as little as \$2,500 per year. This wide range makes creating a cost-sharing model difficult, especially when accounting for the various imagery types.
    - 19% of survey respondents were not in favor of a state-run program because it was assumed that there would be a cost-sharing mechanism. The majority of no survey respondents stated that they had no budget for aerial imagery, and several government entities and tribal governments stated that the state program should be free to access for any government entity or tribal government.
  - Calculating cost-sharing is challenging and needs regular intervals of review and negotiation between parties. Some methods of cost-sharing are:
    - A tiered approach that is based on a percent of the annual government entity's budget.
    - A tiered approach based on the square miles of the government entity.
    - A combination of government entity's budget and geographical size.
  - As cost-sharing models are introduced it creates haves and have-nots across the state based on whether a government entity or tribal government can pay the price of access. Regardless of the structure, there will always be government entities that cannot afford the price of access to aerial imagery.

## Benefit/Cost ratio calculation and return on investment estimate

The annual benefit of aerial imagery to Washington State is \$159 million if the minimal technical specifications are met across the eight industries and government activities listed in Table 9. In order to meet the minimal technical specification for all of Washington governments, it would cost on average, \$36 million every two years.

A simplified cost benefit ratio is  $(\$159 \text{ million in annual benefits} \times 2 \text{ years}) / \$36 \text{ million in cost over two years}$ . This is approximately \$8.80. For every \$1 spent on aerial imagery over two years there are \$8.80 in benefits.

A Return on Investment (ROI) calculation provides a more comprehensive understanding of the benefits by accounting for the accrued benefits of time series aerial imagery. For every \$1 spent on aerial imagery, it will return an aggregated benefit of \$7.35 within six years. To learn more about the full ROI methodology please visit Appendix C: Study methods.

## Comparison to other states

Another way to look at the cost of the high-quality aerial imagery program is to compare it to statewide aerial imagery programs in other states (see Appendix C, Step 9; Appendix F for state information). Table 12 shows technical characteristics and costs per square mile for six other states and for Washington. It further shows the extrapolated statewide cost under current procurement modes and the high-quality program.

The costs vary widely, but Washington's needs for oblique imagery make it most similar to Wyoming and Kentucky. Acquisition costs for a high-quality program for Washington (\$372/sq. mile) fall between Wyoming (which flies only parts of the state and is a much simpler program; \$218/sq. mile) and Kentucky (which is collecting the entire state; \$421/sq. mile). Because none of the costs per square mile for other states include administrative costs, the comparable costs is \$372/sq. mile. It is important to note that Oregon only offers 12-inch orthophotos, which does not meet Washington local, special purpose district, state, or tribal government user needs. Washington is significantly more mountainous than Kentucky, which is why cost per cycle is significantly lower for Kentucky compared to Washington. Wyoming's oblique imagery only covers 10% of the state while Washington's oblique imagery would cover a larger percent of the state due to larger and more numerous population centers.

**Table 12. Statewide aerial imagery program characteristics and costs in six states compared to extrapolated Washington costs under current acquisition modes and Washington high-quality aerial imagery program estimated costs.**

	Oregon	Utah	Texas	Indiana	Wyoming	Kentucky	Washington (current, extrapolated)	Washington (high-quality program)
<b>Oblique</b>	No	No	No	No	6" and 2" (10%)	3"	12" to 3" (partial)	6" and 3"
<b>Ortho</b>	12"	6"	6"	6"	6" and 2" (10%)	3"	6" (partial 3")	6" and 3"
<b>State owns</b>	Yes	No	No	Yes	Yes	Yes	No	Yes
<b>Cost per cycle</b>	\$2,000,000	\$1,000,000	\$5,818,000	\$2,000,000	2,000,000 (10% of state)	\$17,000,000	\$47,338,000	\$36,000,000
<b>Area (sq. miles)</b>	98,378	84,896	268,596	36,419	97,914	40,407	71,297	71,297
<b>Per sq. mile</b>	\$20	\$12	\$22	\$55	\$218	\$421	\$664	\$505 \$372 (acq. only)
<b>Includes admin. cost</b>	No	No	No	No	No	No	Yes	Yes

## Aerial imagery challenges in Washington

Washington's beauty and wide-ranging geographic diversity can make aerial imagery collection challenging and more costly than programs in other states.

- **Limited lighting:** The state is northerly, so the sun is often at a low angle, creating long, deep shadows, even during the summer months when the sun is at its highest angle.
- **Photo distortion:** The state has dramatic topography with two abrupt mountain ranges, the Olympics and Cascades, and many smaller ranges. Vertical relief introduces distortion into aerial photos. Photo distortion is corrected by taking more photos with greater ground control, and the application of photo correction techniques after photos are taken.
- **Difficult to see ground features:** Heavy conifer forests, dense patches of fog, low clouds, snow cover, and dense fire smoke can hide the ground making it difficult to see structures and natural features.
- **Diverse users of the technology:** In addition to the geographical challenges of aerial imagery collection, different government entities and Tribal governments require imagery at a much faster frequency.

- **Rapid changes require rapid imagery collection:** Washington State Department of Transportation often requires more frequent aerial imagery to detect traffic changes in northwest Washington.
- These cumulative challenges make it difficult to compare Washington's costs per square mile with those of Kentucky, Indiana, or Texas.

## Alternative options to the high-quality statewide aerial imagery program

### Current Statewide Imagery Services Program ~ \$210,000 per biennium

The current program offers 6-inch GSD orthophoto imagery, but does not meet any of the other minimum technical specifications, resulting in the challenges and limitations discussed in this report. Because state agencies use this program, the estimated cost to the states biennial budget is approximately \$210,000 and assumes the remaining \$202,000 would be covered by other government entities through existing cost-sharing frameworks. A vendor would continue to license this program. This alternative would not reduce the aggregate cost of \$48 million spent on aerial imagery across the state.

### There are no off-the-shelf market solutions.

The study found that satellite imagery from major technology firms would not meet government needs for many of the same reasons the current program does not allow for control over aerial imagery characteristics. Some national-level aerial imagery vendors (profiled as vendor #1 in Table 13) offer high-quality updated aerial imagery. However, firms in this profile focus on urban areas, and their business model relies upon repeated sale of the same product. They additionally have stringent licensing terms.

Many local, special purpose districts, state, and tribal governments use National Agriculture Imagery Program (NAIP), but it takes orthophoto aerial imagery every three years at a 1-meter resolution, and therefore does not meet the technical minimum specifications of 3-inch to 6-inch orthophotos. NAIP does not offer any oblique imagery.

Other national vendors (profiled as vendor #2) work on a contracted basis. Vendors at this level (some of whom AppGeo interviewed as part of this study) will perform custom collection. Implementing the program probably involves the sort of national vendors shown as National Vendor #2 in Table 13, but their work is to the state's specifications, not to their own.

**Table 13. Possible aerial imagery sources for High-Quality Aerial Imagery Program**

Source	Statewide	Available now	6" ortho	3" ortho	Near IR	6" oblique	3" oblique	Access to archives	Ownership	Frequency
Current WaTech imagery (Hexagon)	Yes	Yes	Yes	No	Yes	No	No	Yes (with ongoing contract)	State, after next paid contract cycle	2 year
Google/Bing/Apple/Planet (Satellite)	Yes	Yes	No	No	No	No	No	No	Vendor	Per vendor; varies and could be monthly
National vendor #1 product (e.g., NearMap)	No	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Paid subscriber	Vendor	Per Vendor
National vendor #2 product (e.g., Eagleview, Sanborn, NV5)	No (available by contract)	No	Yes (per contract)	Yes (per contract)	Yes (per contract)	Yes (per contract)	Yes (per contract)	Per contract	Per contract	Per contract
Custom product	Yes (by design)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2 Year

There are a number of alternative options to the high-quality statewide aerial imagery program. Each of the alternatives discussed below include estimated biennium costs for the state.

## Current program with full state funding ~ \$1 million per biennium

This program provides the same level of service as the current program, but would be fully funded by the state. The added benefit is that all Washington and tribal government entities can receive the same aerial imagery and there is no cost-sharing. However, all of the challenges identified in the current program would persist. This is an average cost of \$1 million per biennium. This program would provide a license to government entities and tribal governments by a vendor. This alternative would not reduce the extrapolated aggregate cost of \$48.1 million spent on aerial imagery across the state.

## Statewide 6-inch with 3-inch buy up (no obliques) ~ \$3 million per biennium

This program would allow the state to own the 6-inch orthophotos as part of an archived dataset instead of going through the current vendor license. The 6-inch ortho would be available to all special purpose districts, tribal, state and local governments. Washington governments could also do a 3-inch ortho buy-up, but there are no oblique options. This alternative would not reduce the extrapolated aggregate cost of \$48.1 million spent on aerial imagery across the state.

## State funded 6-inch minus mountainous areas ~ \$15 million per biennium

Mountainous public lands would not have oblique imagery. This lowers the cost of the overall program below \$36 million, but public lands would not have oblique imagery. This program would be state-owned and a license would not be needed to access it.

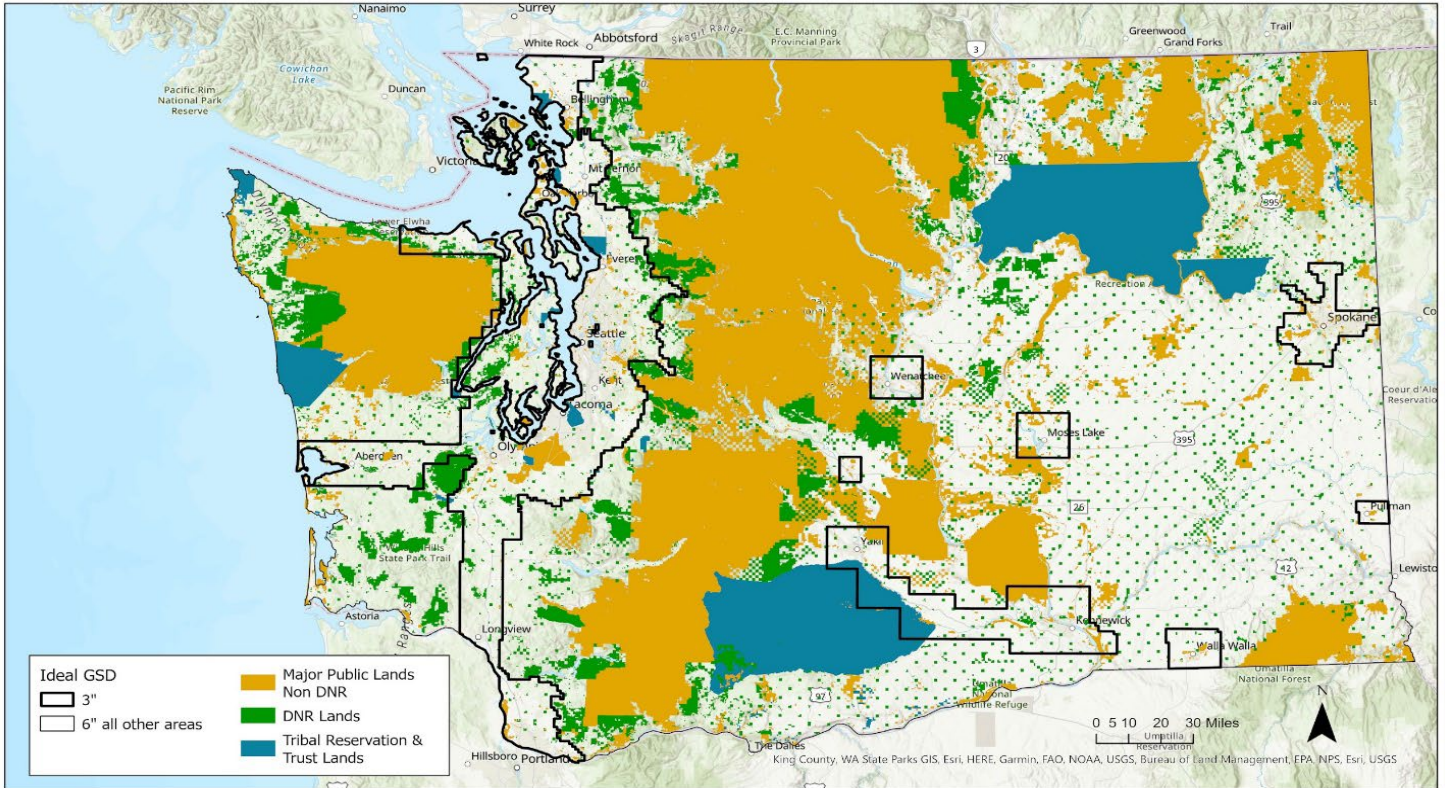
## State funded 6-inch with 3-inch Buy-Up ~ \$23 million per biennium

This program would make the 6-inch ortho and oblique imagery available to all government entities. Three-inch ortho and oblique imagery is available only through buy-ins. This program structure lowers the cost, but makes administrating the program more difficult. The 6-inch orthophotos would meet the minimum technical specifications while the 3-inch might not. This program would be state-owned for 6-inch, and with a vendor license for 3-inch.

## High-quality state program minus 3-inch obliques in public mountainous areas ~ \$28 million per biennium

This program would remove the collection of 3-inch obliques in public mountainous areas of the state. This option does not provide any oblique imagery through much of the Washington Cascade range and the Olympic Peninsula, which cross through 15 counties as shown in Figure 6. County Assessors and Emergency Management (including fire control for forest management) use 6-inch oblique imagery to conduct government business in the Cascades and Olympics. While it is not the most populated area of the state, there are still numerous unincorporated communities that are within the area that would be omitted for 6-inch oblique imagery.

**Figure 6. High-quality statewide aerial imagery program minus public mountainous areas**



The alternative options listed do not meet all of the minimal technical specifications and do not provide access to high-quality oblique imagery; during the aerial imagery study, assessors, planners, natural resource managers and environmental scientists identified high-quality oblique imagery as essential.

## Conclusion of alternative options

The aerial imagery industry validated that all program options provided are considered viable options. Kentucky recently established an oblique plus ortho program and is the most similar to the recommended high-quality aerial imagery program. The benefit-cost ratio is high at \$8.80 and the return on investment shows compounded benefits of \$7.35 over 6 years. A high-quality statewide program would make aerial imagery administration more efficient and save Washington residents money by reducing the duplicity of aerial imagery purchasing at a minimum.



## Appendix A. Aerial Imagery Primer

Aerial imagery is collected from aircraft carrying optical camera systems that record photographs digitally. There are two broadly different categories of aerial photos: vertical and oblique. Vertical photos are taken “straight down” and oblique photos are taken “sideways” (at an angle of about 45 degrees from vertical).

All camera lenses cause distortion away from the center of the image they capture. In order to make accurate maps with air photos, the distortion has to be corrected through a process called orthorectification. The resulting **orthoimagery** (or **orthos**) is suitable for planimetric mapping: distances and areas can be measured relatively accurately. This is the basis of most modern mapmaking. The accuracy of features visible in orthoimagery can be improved by removing distortions caused by height above ground. This creates **corrected or true orthoimagery** in which tall objects don't appear to sway. Removing distortion from orthoimagery can be done to different levels of accuracy (see ASPRS Positional Accuracy Standards for Digital Geospatial Data, Version 1.0, 2014). **Certified orthoimagery** has had distortion removed to a high accuracy standard. This takes more time and effort but is needed for some legal and engineering purposes. Oblique imagery has distortion too, but this is not usually corrected.

**Oblique** air photos are taken at the same time as vertical air photos; camera systems take a vertical photo and simultaneous photos forward, backward, and to each side. So, oblique flights collect four times as many oblique photos. The volume of oblique photos was challenging to manage, search, and use before digital imagery, mass storage, and powerful software made them more accessible. Oblique photos have always been useful because they show the world in familiar ways and allow us to look under or into areas. The mathematics of accurate measurements in oblique photos has been daunting. Through powerful **oblique imagery software**, oblique photos can now be used to measure planar (ground) areas and distances and, most importantly, vertical heights and vertical surface areas. Because of these new capabilities, over the past 15 years, oblique imagery has become a very important tool in property assessment, emergency response, landscape modeling and change detection, forestry and agriculture, and engineering.

Photographic **resolution** is the ability to distinguish detail in an image. Generally, this accords to the real world size that an image pixel (a cell) covers. For example, a 12-inch pixel is a cell that displays a 12-inch square on the ground. Since each pixel has a single color, if that 12-inch square contained a 6” object, then it wouldn't be visible. Because pixel size varies based on the distance between the lens and the object being photographed, in aerial photography it is more useful to talk about **ground separation distance (GSD)** - the ability to distinguish things on the ground. A 3” GSD can (at best) display objects that are 3” in size, a 12” GSD a foot, and so on. The GSD, which one could think of as the detail visible, can range anywhere from 1 inch to 10 feet. Typical GSD values in government use are 1 meter, ½ meter, 1 foot, 9 inch, 6 inch, 3 inch, and 2 inch. Most municipal and engineering uses currently prefer or even require 3 inch GSD.

Most people are familiar with aerial imagery that looks like any other color photograph, made up of red, green, and blue wavelengths of visible light. Wavelengths invisible to human eyes are also collected in aerial photography. Near infrared (**NIR** or **Near IR**) wavelengths are often collected as a “fourth band” in aerial photography since it is particularly good at showing the relative health of vegetation and is therefore very important to agriculture, timber, conservation, and ecological studies.

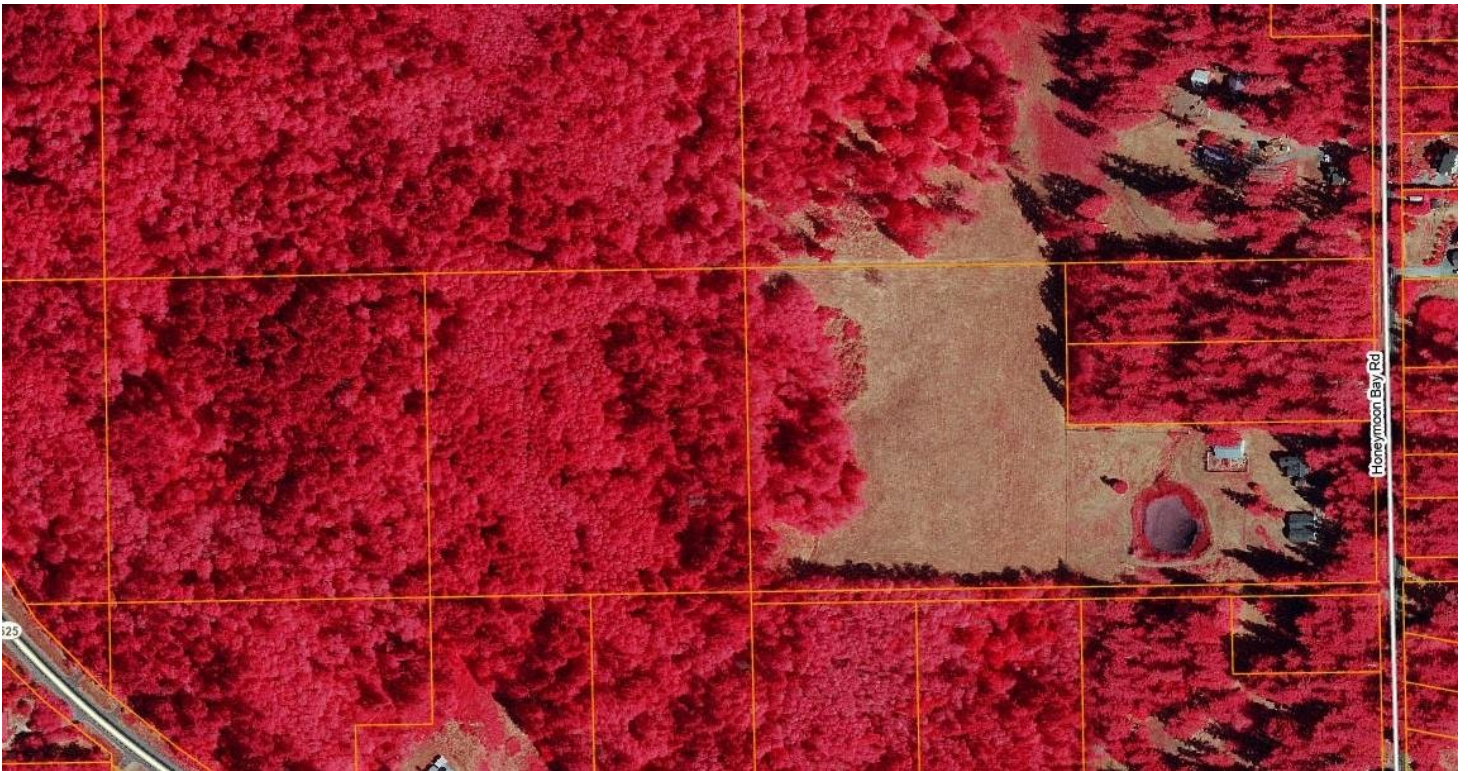


Figure B1. Example of a near infrared ortho image (upper image) vs a standard color ortho (lower image). Images are from Island County's GIS web-mapping application ICGeoMap

Aerial imagery has to be made available for use. Common ways to do so are to store it on local digital drives and use it within a network or to stream imagery from an internet-connected server that moves the bytes of imagery requested by some sort of client software like a web-browser mapping application or a desktop GIS.

Every time one cuts the GSD of imagery by 50% (e.g., 12-inch to 6-inch), the number of images increases by four times. The costs of storage, computing time, and data transfer can be considerable.

Aerial photography and the compilation of aerial imagery is a complicated undertaking. Some of the factors that go into an aerial imagery program are:

### **General Orthoimagery factors to be considered**

- Imagery characteristics
- Acquisition related
- Software and data related
- Usage related
- Miscellaneous

### **Imagery characteristics**

- Optimal GSD of the imagery
- Number of bands
- Projection (Anticipated changes in the projection)
- Repeat cycle
- Leaf off/Leaf on
- Perspective (Ortho/Oblique)
- Size of the tiles
- File formats
- Compressed file formats
- Requirement for true orthos

### **Acquisition related**

- Percentage of cloud/cloud shadow
- Smoke
- Haze
- Light streaks
- Snow
- Flooding
- Excessive soil moisture
- Sun angle
- Partial tiles

### **Software and data related**

- Proprietary /Non Proprietary image format
- Licensed/Unlicensed data
- Delivery/Hosting related
- Web Apps/Web services (WMS/WTS), self-served downloads

### **Usage related**

- Frequency of usage of data
- Current use of aerial imagery
- Additional anticipated uses
- Any associated derivative products

## Aerial Imagery Characteristics - Washington State Governmental Sectors

Aerial imagery has many characteristics and for Washington government sectors the following are important characteristics:

- Vertical air photos
  - Orthoimagery
    - Corrected orthoimagery
    - Color-balanced imagery
    - Orthoimagery adjusted to error tolerance with surveyed ground points
  - Ground separation distance (GSD)
    - Common values: 1m, 0.5m, 1 foot, 9 inch, 6 inch, 3 inch, 1 inch
  - Bands collected: black and white; color - red, green, blue; near infrared.
  - Cost continuum: black and white air photos to 1" certified orthoimagery 4-band
  - Cost range per square mile
- Oblique air photos
  - Paired with orthoimagery to locate viewpoints.
  - Photo direction (N, S, E, W, custom such as perpendicular to a shoreline)
  - Resolution (ability to resolve detail)
    - Common values: 1 foot, 9 inch, 6 inch, 3 inch, 1 inch
  - Usually requires specialized software.
  - At least 4x the data storage size of orthoimagery of same resolution
  - Cost factors: positional accuracy, resolution, software
  - Cost range per square mile

**Derived products** are made from aerial imagery using automated and semi-automated methods. Some common derived products include planimetric maps, building footprints, change detection in landscapes, identifying changes in building footprints for tax and permitting purposes, vegetation mapping, land use and land cover mapping. Derived products are systematic, objective, information sources that have become very important tools for public policy and operations.

Derived products are data that require aerial imagery to be created. Usually, source imagery is processed in some way, and, for most purposes, the most current imagery is the best source. Some commonly derived products that are or would be valuable to Washington governments are described below.

### Commonly Requested Derived products

- Planimetric maps
- Building footprints
- Change detection in buildings.
  - Requires two building footprints products / layers derived from two different imagery flights in order to detect change over time.
- Impervious surface

- Vegetation mapping
- Change detection in landscapes.
  - Requires two landscapes products / layers derived from two different imagery flights in order to detect change over time.
- Land use and land cover type
  - There is a broad range of landuse and landcover derived products that can be derived from the source aerial imagery.
  - These can include high resolution raster (cell-based data) and vector (lines and polygons) land cover data which includes such layers as impervious surfaces, building footprints, canopy and open water among others. This derived information should be updated every 2-4 years based on updated imagery data.
  - More detail on Land use and land cover can be found at the following URLs [Land Use Land Cover Modeling | U.S. Geological Survey \(usgs.gov\)](#); [Acquiring Land-Cover Modeling Data from USGS / EROS Center | U.S. Geological Survey](#)

# Appendix B: Aerial imagery study stakeholder workshop

(See the following pages for this appendix.)



Washington State  
Department of  
**Commerce**

## **Aerial Imagery Study**

## **Stakeholder Workshop #2**

**Tuesday, Sept 27, 2022 - 9:00 - 10:30 am (PDT)**



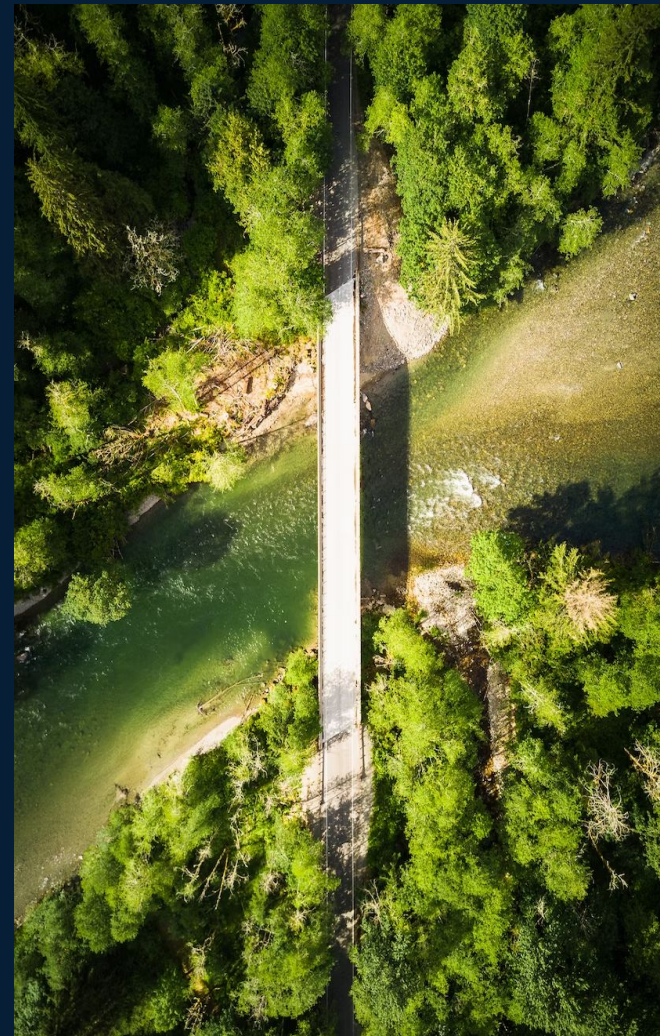
# Welcome to the Workshop

## Opening Remarks



# A Few Workshop Notes

- **This workshop will be recorded.**
- Please **mute** when you are not speaking.
- **Please make sure** your full name and affiliation displays in the participants list. (Right-click to change it)
- **Your involvement is important!** Raise your hand, enter questions into chat, and participate in the live questions.
- **Mention your name/affiliation** when speaking, so we know who you are.
- **Thank you!** Your input is critical to the success of this project.



# Workshop Facilitators



**Kate Hickey**  
APPGEO



**Jeremy Walker**  
DEPT. OF COMMERCE  
PROJECT LEAD



**Eric Ingbar**  
APPGEO



**Priya Sankalia**  
APPGEO

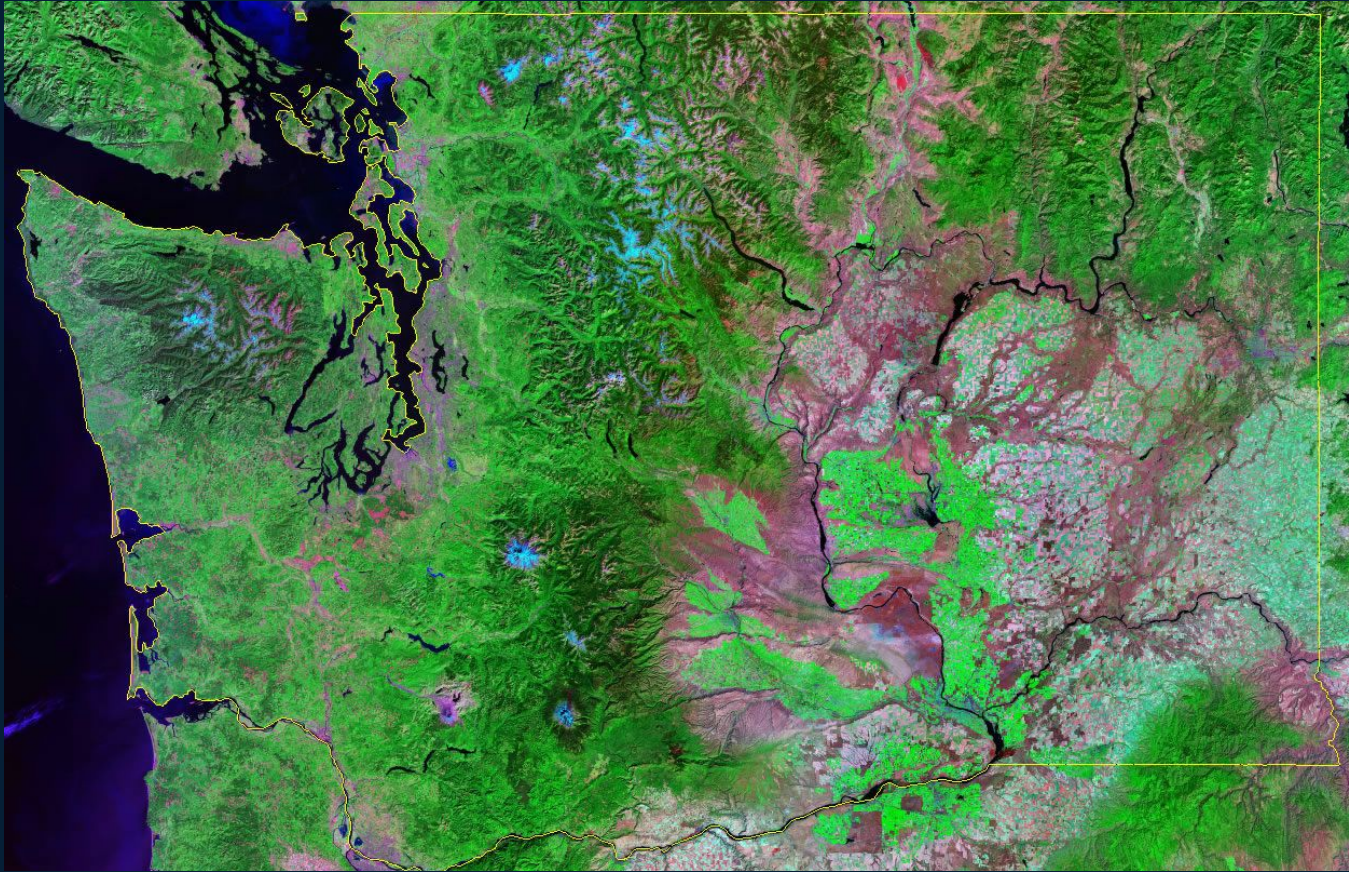


**Peter Lemack**  
APPGEO

# Agenda

- ✓ Today's Objectives
- ✓ Aerial Imagery Study Overview - Why, What, How
- ✓ Your Involvement
- ✓ Aerial Imagery: Uses and Characteristics
- ✓ Interactive Q&A
- ✓ Next Steps

# Today's Objectives



# Live Questions #1-4

[www.menti.com](http://www.menti.com)  
code 3442 1610

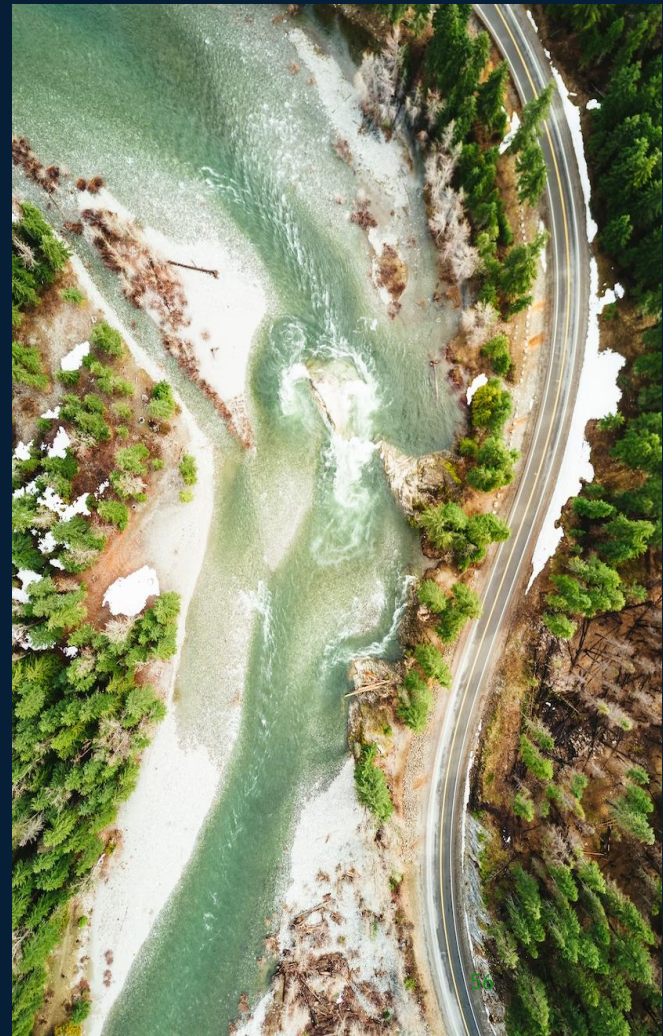
Go to [www.menti.com](http://www.menti.com) and use the code 4164 8499

What is the state bird of Washington?

Mentimeter



# Aerial Imagery Study Overview



# Background - Why

## Current Situation

There are thousands of Washington government sector entities. Many use aerial imagery from various sources and some pay to acquire imagery and related software

## The Legislature Wants to Understand

1. *What does aerial imagery cost Washington citizens?*
2. *Could a single State Imagery acquisition program, perhaps creating multiple products, meet many needs and save costs for Washington citizens?*

## Resulting Authorization

These considerations led to the passage of HB 1629-S calling for an aerial imagery study

# The Legislation: HB 1629-S - What

## Defines Stakeholders

State Agencies  
Tribal Governments  
Local Governments  
Special Purpose Districts

## Prescribes Assessment

Current benefits (uses) from aerial imagery  
Specifications of imagery currently used  
Costs of current imagery  
Potential new benefits and uses of using aerial imagery  
Specifications of desired aerial imagery in future

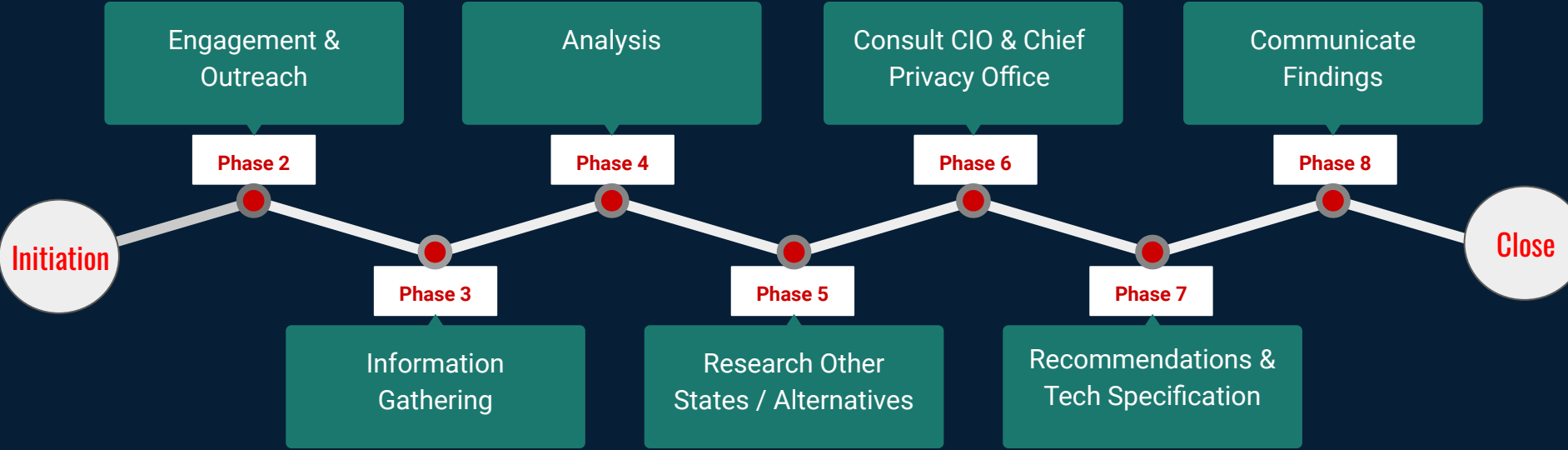
## States Desired Outcomes

Tally current statewide stakeholder expenditure  
Find minimum imagery specifications that would serve many stakeholders  
Estimate cost of statewide imagery program that meets specifications  
Examine economies of scale and cost-benefits between single imagery program and multiple flights  
Recommend cost sharing mechanisms

Authorizes the Aerial Imagery Study



# Project Overview - How



# Your Involvement



# Why should you participate? How you could benefit?

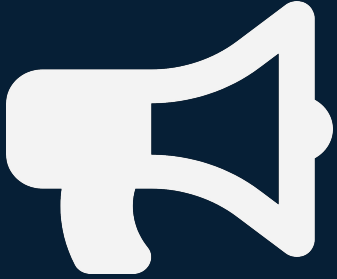
The Aerial Imagery Study could lead to:

- Cost savings
- Increased technical quality
- Additional imagery solutions
- Expanded use cases
- Statewide efficiencies
- More benefits from imagery



**Your voice, insights,  
and participation in  
the study is important!**

# How you can participate in the study



*Spread the word  
and share the  
website*



*Participate in a  
workshop  
Sept - Oct 2022*



*Complete the  
Online Survey  
Oct - Nov 2022*



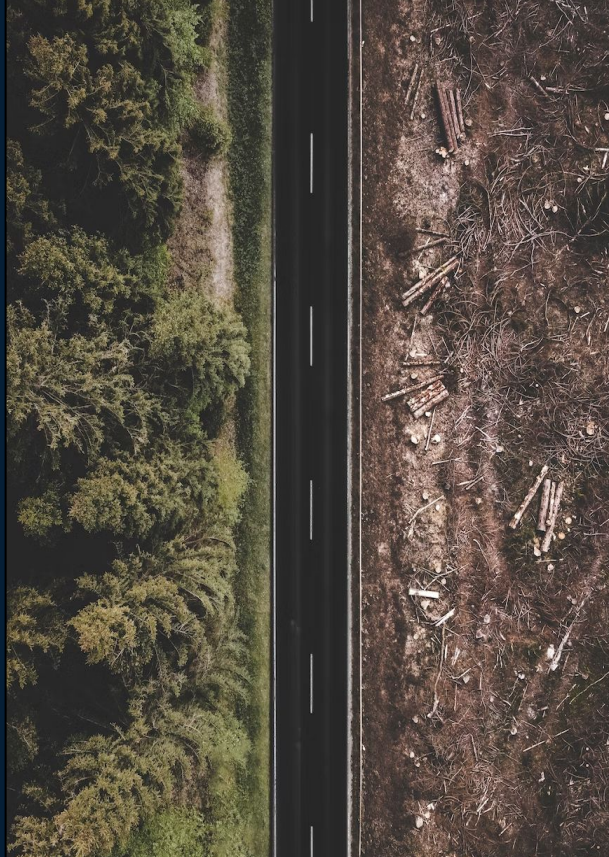
*Participate in a  
focus group  
Oct - Nov 2022*

<https://washington-state-aerial-imagery-study-wacommerce.hub.arcgis.com/>

*Agencies that monitor growth and zoning use imagery to assess urban density and to designate and protect critical areas*



*The Department of Natural Resources uses aerial imagery to monitor forest health, riparian buffers, and timber harvest*



*County assessors use aerial imagery as an integral part of their valuation activities*



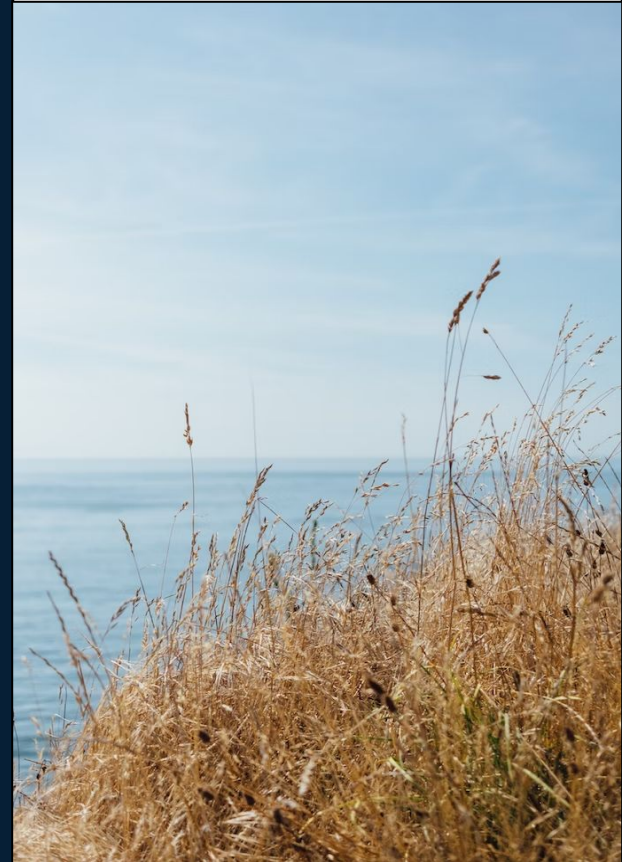
*The Nisqually Tribe is using imagery to monitor the rerouting of the Nisqually River / bridge due to inadequate water passage*



*Conservation districts use aerial imagery to plan salmon restoration projects and to assess fire and flood damage*



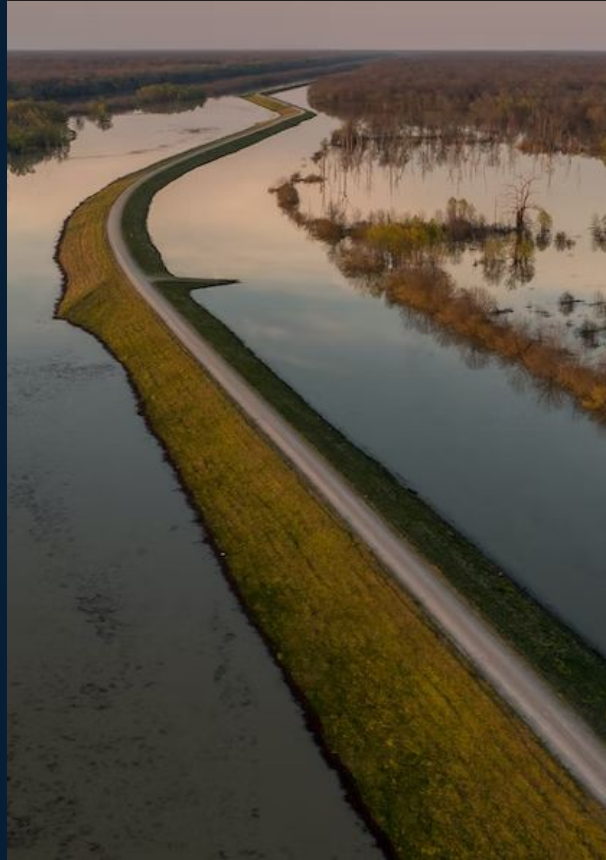
*The Department of Ecology uses imagery to monitor changes to the Washington coastline*



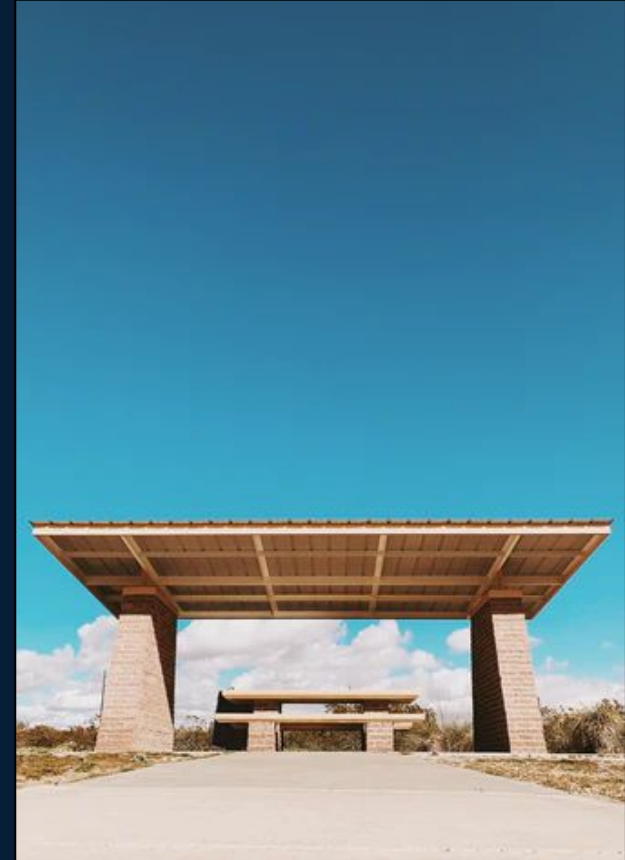
*The Department of Transportation uses aerial imagery to plan and manage culverts and other highway infrastructure*



*Emergency management agencies use aerial imagery to locate damage and plan emergency response*



*State Parks use aerial imagery to track structures on park land and for land management*

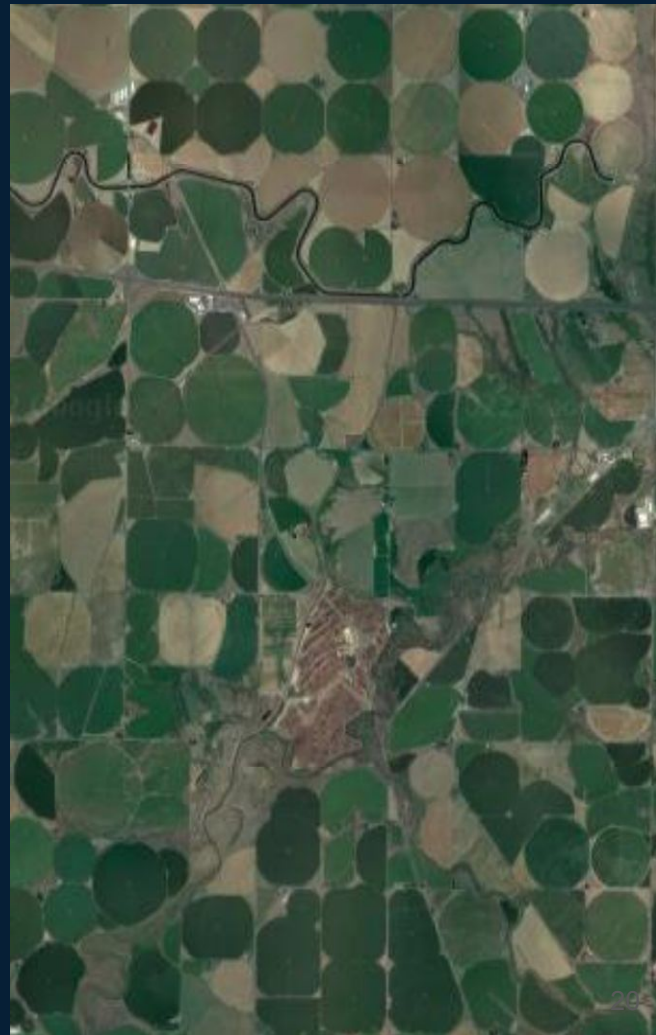


# Live Questions #5-7

[www.menti.com](http://www.menti.com)  
code 6719 3955



# Aerial Imagery Characteristics

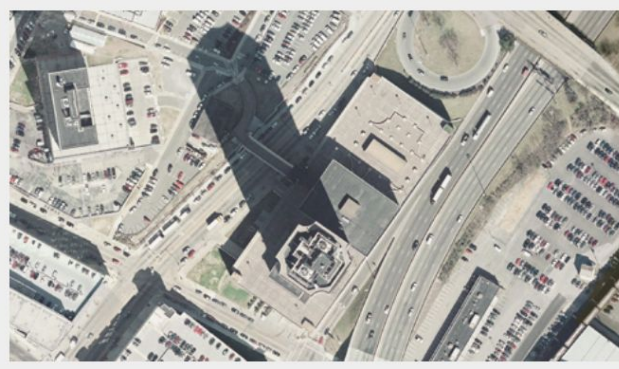


# Image Angle

Imagery can be taken from vertical or oblique camera (sensor) angles



Orthophoto



Corrected  
Orthophoto

Vertical



Oblique

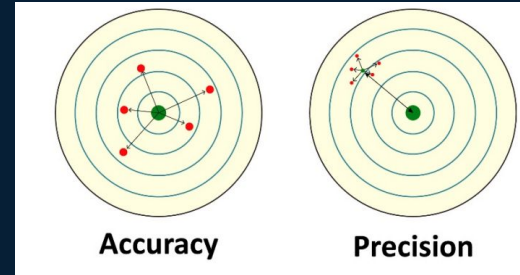
# Image Resolution

Image resolution is how “fine-grained” the image is.



# Positional Accuracy

Describes how close phenomena seen on an image are to their actual position on the earth

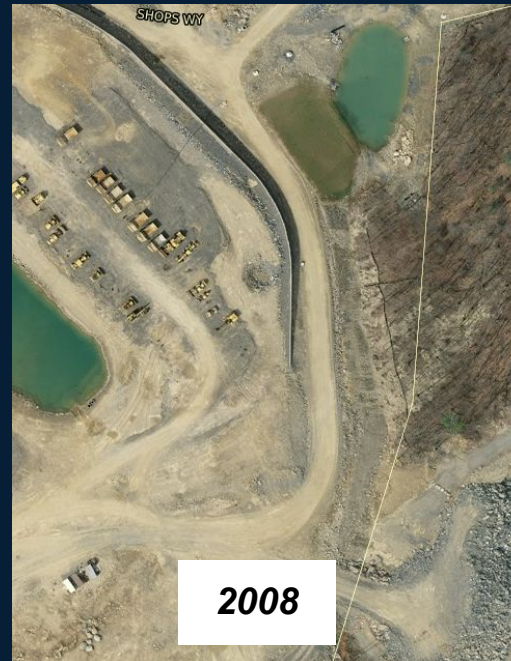


[https://www.gis.fhwa.dot.gov/documents/AEGIST\\_Guidebook.pdf](https://www.gis.fhwa.dot.gov/documents/AEGIST_Guidebook.pdf)

# Update Cycle or Temporal Resolution

Indicates how often an area is recaptured and reprocessed.

A higher update rate allows for more up-to-date imagery and enables processes such as change detection.



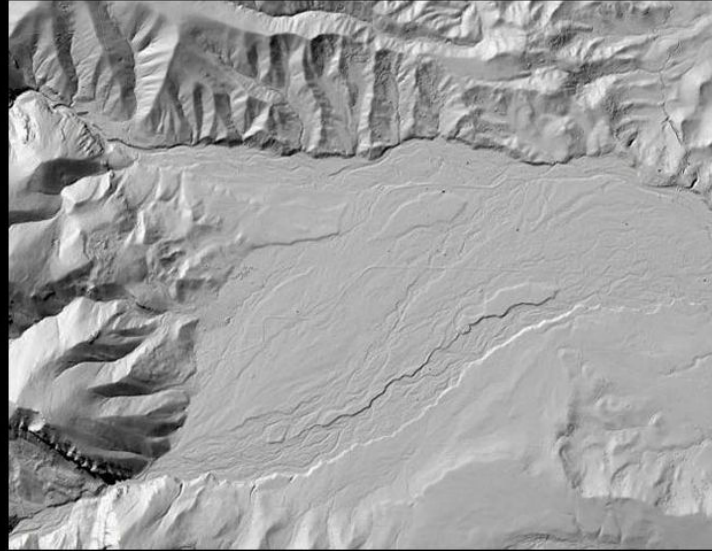
# Spectral Characteristics and Color Balance

Spectral characteristics are the wavelengths of light captured and shown in the image. Color balance is the accuracy of the colors shown.



# Other Sensors - LiDAR

Light Imaging Detection and Ranging - LiDAR creates 3-D points (x, y, z) and is often collected with aerial imagery.



# Spectral Characteristics and Color Balance

Spectral characteristics are the wavelengths of light captured and shown in the image. Color balance is the accuracy of the colors shown.

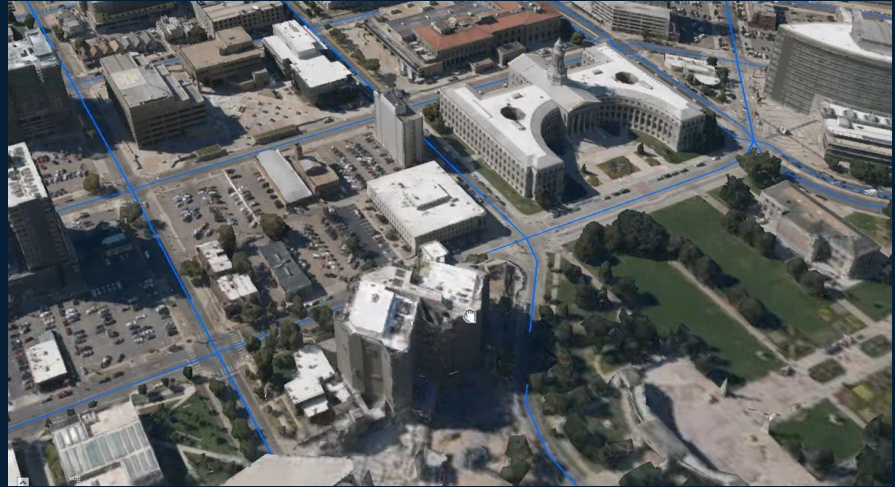




# Need for Derived Products

Imagery data can be used to produce various base maps

- Planimetrics
- Digital Twin
- Centerline with address
- Land use
- Impervious surfaces
- Delineation of the shoreline
- Topographic data
- Contours

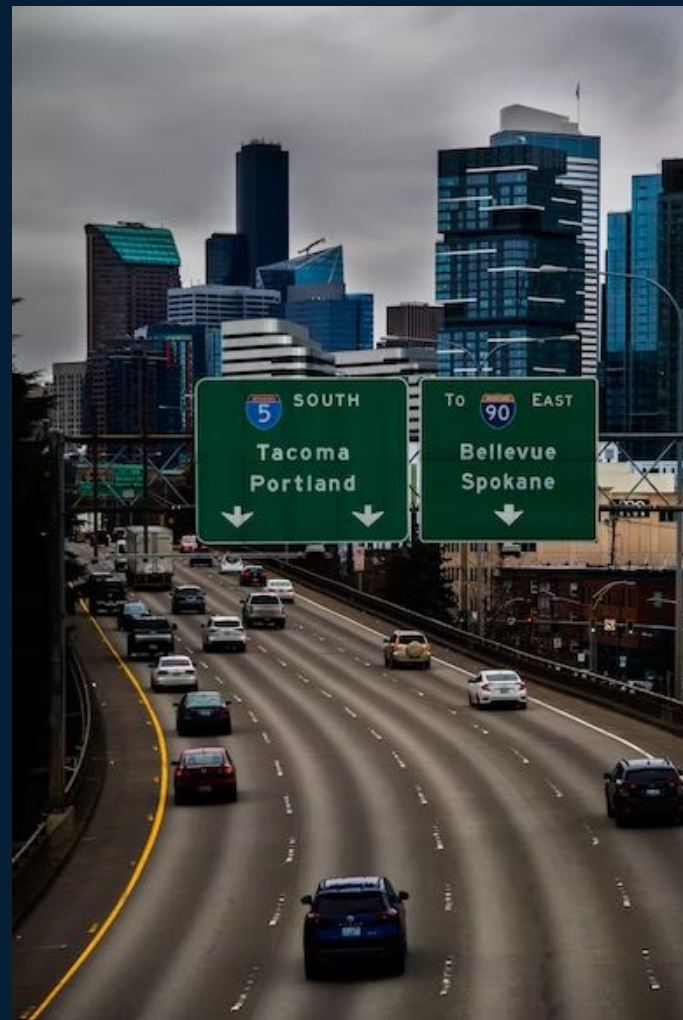


# Live Questions #8-9

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code 6719 3955

# Let's Hear From You

## Questions / Open Discussion



# Next Steps

1. Take the Online Survey
2. Let us know if you would be interested/willing to participate in a focus group
3. Monitor the Project Website for status updates

# Thank You For Your Participation!

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# Appendix C: Study methods

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# Appendix C. Methods

The State of Washington Department of Commerce Aerial Imagery Study focused on documenting the current uses of aerial imagery, the unmet business needs, the technical imagery requirements of the state's aerial imagery user base, and the current financial investment in aerial imagery across the state.

The objective of this study was to design an imagery program that would meet the existing needs of the state's user base, reduce duplicative spending by sectors of government and WaTech on similar imagery products, and reimagine the state's existing aerial imagery program into a program that would address all of the state's users unmet business needs in the most cost effective and equitable manner, while also delivering high-quality imagery products to the end users.

Within the context of this appendix, the Aerial Imagery Study defines a "sector of government" a governmental organization(s), department(s), government agency(s), or government entity(s), etc. For example, King County, the Department of Transportation, and the Nisqually Tribe can all be described as "sectors of government".

Engagement, outreach, and information gathering from the state's aerial imagery user base (stakeholders) was the primary mechanism implemented by the research team to collect information on the aerial imagery needs in Washington State. A detailed description of all the steps taken to complete this study is below:

## Step 1. Initiated the aerial imagery study

Following the passage of ESHB-1629S, the Department of Commerce issued a competitive solicitation for vendors to assist the State in conducting the study. Applied Geographics, Inc. (AppGeo), of Boston, Massachusetts was selected as the vendor for the work. The following steps were conducted with AppGeo's assistance.

## Step 2. Established aerial imagery study project team

Commerce's Aerial Imagery Study project research team is made up of two teams, the Washington project consulting team led by Commerce, and the research team led by AppGeo.

The Washington project consulting team is a group of aerial imagery subject matter experts, local and state stakeholders, and Commerce staff and managers tasked with managing the study, guiding the direction of the research team, reviewing, and providing feedback on study findings, deliverables, and program recommendations, and delivering a formal report to the state legislature.

The members of the Commerce's Washington project consulting team are as follows:

- **Jeremy Walker**, Senior Project Management Analyst, Project Manager and WA Project Consulting Team Lead, Washington Department of Commerce
- **Joanne Markert**, State Geographic Information Officer at WaTech, Office of the Chief Information Officer
- **Steven Drew**, Thurston County Assessor, Thurston County Auditor and Chair of the Washington State County Assessors Association, Thurston County
- **Jason Henderson**, GIS Coordinator, Washington Department of Commerce
- **Michelle Gladstone-Wade**, Tribal Liaison, Washington Department of Commerce
- **Elizabeth Saylor**, Applications Development Manager, Washington Department of Commerce
- **Lynda Jensen**, Publications and Web Content Editor, Washington Department of Commerce

The research team, the primary investigators tasked with facilitating stakeholder engagement, collecting, and analyzing stakeholder feedback, and designing an high quality, equitable and economically balanced imagery program, is staffed by consultants from Applied Geographics, Inc.

- **Kate Hickey**, AppGeo Chief Operating Officer, Project Lead
- **Peter Lemack**, Senior Project Manager, Co-Project Manager
- **Priya Sankalia**, Senior Project Manager, Co-Project Manager
- **Eric Ingbar**, Senior Consultant, Senior Business Analyst
- **Ian Von Essen**, Consultant to AppGeo, Washington State Subject Matter Expert
- **George Halley**, Business Manager, Sanborn Map Company, Inc.
- **Srini Dharmapuri**, Vice President & Chief Scientist, Sanborn Map Company, Inc.
- **Anya Schneider**, Flight Planning, Sanborn Map Company, Inc.

### Step 3. Identified aerial imagery stakeholders

The ESHB-1629S legislation identifies six (6) government sectors whose agencies, departments, and organizations were identified as users or purchasers of aerial imagery. These groups, categorized by their sector of government, needed to be included and engaged with during the aerial imagery study. They are as follows:

- state agencies
- county governments
- tribal governments
- local governments
- special purpose districts
- school districts.

Prior to stakeholder outreach and engagement, the Washington project consulting team compiled a list of the primary contacts of practitioners who use, administer, purchase, or influence decisions about aerial imagery for each of the six sectors of government stakeholder groups. The research team supplemented the list of stakeholders with known imagery users of their own. This stakeholder list formed the basis of the study's outreach and engagement activities. This list of experts grew as the study reached later phases of engagement.

All 29 federally recognized sovereign tribal governments were invited to participate in the aerial imagery study. Understanding the connection between the land and the digital representation of the land, the importance of imagery in supporting business needs, and the current technical characteristics of aerial imagery used by tribal governments was critical to ensure that the study and the resulting imagery recommendations considered tribal government's needs and concerns. All tribal governments were invited to meet with the Research team. Not all elected to participate in the study (Appendix H).

### Step 4: Conducted stakeholder outreach and engagement

The outcome of the aerial imagery study and the degree to which the recommended aerial imagery program would meet the stakeholders' needs in an equitable and economic manner was dependent on engagement, participation, and openness from the State's various stakeholders.

As described in the steps below, the aerial imagery study provided numerous opportunities for stakeholders to provide information about their use of imagery. To initiate engagement with the study's stakeholders, the Research team facilitated four (4) Stakeholder Workshops (Appendix B). These workshops informed aerial



imagery stakeholders about the project background, approach and timeline, desired outcomes, and opportunities for engagement. Three of the workshops were open to all invited stakeholder groups. The fourth workshop was open to all, but reserved specifically for tribal governments

During the workshops, the research team introduced the project website, where stakeholders could track the progress of the project, sign up for engagement opportunities, and provide feedback on the trajectory of the project.

At the conclusion of the workshops, the registrants were provided a link to complete an online survey and share the survey with subject matter experts they knew from other government sectors.

## Step 5: Collected information through an online survey

The research team designed and administered an online survey (Appendix E) to collect information from stakeholders across the state's 6 stakeholder groups. For each sector of government (i.e., County, Tribal Government, State Agency, etc.) the survey aimed to collect information on the:

- Background of the aerial imagery users (Sector of Government, Role, Experience).
- Current business use cases met with existing imagery.
- Desired business use cases currently unmet with existing imagery.
- Current and desired imagery requirements and technical specifications.
- Current imagery costs across their sectors of government.
- Current limitations of aerial imagery.
- Willingness to participate in a statewide aerial imagery program (now or in the future).

In total, the research team collected 435 unique responses from the state's stakeholders. Responses reflected the current state of imagery in 34 counties, 61 municipalities, 16 tribal governments, 25 special purpose districts, 6 school districts, and 11 state agencies.

In many cases, multiple respondents from the same sector of government submitted a response. In some of those cases the responses presented contradicting, or differing views into their perceived use of aerial imagery within their sector of government. To avoid redundant counting from the same sector of government, the research team aggregated results and selected the most authoritative information as representative of the entire sector of government. For instance, if a respondent of a sector of government stated that they did not use imagery to support their needs, but another member of the same sector of government stated that imagery was used by them on a daily basis, the research team determined that the sector of government had access to and used aerial imagery.

## Step 6: Facilitated focus Group Sessions

A final component of the online survey presented the opportunity for respondents to volunteer to participate in facilitated focus group sessions.

The research team facilitated twelve (12) focus group sessions. During these group interviews, the research team met with aerial imagery users from various agencies, organizations, and tribal governments. The purpose of these focus groups was to document the imagery needs, benefits, current costs, current or potential limitations, and administration of aerial imagery to understand how similar or dissimilar the aerial imagery uses were within different entities of a similar sector of government.

The research team placed the invited stakeholders into twelve (12) focus groups identified by industry, sector of government, discipline, and or departmental role. In some cases, a group was split to account for

differences between urban and rural sectors of government, or to provide additional opportunities for larger groups of participants to meet with the research team. The research team facilitated and documented findings from the following twelve (12) focus groups (See Appendix F):

- #1: GIS Managers - 11/2/2022
- #2: Planning - 11/3/2022
- #3: Environment / Natural Resources - 11/9/2022
- #4: Infrastructure - 11/9/2022
- #5: Transportation - 11/10/2022
- #6: Public Safety - 11/15/2022
- #7: Emergency Preparedness - 11/16/2022
- #8: Western Assessors - 11/17/2022
- #9: Eastern Assessors - 11/18/2022
- #10: Tribal governments - 11/29/2022
- #11: Tribal governments - 11/30/2022
- #12: WaTech Imagery Program - 12/9/2022

## Step 7: Targeted outreach for follow up information

Guided by the findings from the online survey, and the focus groups, the research team reached out to the following sectors of government for follow up conversations: the Department of Natural Resources, Department of Ecology, King County, Thurston County and Skagit County. The research team also met with the following aerial imagery vendors: The Sanborn Mapping Company, EagleView, Miller Creek and Associates, and NV5.

The research team also made a public information request under the Public Records Act, chapter 42.56 RCW to WaTech, requesting materials related to the current WaTech statewide aerial imagery program. This included subscriber lists, the current contract, and related materials. This information was critical to understanding the current state aerial imagery program.

## Step 8: Analyzed the Current State of Aerial Imagery Use in Washington State

To analyze the current state of aerial imagery use in Washington State, the research team:

- Tallied and evaluated the survey responses using SurveyMonkey tools, Alteryx business intelligence software, and Microsoft Excel.
  - Consolidated the survey responses that came from a single government office (e.g., a county, a state agency, a municipality) using the most consistent values or those that were verified in focus groups, targeted interviews, or emails. This avoided overcounting of single government office responses.
- Public information requests were made on current purchases where there was knowledge that a purchase occurred, but survey responses were absent or unclear.
- Examined current costs of the WaTech statewide aerial imagery program.
  - Costs to the state (contracted services) and administrative costs
  - Costs to WaTech imagery coalition participants
- Estimated current costs for independent purchases based on survey responses.

- Calculated cost per year and cost per image acquisition cycle
- For each government unit other than a state agency that reported purchasing imagery, the cost per square mile was calculated per year and per acquisition cycle, using the area administered by the government unit.
- For government units within another unit, such as a city within a county, the cost numbers reported by the city were divided by the city's area to determine cost per square mile per year and per acquisition cycle.

Table 1. Annual average independent purchase costs from survey, focus groups, and interviews.

Government Type	Annual Expenditure on Aerial Imagery
Counties (13 of 39)	\$1,446,440
Municipalities (26 of 280)	\$427,042
State Agencies (3)	\$499,300
School District (2)	\$0
Special Purpose District (25)	\$152,000
Tribal Government (15)	\$66,070
Other (regional councils)	\$54,317
<b>Total</b>	<b>\$2,645,169</b>

- Extrapolated independent aerial imagery purchase cost.
  - Chose a conservative cost per square mile for a mix of 3-inch, 6-inch, and 9-inch GSD orthophoto and oblique acquisition based on reported values.
  - Generalized to the entire state as if each county and municipality purchased imagery independently.
    - Multiplied each governmental unit's area in square miles by the selected conservative cost per square mile.
    - To be conservative, state agencies, tribal government, and special purpose districts were not included in this extrapolation.
- Extrapolated administrative costs associated with the WaTech program.
  - Interviewed WaTech Imagery Program administrator and WA State DNR imagery processing support staff and determined that annually 10% of one WaTech FTE (0.1) and 10% of one DNR FTE (0.1) were involved in the administration of the WaTech Imagery program on an annual basis. An encumbered staff rate of \$250 per year provided by WaTech was used to calculate annual WaTech Administrative costs.
  - Extrapolated administrative costs for independent imagery purchases.
  - Administrative costs are significant if we assume that every government that could use imagery procured it independently. This includes 39 counties, 29 federally recognized tribes, 279 cities and towns, and 1465 special purpose districts (of more than 1900) that might use aerial imagery.
  - During our study, we came across one county, Skagit County, who over the last 18 years documented the exact amount of GIS staff time that was put forth in making purchases of independent imagery.

- Skagit County documented that their internal GIS staff averaged 279 hours (or .13 FTE) per year over an 18 year period (2004-2022) performing the various administrative tasks associated with acquiring imagery and maintaining a regional imagery consortium.
- This 18-year case study documenting administrative time in the purchase of independent imagery was used as supporting documentation in our administrative cost calculations.
- For each government sector we then assigned an administrative full-time-equivalent value from 0.1 to 0.05 for staff time spent managing or administering the purchase of a flight cycle (2 years is assumed).
- Annual encumbered staff rates for those local and tribal governments who reported staff rates associated with the purchase of independent imagery were aggregated and averaged resulting in an encumbered staff rate of \$125,000 per year.
- For the remaining government sectors (n=1822) that might use imagery a conservative encumbered staff rate of \$100,000 per year was chosen.
- The results were then tallied to determine total extrapolated administrative costs for all government sectors.

Table 2. Extrapolated annual and per cycle cost of statewide aerial imagery under current procurement methods.

	Annual Imagery Cost	Annual Administrative Cost	Per Cycle Cost Total (2 year)
<b>WaTech Aerial Imagery Program (100% orthophoto)</b>	\$350,000	FTE 0.1 (WaTech); DNR 0.1; @250k/FTE = \$50,000	\$800,000 (2-year cycle)
<b>Reported Independent Purchases (25% oblique, 75% orthophoto)</b>	\$2,645,000	5.0 FTE (aggregate, 50 respondents @ 0.1 ea) @\$125k/FTE = \$625,000	\$6,540,000
<b>Extrapolated* Independent Purchases NOTE: 25% oblique, 75% orthophoto</b>	\$6,414,000	172.55 FTE (aggregate 1822 govt. entities) @\$100k = \$17,255,000	\$47,338,000
<b>Total (WaTech + Extrapolated)</b>	\$6,764,000	\$17,305,000	\$48,138,000

The key point is that even if one only paid for **acquiring** imagery once in a cycle (at about \$13M), the duplication in administrative costs within 1,822 government sector organizations) would bring the total per cycle cost to over \$48M.

## Step 9: Researched Aerial Imagery Programs in Other States (Appendix F)

As part of the research that informed the recommended aerial imagery program, the Aerial Imagery Research team documented the components of statewide aerial imagery programs for 6 comparable states:

- Indiana
- Kentucky
- Oregon
- Texas
- Utah
- Wyoming

States were selected based on the presence of an existing aerial imagery program, state size, geographic location compared to Washington, topography, and parameters of programs that meet similar stakeholder needs i.e., statewide oblique and orthophoto collection.

The research into these states documented the description of the approach, the cost, imagery capture frequency, relevant limitations, distribution details, and cost sharing approaches (See Appendix G). The Research team interviewed the following contacts to collect information on their respective state’s aerial imagery programs:

Table 3: List of individuals contacted for state imagery program research.

State	Contact	Position
Indiana	Shaun Scholer	GIS Program Director
Kentucky	Kent Anness	GIS Manager, Kentucky Office of Technology
Oregon	Brady Callahan	Geospatial Lead, sUAS Coordinator, Oregon Imagery
Texas	Gayla Mullins	StratMap Program Manager
Utah	Matt Peters	Director of The Utah Geospatial Resource Center
Wyoming	Brenda L. Henson	Director of The Wyoming Department of Revenue

## Step 10: Designed the High quality Program Recommendation

Designing the high quality (the high-quality statewide aerial imagery program – referred to as high quality here for brevity) imagery program required first identifying current aerial imagery types, uses and needs across all government sectors.

This was accomplished through an online survey (described in Appendix Methods section under Step 5), facilitated focus group sessions (described in Appendix Methods section under Step 6) and targeted outreach to specific governmental staff and five vendors (described in Appendix Methods section under Step 7).

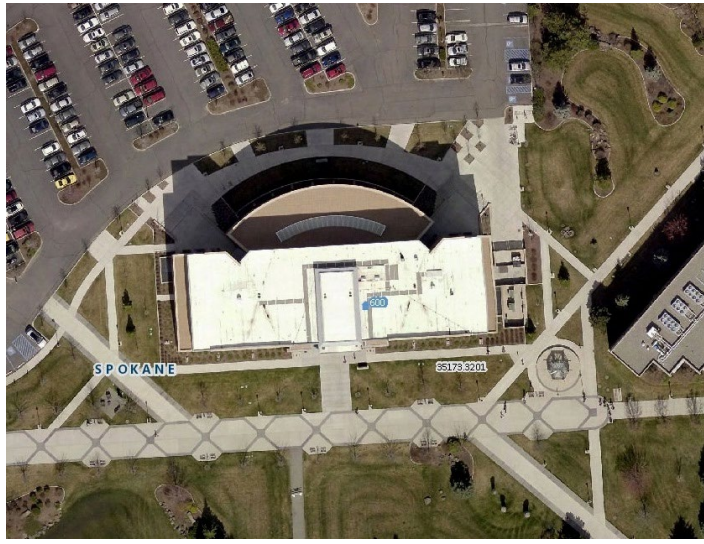
Analysis of these various sources of information was then carried out (as described in Appendix Methods section under Step 8).

Based on this analysis the characteristics of an high quality aerial imagery program were determined.

## Technical Recommendations for High quality Program

Orthophoto (“top-down”)	Oblique imagery
<ul style="list-style-type: none"> <li>6” ground separation distance (GSD; “resolution”) minimum; 3” in urban/growth areas</li> <li>4-band (includes near IR)</li> <li>2-year acquisition cycle</li> <li>Control network -&gt; repeatable positional / spatial accuracy</li> <li>High sun angle</li> <li>Excellent ground visibility</li> <li>Stereo pairs for DNR use</li> </ul>	<ul style="list-style-type: none"> <li>Nominal 6” resolution minimum; 3” in urban areas</li> <li>Statewide</li> <li>2-year acquisition cycle</li> <li>Positional accuracy same as orthoimagery</li> <li>Leaf-off as much as possible</li> <li>Minimal snow cover (mountains)</li> <li>Viewer tool with x/y/z measurement features</li> </ul>

Orthophoto ("top-down")



Oblique imagery



It was determined based on this analysis that neither the WA State's current WaTech imagery program nor any of the off the shelf imagery products available through today's vendor community met these technical requirements as detailed in the table below.

## Characteristics of Off-the-Shelf and Custom Products

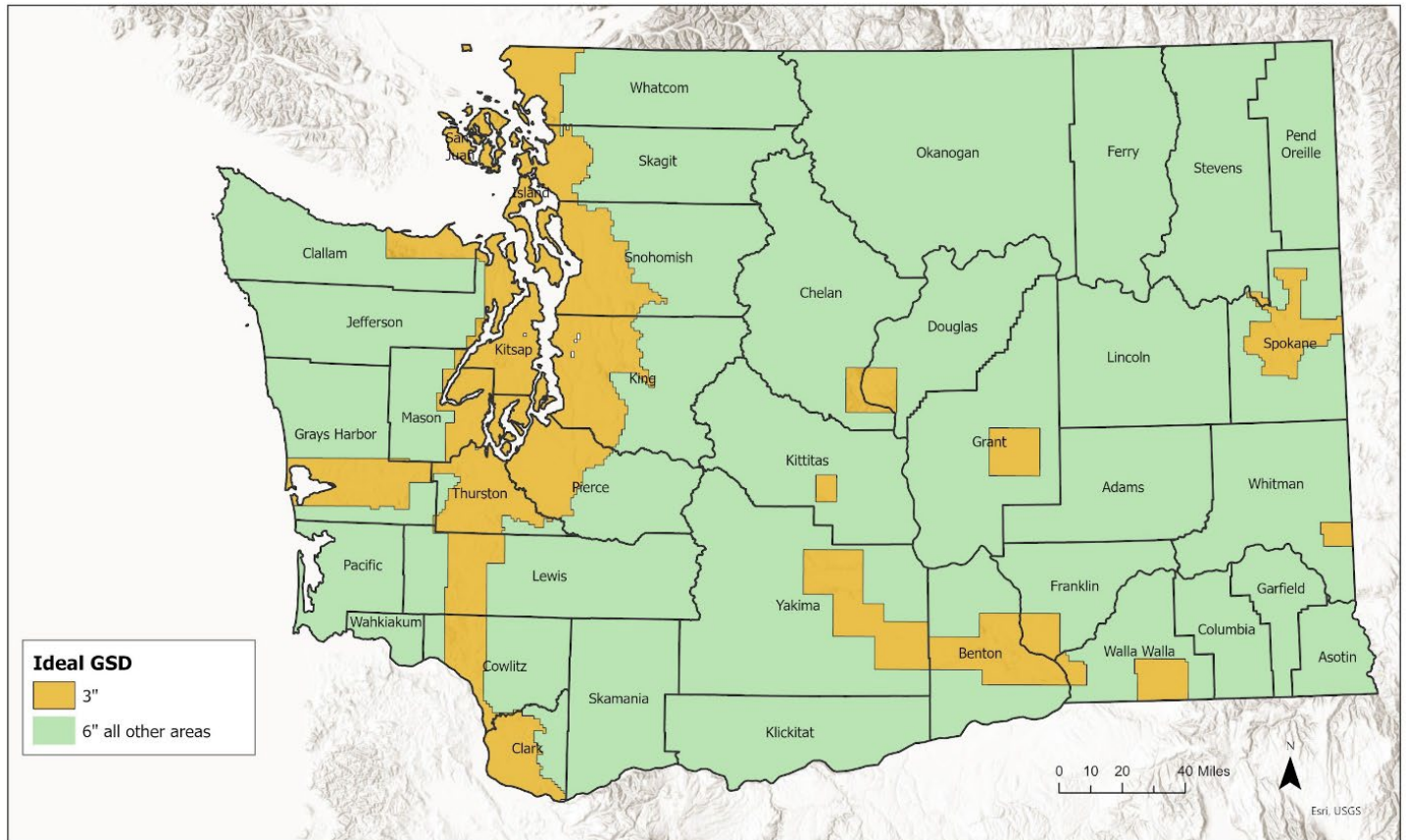
Table 4: Characteristics of Off-the-Shelf and Custom Products

	Statewide (off the shelf)	Available now	6" ortho	3" ortho	Near IR	6" oblique	3" oblique	Access to Archive	Ownership	Frequency
<b>Current WaTech imagery (Hexagon)</b>	Yes	Yes	Yes	No	Yes	No	No	Yes (with ongoing contract)	State, after next paid contract cycle	2-year
<b>Google/Bing/Apple/Planet (Satellite)</b>	Yes	Yes	No	No	No	No	No	No	Vendor	Per vendor, varies and could be monthly
<b>National Vendor #1 Product (e.g., NearMap)</b>	No	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Yes (urban only)	Paid subscriber	Vendor	Per Vendor
<b>National Vendor #2 Product (e.g., Eagleview, Sanborn, NV5)</b>	No (available by contract)	No	Yes (per contract)	Yes (per contract)	Yes (per contract)	Yes (per contract)	Yes (per contract)	Per contract	Per contract	Per contract
<b>Custom Product</b>	Yes (by design)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	2-Year

An high quality program coverage map (below) was then produced based on the technical requirements needed for an high quality program within Washington State. This high quality program map was then reviewed and compared to the existing WaTech Imagery program coverage map by the WA State GIS Coordinator, Joanne Markert (Washington Technology Solutions) and modified to meet current and requested imagery needs.

## High quality Program Coverage Map

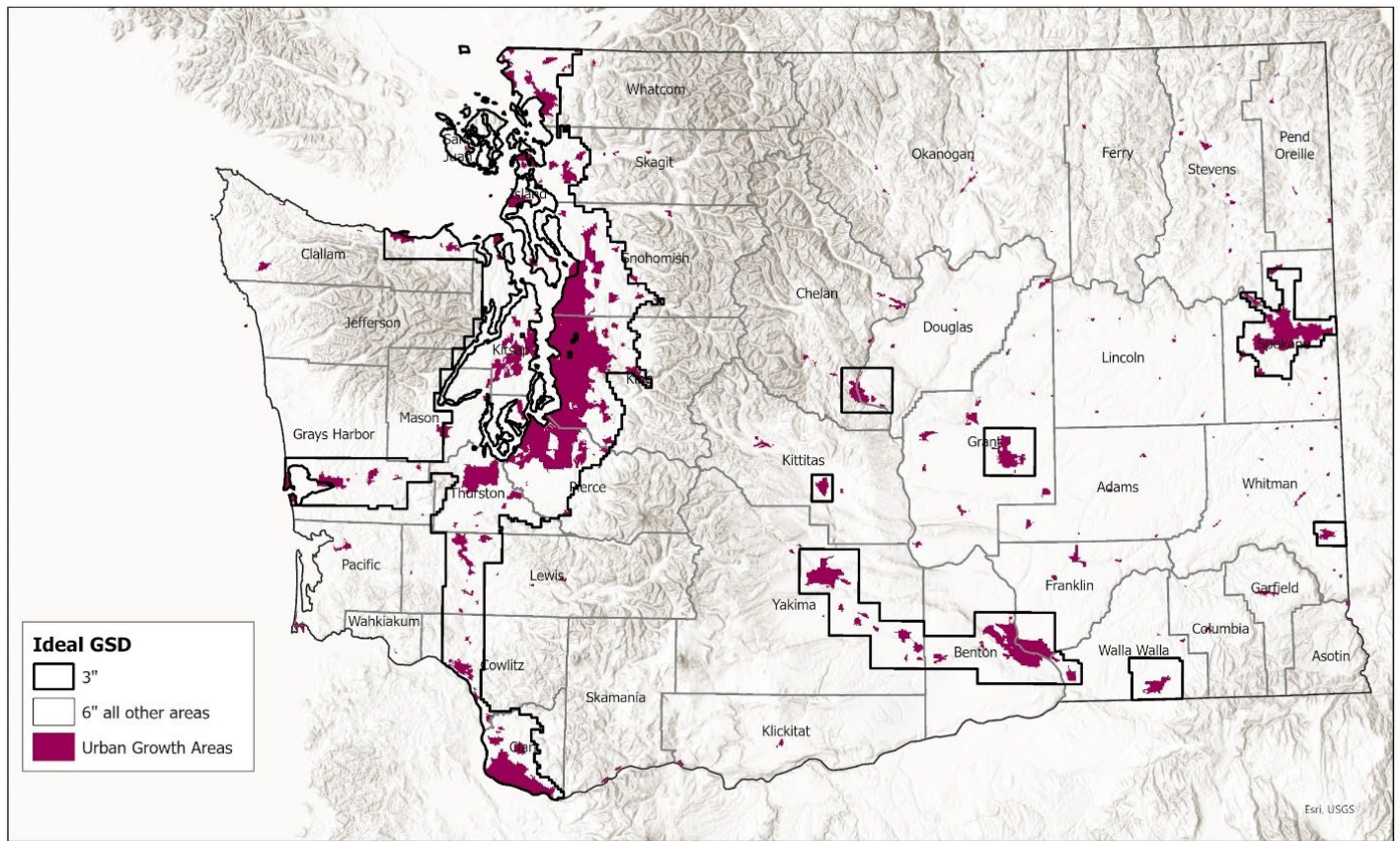
% Area Covered: 3" GSD: 16%, 6" GSD: 84%



The high quality Imagery Program Coverage Map was then compared with a map of all Washington State UGAs and modified to ensure that the majority of the UGA's were covered by urban 3-inch ortho and oblique imagery (below).

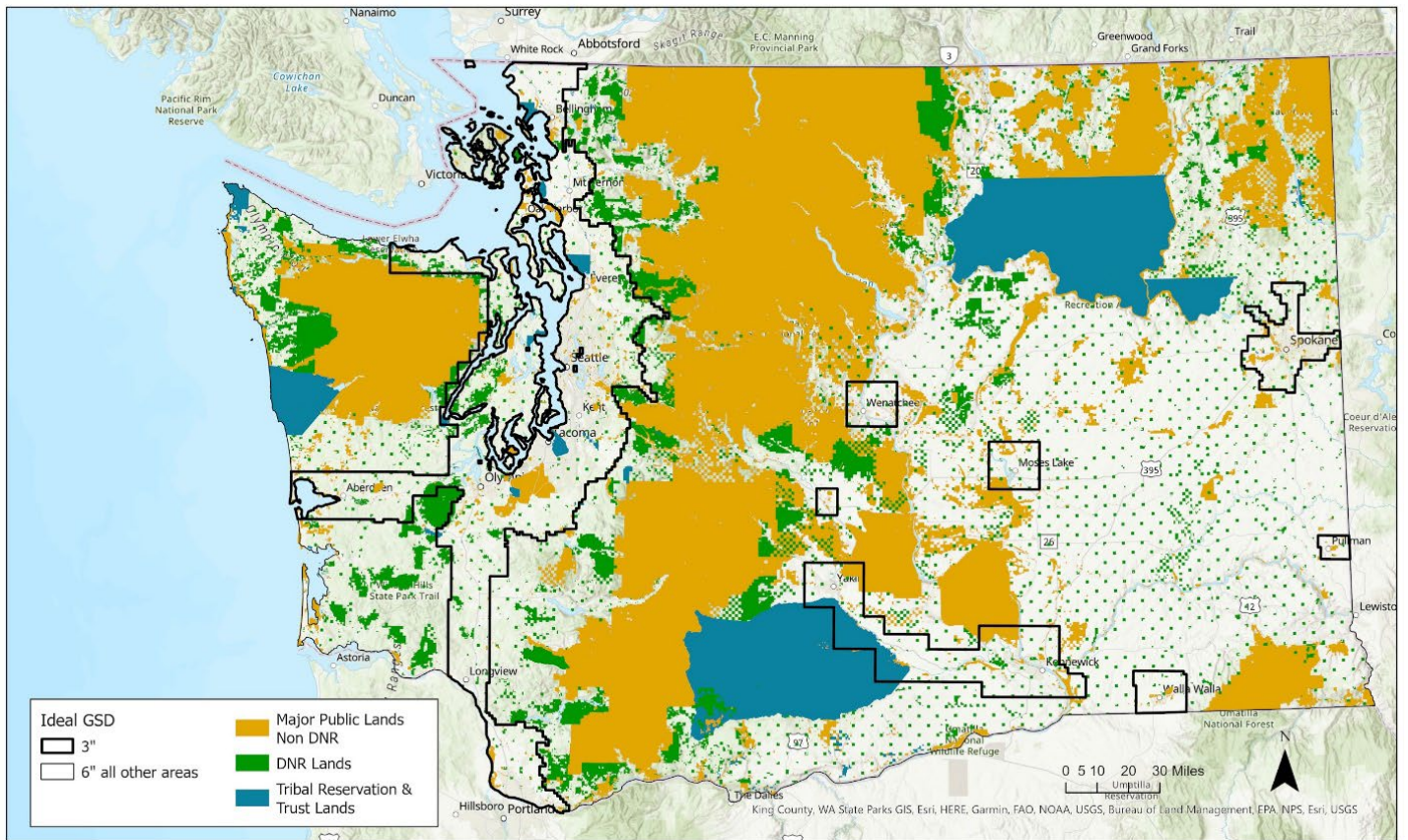


## High quality Program Coverage Map - with Urban Growth Areas (UGAs)



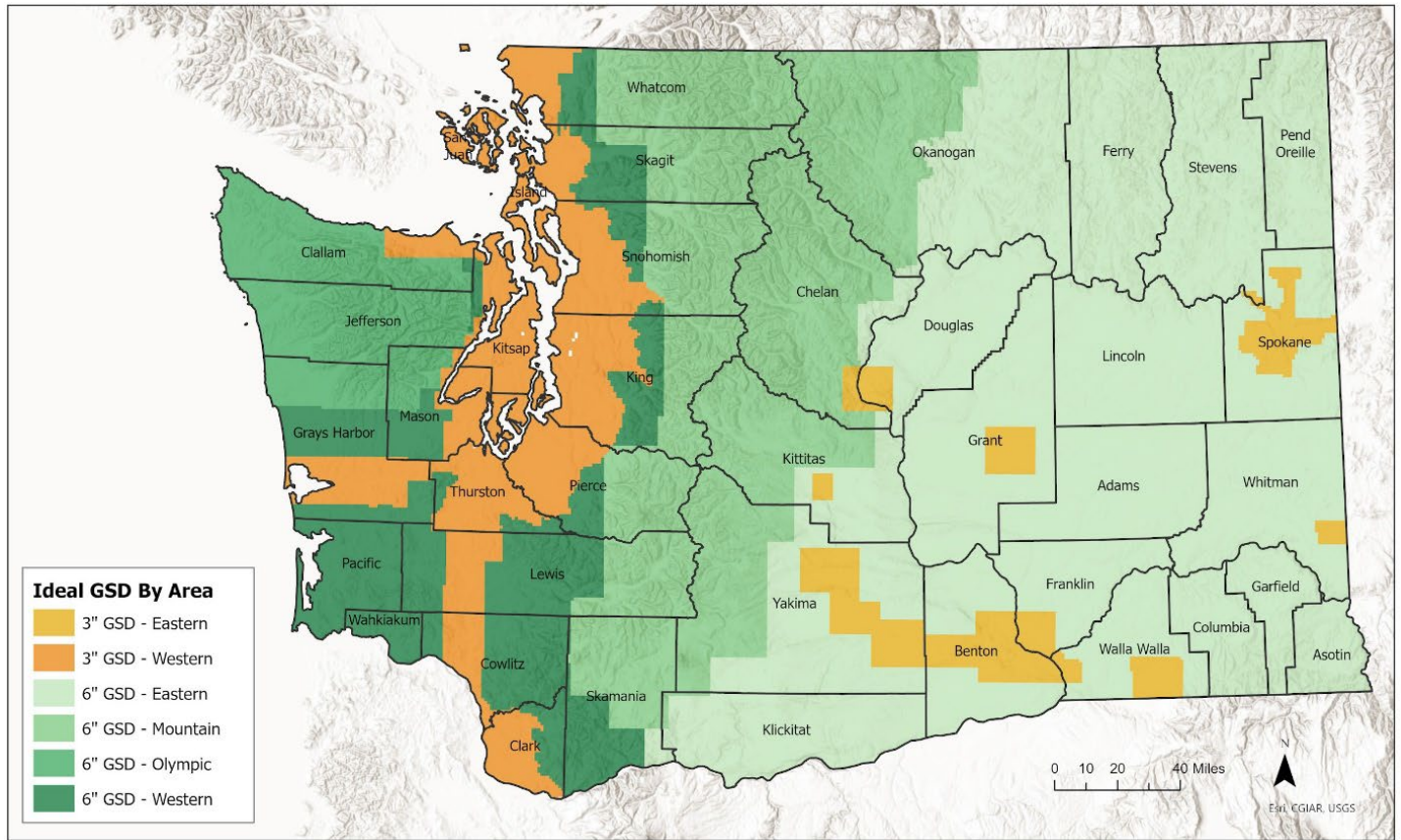
The High quality Imagery Program Coverage Map by Landowner (below) depicts proposed 6-inch and 3-inch ortho and oblique capture areas and then compares those to all public and tribal lands across the state of Washington. It was determined that most 3-inch capture zones proposed occur outside of those areas.

## High quality Program Coverage Map - By Landowner



Next a high quality program coverage map was created that further divided the proposed 6-inch and 3-inch ortho and oblique capture areas into six separate phased capture zones that are delineated by their recommended capture season (below). The imagery capture seasons are identified on the map above. Generally, leaf-off urban areas are captured first in the late winter to early spring followed by the mountainous terrain, Cascades, Olympics, and Rockies, which are the most difficult to fly due to elevation and snow cover. The capture seasons for the mountainous terrain range from late spring to early fall.

# High quality Program Coverage Map - By Area



## Estimate future costs for the high quality program

To determine the future cost of a High Quality Washington State Imagery Program the mandatory requirements of the imagery program were identified. These are:

- 1) the acquisition and quality control of the statewide imagery,
- 2) having the operational and technical support staff to manage the high quality program,
- 3) having sufficient storage infrastructure for the imagery,
- 4) having the imagery accessible as data downloads, online services, and as web maps, and finally,
- 5) having the software to view and use the imagery which is especially critical to use oblique imagery. These requirements are identified in the table below.

### Meeting Mandatory Needs

#### Acquisition

- Statewide orthophoto and oblique imagery
- Single master contract for acquisition
- May use separate quality assurance and control vendor for
- spatial accuracy and imagery quality

#### Operational & Technical Support

- Consulting support for technical services
- General IT support

#### Infrastructure & Distribution

- Storage (~ 1000 TB with oblique imagery)
- Freely available to all government sectors
- Accessible as data downloads, online services, and web maps

#### Software

- Oblique viewer software

As identified in our needs analysis many government sectors throughout Washington need ancillary products that are derived from the source imagery. These are identified in the table below.

### Meeting Optional Needs

#### Buy Ups (ancillary products)

- Pre-negotiated pricing for products
  - Building footprints
  - Change detection
  - Certified imagery
  - Land cover and land use
  - Custom flights
  - Digital models

- Requests occur a year in advance of acquisition.
- If buy up is enhancement of regular product, then additional cost but base price subsidized.
- If buy up is not an enhancement, then it is not subsidized

Staffing and management of the High Quality Washington State Imagery Program were identified and are described in the table below.

## Management & Staffing

### Collaboration & Consultation

- Involve representatives from all levels of government.
- Provide forum so that priorities and concerns are recognized.
- Ensure the State is meeting obligations to Tribal governments

### Staffing

- WaTech Aerial Imagery Program Manager (1 FTE)
  - Manages solicitation and contract activities.
- WaTech Support Engineer (1 FTE)
  - Supports users and communities.
- Tribal Coordinator (1 FTE)
  - Coordination with Tribal governments
- Community Relations Coordinator (1 FTE)
  - Works with all sectors of government, outreach, concerns, etc.

High quality imagery program costs were identified based on the mandatory requirements previously listed above for each of the three major categories shown in the table below.

Imagery acquisition and associated imagery quality control costs were identified through extensive vendor interviews.

Program staffing needs and associated costs were identified through interviews with the WA State Imagery project team including WA State encumber staffing rates.

Infrastructure (storage, hosting, & streaming services) and oblique software costs were identified through extensive vendor interviews. Estimated storage size requirements per flight cycle for statewide imagery for 6 inch and 3-inch ortho and obliques were determined to be 1 petabyte or 1000 terabytes. Storage and web streaming service costs of 1 petabyte of imagery data were based on the current rates beginning charged by the major commercial cloud vendors (Google, Amazon Web Services, Azure). Both infrastructure and software costs vary widely between photogrammetric vendors - some embed all of those costs in their per sq. mile capture costs others do not.

The staging of the High Quality State Aerial Imagery Program is detailed across the top of the table below and color coded by start-up and flight capture cycles.

One-time high quality imagery program costs are shown in tan; these are the initial set up of the WA State imagery control network to ensure the spatial accuracy of the imagery captures and the initial acquisition of oblique imagery viewing software.

## Recommended/High quality Program Costs

Table XX5: High quality Program Costs Breakdown

Cost Category		Project Start-up Year 0 Estimate	Flight #1 Year 1-2 Estimate	Flight #2 Year 3-4+ Estimate
Acquisition	Ortho & Oblique Imagery Acquisition		\$26,479,825	\$26,479,825
	Creation & maintenance of statewide control network	\$1,325,000	\$26,500	\$26,500
	Spatial & Image Quality Control	\$100,000	\$1,712,500	\$1,712,500
Staffing	FTE (4) *	\$1,000,000	\$2,000,000	\$2,000,000
	External technical support	\$100,000	\$200,000	\$200,000
Access	Infrastructure (Storage, Hosting, & Streaming Services) **	\$32,400	\$1,958,400	\$5,875,200
	Software (to support viewing, distribution, etc.) **		\$850,000	\$340,000
<b>Total Cost</b>		<b>\$2,557,400.00</b>	<b>\$33,227,225.00</b>	<b>\$36,634,025.00</b>

## Alternatives to the High quality Program

While developing the High quality Program several alternatives were considered. The High quality Program has the best return on investment compared to the alternatives presented below. Each of the alternatives lower the cost of the program compared to the high quality program. Generally, with each subsequent alternative, fewer benefits come with the lower costs yielding a lower return on investment. Additionally, with lower state program costs the cost burden is shifted to the end-user governmental sectors which dramatically increases overhead and/or administrative costs across government sectors.

One thing that remains true for all the alternatives described below is the primary goal of providing equal access to imagery for all.

- 1) **High quality Program minus Mountainous Areas:** In this alternative, all mountainous areas that are public lands are dropped from the High quality Imagery Program. These areas are identified in tan on the High quality Imagery Program Coverage Map by the Landowner. Dropping these public lands from the imagery program saves approximately 8 million dollars per imagery capture cycle. One of the drawbacks with this option is that Washington State will no longer have a complete standardized imagery coverage for the state.
- 2) **Statewide 6" with 3" buy up (6" Orthophoto and Oblique Only):** In this alternative all 3-inch ortho and obliques are dropped from the program. Dropping 3-inch orthos and obliques from the High quality Imagery program saves approximately 14 million dollars per imagery capture cycle. 3-inch orthos and obliques are then available as a buy-up option for those highly urbanized cities and counties who need such high-resolution imagery for infrastructure mapping. The benefits to this option are that the state of Washington still has a standardized statewide orthophoto coverage though at a lower resolution of 6 inches. The disadvantages are that the cost burden is then shifted to the end-user governmental sectors who need 3-inch orthos and obliques and it dramatically increases overhead and/or administrative costs to administer a statewide buy-up program.
- 3) **Statewide 6" minus Mountainous Areas (6" Orthophoto and Oblique only):** In this alternative besides dropping all 3-inch ortho and obliques, all mountainous areas are dropped as well. This option saves approximately 23 million per imagery capture cycle as compared to the High quality Imagery program. Again, there would be a buy-up option for 3-inch orthophotos and obliques as detailed in the previous option. There are many disadvantages to this option. Washington State will no longer have a complete standardized imagery coverage for the state; the cost burden, is shifted to the end-user governmental sectors who need 3-inch orthos and obliques; and it dramatically increases overhead and/or administrative costs to administer a statewide buy-up program.
- 4) **New Orthoimagery Program (6" Orthophoto, No Obliques):** In this alternative no oblique imagery is purchased, only a 6-inch statewide orthophotos. This alternative saves approximately 30.7 million per imagery capture cycle as compared to the High quality Imagery program. The benefits to this option are that the state of Washington still has a standardized statewide imagery orthophoto coverage at a resolution of 6 inches with control over the specifications. All oblique imagery, both 3-inch and 6-inch, must be purchased via a statewide buy-up program. The disadvantages to this option are that the cost burden is shifted to the end-user governmental sectors, no oblique imagery is provided in this option except as a buy-up, and it dramatically increases overhead and/or administrative costs.
- 5) **Current Program with Full State Funding (6" Orthophoto Statewide License, no oblique):** In this option a 6-inch statewide ortho subscription is purchased by the State. This option is similar to the existing WaTech



Imagery Program. The primary difference is the state funds this subscription so that all governments can have access to this imagery unlike the situation we have today where you only have access if as a government entity you pay for it. This option saves approximately 33.9 million per imagery capture cycle as compared to the High quality Imagery Program. The benefits to this option are that the state of Washington still has a standardized statewide imagery ortho coverage at a resolution of 6 inches and that all governments have access to the imagery via the subscription imagery license. The disadvantages are the same as the ones above – the state has no control over the imagery, the cost burden is shifted to the end-user governmental sectors, it increases overhead and/or administrative costs.

The two tables below summarize the alternatives.

The table below summarizes the alternatives from a benefits perspective and provides the cost per image cycle. Only the high quality program meets all the benefits.

## Program Alternatives by benefits (cost per image capture cycle)

Table 6: Alternative programs summarized by benefits.

	BENEFITS				
	Equal Access	Standardized Coverage of State	Low Administration Cost to Users	Meets Regulatory Standards (e.g. IAAO)	Cost Per Image Cycle
High quality Program	✓	✓	✓	✓	\$36M
High quality Program Minus Mountainous Areas	✓	X	✓	✓	\$28M
Statewide 6" with 3" Buy Up	✓	6" only, higher resolution requires buy-up	Buy-up (3") administrative costs	✓	\$23M
Statewide 6" Minus Mountainous Areas	✓	6" only, higher resolution requires buy-up	Buy-up (3") administrative costs	✓	\$15M
Statewide 6" with 3" Buy Up	✓	✓	Buy-up (all obliques and 3" orthos) and administrative costs		\$3M
Current Program w/Full State Funding	✓	✓	Buy-up (all obliques and 3" orthos) and administrative costs		\$1M

## Detailed Summary of Alternatives

Table 7: Detailed summary of program alternatives

	Current Program	High Quality Program	High Quality Program Minus Mountainous Areas	Statewide 6" with 3" Buy Up	Statewide 6" Minus Mountainous Areas	New Orthoimagery Program	Current Program w/Full State Funding
	Statewide orthoimagery every 2 years; no oblique	Statewide 6" orthoimagery; 3" oblique urban/urbanizing areas; 6" oblique all other areas	High quality Program without Mountainous Areas public lands	Statewide 6" orthoimagery and oblique with 3" oblique buy up (shared product)	6" Orthophoto and Oblique Only without mountainous areas	State fully funded orthoimagery w/new capture contract	6" orthophoto Statewide License; no oblique
<b>Aerial Imagery Characteristics</b>							
6" Orthoimagery	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3" Orthoimagery (urbanizing areas)	No	Yes	Yes	Buy Up	No	No	No
3" Oblique imagery (urbanizing areas)	No	Yes	Yes	Buy Up	No	No	No
6" Oblique imagery (rural areas)	No	Yes	Yes	Yes	Yes	No	No
6" Oblique imagery (urbanizing areas)	No	No (covered in 3")	No	Yes	Yes	No	No
6" Mountainous Areas public lands oblique (state and federal)	No	Yes	No	Yes	No	No	No
<b>Availability and administrative burden</b>							
Freely available for use by all government sectors	No	Yes	Yes	Yes	Yes	Yes	Yes
Freely available for use by public	No	Yes	Yes	Yes	Yes	Yes	Yes

	Current Program	High Quality Program	High Quality Program Minus Mountainous Areas	Statewide 6" with 3" Buy Up	Statewide 6" Minus Mountainous Areas	New Orthoimagery Program	Current Program w/Full State Funding
No cost to all government sectors	No	Yes	Yes	Yes	Yes	Yes	Yes
Reduces redundant imagery acquisition	No	Yes	Yes	Yes	Yes	No	No
Minimizes local government administrative burden	No	Yes	Yes	Yes (6"), No (3")	Yes (6"), No (3")	No	No
Minimizes state government administrative burden	No	Yes*	Yes*	No**	No**	Yes*	Yes*
<b>Ownership and costs</b>							
Ownership model	Licensed by vendor	State-owned	State-owned	State-owned	State-owned	State-owned	Licensed by vendor
Cost model for imagery users	Subscription	Free	Free	Free (6") Buy up (3")	Free (6") Buy up (3")	Free	Free
State can retain archive datasets	No***	Yes	Yes	Yes	Yes	Yes	No***
Cost per imagery refresh cycle	700K	\$36M	\$28M	\$23M	\$15M	\$3M	\$1M
Drawbacks	<ul style="list-style-type: none"> <li>* Highly restrictive access (No imagery availability to govts who are not funding participants)</li> <li>* vendor lock-in</li> <li>* State has no control over the timing and quality of 6" ortho imagery</li> </ul>	* Cost	* Montane public lands would not have oblique imagery	<ul style="list-style-type: none"> <li>* State has to coordinate 3" buy-ups</li> <li>* State has to integrate 3" (buy up products) into statewide 6" imagery base layer</li> <li>* 3" buy ups will involve duplicative administrative costs at all levels of</li> </ul>	<ul style="list-style-type: none"> <li>* State has to coordinate 3" buy-ups</li> <li>* State has to integrate 3" (buy up products) into statewide 6" imagery base layer</li> <li>* 3" buy ups will involve duplicative administrative costs at all levels of</li> </ul>	<ul style="list-style-type: none"> <li>* No oblique imagery</li> <li>* Local govt. and tribes may pursue redundant purchasing to get oblique imagery resulting in duplicative Imagery acquisitions w/ duplicative</li> </ul>	<ul style="list-style-type: none"> <li>* No oblique imagery</li> <li>* State has no control over the timing and quality of subscription based 6" ortho imagery</li> <li>* Local govt. and tribes may pursue redundant</li> </ul>

	Current Program	High Quality Program	High Quality Program Minus Mountainous Areas	Statewide 6" with 3" Buy Up	Statewide 6" Minus Mountainous Areas	New Orthoimagery Program	Current Program w/Full State Funding
	<ul style="list-style-type: none"> <li>* Local govt. and tribes purchases oblique imagery separately w/high administrative burden</li> <li>* Duplicative Imagery acquisitions w/ duplicative administrative costs</li> <li>* State has no access to oblique imagery purchased by local or tribal govts</li> </ul>			<ul style="list-style-type: none"> <li>government</li> <li>* State has no control over the acquisition timing of 3' oblique imagery resulting in temporal patchwork of statewide 3' oblique imagery</li> <li>* Unequal taxpayer funding of 3' oblique imagery (higher burden on selected local govts)</li> </ul>	<ul style="list-style-type: none"> <li>government</li> <li>* State has no control over the acquisition timing of 3' oblique imagery resulting in temporal patchwork of statewide 3' oblique imagery</li> <li>* Unequal taxpayer funding of 3' oblique imagery (higher burden on selected local govts)</li> </ul>	<ul style="list-style-type: none"> <li>administrative costs</li> <li>* Unequal taxpayer funding of all oblique imagery acquisitions (higher burden on selected local govts and tribes)</li> <li>* State has no access to oblique imagery purchased by local govts or tribes</li> </ul>	<ul style="list-style-type: none"> <li>purchasing to get oblique imagery resulting in duplicative Imagery acquisitions w/ duplicative administrative costs</li> <li>* Unequal taxpayer funding of all oblique imagery acquisitions (higher burden on selected local govts and tribes)</li> <li>* State has no access to oblique imagery purchased by local govts or tribes</li> </ul>
Benefits	<ul style="list-style-type: none"> <li>* Low cost</li> </ul>	<ul style="list-style-type: none"> <li>* All imagery types available to all levels of govt</li> <li>* State controls timing and quality of ortho &amp; oblique imagery</li> <li>* High quality oblique Imagery available to all govts (3'urban, 6' rural)</li> <li>* Highly reduced administrative costs</li> </ul>	<ul style="list-style-type: none"> <li>* Lower cost</li> <li>* All imagery types available to all levels of govt</li> <li>* State controls timing and quality of ortho &amp; oblique imagery</li> <li>* High quality oblique Imagery available to all govts (3'urban, 6' rural)</li> </ul>	<ul style="list-style-type: none"> <li>* Lower cost</li> <li>* Available to all levels of govt (6' only - obliques/orthos)</li> <li>* State controls timing and quality of 6"ortho &amp; 6"oblique imagery</li> <li>* Ability of local govts and tribes to buy-up 3" obliques</li> </ul>	<ul style="list-style-type: none"> <li>* Lower cost</li> <li>* Available to all levels of govt (6' only - obliques/orthos)</li> <li>* State controls timing and quality of 6"ortho &amp; 6"oblique imagery</li> <li>* Ability of local govts and tribes to buy-up 3" obliques</li> </ul>	<ul style="list-style-type: none"> <li>* Lower cost</li> <li>* Higher quality 6" ortho Imagery because State determines capture parameters</li> <li>* 6" ortho Imagery available to all levels of govt</li> <li>* Reduced administrative cost (1 FTE</li> </ul>	<ul style="list-style-type: none"> <li>* Lowest cost</li> <li>* Subscription 6' ortho imagery available to all levels of govt</li> <li>* Reduced administrative costs (add only 1 FTE to WaTech)</li> </ul>

	Current Program	High Quality Program	High Quality Program Minus Mountainous Areas	Statewide 6" with 3" Buy Up	Statewide 6" Minus Mountainous Areas	New Orthoimagery Program	Current Program w/Full State Funding
			* Highly reduced administrative costs			technical staff; 1 FTE tribal government coordinator)  * State controls timing and quality of imagery	

\* State must still administer the program as a whole

\*\* State must still coordinate 3" buy-ups and integrate with statewide imagery

\*\*\* State can retain imagery by continuing future subscription contracts

# Step 11: Verified High Quality Program Recommendations with Commercial Vendors

The research team contacted and interviewed four commercial vendors. All vendors were selected based on their extensive experience within Washington State with its unique and challenging combination of topography, climate and atmospheric conditions, and high latitude sun angles. All vendors have extensive experience in capturing statewide high-resolution oblique and ortho photo collections and in the quality control / quality assurance of those imagery collections. The research team interviewed the following contacts and the topics discussed are listed below.

## Commercial Vendor Contacts and Discussion Topics

### Vendor: Eagleview

#### Contact: Dustin Walters, District Manager Pacific NW

- Discussion Topics
- Oblique resolution trends - 9" to 6" to 3"
- Popular derived products: change detection 75% of client counties. Derived products pricing by parcel
- Evolution of Assessor assessment site visit rules; safety benefits of virtual vs onsite parcel inspection
- Embedding oblique imagery in Assessor assessment CAMA systems
- Eagleview Oblique Image viewer licensing
- Eagleview's viewing and measuring tools
- Eagleview's oblique imagery integrations w/ 911 CAD systems
- 50/50 client split between software integration & use of Eagleview's standard oblique viewer.
- Eagleview's management of streaming and hosting services for clients
- Eagleview's standard pricing model for all contracted counties includes all software tools, integrations, etc.
- Challenges w/ acquiring Leaf-off imagery in the Puget Sound requiring winter flights (January/February)
- Infrared imagery vs oblique Imagery needs.
- Certified imagery & obliques
- Cost differentials between standard vs certified ortho cost
- 30% Eagleview customers need certified products.
- Eagleview customers rarely request 4-band (IR) products.
- Certified product vs non-certified delivery timelines
- Working w/ outside QC vendors & turnaround times
- Aligning the customer expectations with vendor capabilities
- Eagleview's disaster response contract clauses
- Urban vs Rural control challenges
- Working with local image consortiums
- Worked with tribal governments
- Degrading imagery for public uses (military requirements)
- Shoreline oblique acquisitions & capture challenges
- Accessing existing (historical) Puget Sound oblique Eagleview imagery
- Eagleview's standard contract (perpetually license for ortho and obliques)
- Eagleview government contract language restricts free distribution to Google, Bing or other "big imagery" competitors.

- Structuring statewide imagery captures

**Vendor: Miller Creek Associates**

**Contact 1: Jimmy Schultz, Production Management & Partner**

**Contact 2: Jeff Kenner, Vice President**

Discussion Topics – (QA/QC Focused)

- Third party QA/QC vendor for King and Snohomish Counties
- Miller Creek Associates does not do Oblique QC/QA, only Ortho QC/QA
- Pre-flight Review of Flight Plan Design
  - Flying with the appropriate coverage overlap
- Determining if sufficient ground control exists to meet the accuracy needs of the project.
- Post-flight Review
  - Imagery acquired with appropriate Sun-angles
  - Detecting Post flight gaps in coverage
- Final Visual Inspection Review of captured orthophotos based on RFP specs e.g., color matching flight lines, building lean, tree lean over roads, etc.

**Vendor: NV5 Geospatial**

**Contact: Melissa Christie, Senior Account Manager**

Discussion Topics

- RFP Considerations
  - Clear technical specs that match use case needs
  - Include overlap, edge-match, color-match, cloud, smoke obscuration, etc.
  - Involve industry early in specification delineation process.
  - QC is essential.
  - Stratification of imagery capture

**Vendor: Sanborn Map Company, Inc.**

**Contact 1: George Halley, Business Manager**

**Contact 2: Srimi Dharmapuri, Ph.D., CP, PMP, Vice President & Chief Scientist**

**Contact 3: Anya Schneider, Flight Planning**

Discussion Topics - (QC/QA focused)

- Imagery, streaming, software, storage, and hosting cost estimates
- Cross state comparisons
- Imagery characteristics: control, true orthos, obliques, multi spectral bands, visual (leaf-on/leaf-off, file size & file formats, compression formats, etc.)
- Imagery Acquisition: WA State acquisition considerations: sun angle, cloud cover, smoke, snow, flooding, etc.
- Imagery Software & Data: (viewing software, proprietary vs non-proprietary image formats, storage, streaming, downloads, licensed vs unlicensed imagery data)
- Imagery Usage: frequency of use, current uses, anticipated uses, derivative products

## Step 12: Analyzed Cost Benefits and Economies of Scale

- Collaboration between organizations provides orthophoto at a lower cost, higher resolution, and on a better schedule – all of which improves the availability and usefulness of the data. The economies of scale of a statewide program reduces the cost per participating organization in both the short and long term.
- Consistent statewide imagery on a 2-year cycle is essential to nearly all key industries in the State of Washington
- From an economic perspective, this was a conscientiously conservative approach – i.e., all costs were included, but only a subset of benefits can be captured and quantified.
- Estimated benefits are forecasted based on the recommended technical specifications (acquisition cycle, resolution, imagery type). Benefits will be reduced if specifications are not met as many of the use cases reported by stakeholders depend on currency of imagery for decision making or change detection, resolution of imagery for viewing necessary detail, and type of imagery (e.g., vertical, oblique) for conducting assessment.
- Washington State has numerous key industries, but within the bounds of this study it was not feasible to measure or estimate ALL potential benefits of an enhanced imagery program. This study focuses on 6 key industries as summarized in the table below. As the calculations demonstrate the ROI for this investment is between XXX and XXX – even while bounding the capture of benefits. Had it been feasible to capture ALL benefits, the ROI would have likely been much larger. Thus, even taking a conservative approach to benefits quantification results in a positive ROI for the State of Washington.

### Quantitative Benefits

- The study performed a high-level estimate of the dollar value benefits that aerial imagery provides to selected parts of the State's economy. The goal was to create a dollar estimate using reasonable, conservative, assumptions. A detailed econometric analysis that might have included industry interviews and desk audits of how aerial imagery is used in each of the areas examined was beyond the scope of this study. Instead, we used general professional knowledge about the use of imagery in major business sectors and government operations. For government operations, we confirmed our understanding with focus group participants from state, tribal, and local government sectors.
- To determine the value of an improved aerial imagery program, the value of aerial imagery is based on the high quality statewide imagery program described in this report. Depending on the industry or government area, aerial imagery at a lower standard than the high quality program provides lesser value. For example, if imagery does not meet legal or professional standards for some use, such as property assessment under the International Association of Assessing Officers and state guidelines, then the time, effort, and risks minimized by using imagery (i.e., its value) are lost.
- Washington State has many key industries and important government operations. This study focuses on 4 key industries and 4 areas of government operations. The table below lists each industry or area of operations, and its estimated financial value.



Table 8: List of industries and their estimated financial value

Key Industry/ Operation	Annual Economic Value	Est Benefit % (Low)	Est Benefit \$ (Low)	Est Benefit % (High)	Est Benefit \$ (High)	Key Use Cases
Salmon Fishery	\$462M*	1.0%	\$4,620,000	2.0%	\$9,240,000	<b>ESSENTIAL to State of WA and Tribal governments</b> <ul style="list-style-type: none"> <li>• Informs critical decisions regarding management, protection, and resource allocation.</li> <li>• Monitoring salmon habitat vs land and waterway development</li> <li>• Change detection in development of impervious surfaces which impact volume and hydraulics of the waterways.</li> <li>• Monitoring of coastal erosion and shoreline change</li> </ul>
Forest Products	\$36B*	0.1%	\$36,000,000	0.2%	\$72,000,000	<b>ESSENTIAL to all sectors of government</b> <ul style="list-style-type: none"> <li>• Identification of stand types and health</li> <li>• Improved accuracy of stand delineations</li> <li>• Reduced need for field inspections</li> </ul>
Agriculture	\$20.4B*	0.1%	\$20,400,000	0.2%	\$40,800,000	<b>ESSENTIAL to all sectors of government</b> <ul style="list-style-type: none"> <li>• Crop identification and delineation</li> <li>• Management practices improvement</li> </ul>
Property Tax Assessment	\$16B**	0.1%	\$16,000,000	0.2%	\$32,000,000	<b>ESSENTIAL to local and Tribal governments</b> <ul style="list-style-type: none"> <li>• Significant time savings for assessor field staff in performing inspections.</li> <li>• Improved safety of assessor field staff in performing inspections</li> <li>• Improved accuracy of assessment</li> <li>• Scope of time savings will increase over time, as imagery and inspection standards evolve</li> </ul>
Emergency Planning	\$1B	0.2%	\$2,000,000	0.5%	\$5,000,000	<b>ESSENTIAL to all sectors of government</b> <ul style="list-style-type: none"> <li>• Natural disaster planning prior to critical events</li> </ul>
Emergency Management and Response	\$1B	1%	\$10,000,000	2.5%	\$25,000,000	<ul style="list-style-type: none"> <li>• Post-disaster identification of buildings and critical infrastructure</li> <li>• Response and recovery</li> </ul>
Transportation	\$70B*	0.1%	\$70,000,000	0.2%	\$140,000,000	<b>ESSENTIAL to all sectors of government</b> <ul style="list-style-type: none"> <li>• Asset management</li> <li>• Condition assessment</li> <li>• Stormwater management</li> <li>• Right-of-Way delineation</li> <li>• Encroachment monitoring</li> <li>• Transportation planning to promote economic development, resilience, safety, energy conservation, healthy communities</li> </ul>

Key Industry/ Operation	Annual Economic Value	Est Benefit % (Low)	Est Benefit \$ (Low)	Est Benefit % (High)	Est Benefit \$ (High)	Key Use Cases
<b>TOTALS</b>			\$159,020,000		\$298,052,880	

\* Annual economic value as reported by the WA Department of Commerce

\*\* Annual tax revenue for State of WA in 2021

\*\*\* Annual value of goods and services moved by Washington's Transportation infrastructure

\*\*\*\* ROI Study

- Estimate future benefits of expanded program.
- See table in main body of report, worksheet below.
- Perform Cost-Benefit Analysis
- Estimated cost: \$36M, estimated benefits \$159M.
- Return on investment analysis.

The ROI estimation used three flight cycles as the time period to examine. This should be sufficient for the high quality aerial imagery program to achieve stability in operations. Other factors were drawn from calendar year 2022 sources. Sources and symbols used for them are:

- (t) Time period: 6 years
- Inflation rate (source: US Treasury): 6.5%
- (c) Opportunity cost of capital (sources: US Treasury and Wall Street Journal): 5.9%
- (r) Discount rate: -0.6% (5 years)
  - <https://www.whitehouse.gov/wp-content/uploads/2022/06/M-22-13-Discount-Rates.pdf>
- (NPV) Net present value calculated using the variables above.

Table XX9 shows the ROI calculations. In each odd number year, imagery is collected (and thus is a cost). For even number years, a likely inflated value of \$2M was assumed, covering State staff, hosting costs, and other needs in these years. Although the value of the 8 areas examined will probably increase over time, the net benefits were kept at \$149M per year.

Table 9. Return on investment calculations.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Totals
<b>Benefits (B)</b>	\$159,000,000	\$159,000,000	\$159,000,000	\$159,000,000	\$159,000,000	\$159,000,000	
<b>Costs (C)</b>	\$36,000,000	\$2,000,000	\$36,000,000	\$2,000,000	\$36,000,000	\$2,000,000	
<b>Net Benefits (B-C)</b>	\$113,000,000	\$147,000,000	\$113,000,000	\$147,000,000	\$113,000,000	\$147,000,000	
<b>Discount Factor (1+r)</b>	1.000	0.994	0.988	0.982	0.976	0.970	
<b>NPV (B-C)/(1+r)</b>	\$113,000,000	\$147,887,324	\$114,372,470	\$149,694,501	\$115,778,689	\$151,546,392	
<b>Discount Cost (DC)</b>	\$36,000,000	\$1,988,000	\$35,568,000	\$1,964,000	\$35,136,000	<b>\$1,940,000</b>	<b>\$112,596,000</b>
<b>Discount Benefit (DB)</b>	\$159,000,000	\$158,046,000	\$157,092,000	\$156,138,000	\$155,184,000	<b>\$154,230,000</b>	<b>\$939,690,000</b>
						<b>Benefit:Cost Ratio</b>	<b>8.35</b>
						<b>ROI Calculation (DB-DC)/DC</b>	<b>7.35</b>

## Step 13: Prepared Presentations for Stakeholders

Throughout the process of and following the final design of the high quality aerial imagery program recommendations, calculation of the estimated budget, and documentation of the cost benefit of the high quality program, the Aerial Imagery Research team presented its findings to the various aerial imagery study stakeholder groups. The presentations were as follows:

- 1) A draft presentation was made to the Washington Project Consulting Team to review the first draft of the aerial imagery program recommendation and provide feedback and direction.
- 2) A presentation was made to the Washington Project Consulting Team to review the final aerial imagery program recommendations and review the findings from the aerial imagery program study.
- 3) An executive presentation was delivered to the Department of Commerce project team outlining the recommended aerial imagery program and the findings of the study.
- 4) A presentation was made to all stakeholders of the aerial imagery program. Participants from the study's kickoff workshops, online survey respondents, and focus group interviewees were invited to join the presentation on the recommended program and the final findings of the aerial imagery program.
- 5) Per state statute and following the Tribal Government stakeholder engagement approach from the study, the Aerial Imagery Research team reserved and made a presentation to stakeholders from Tribal governments, presenting the recommended program, and the final findings of the aerial imagery program.

## Step 14: Prepared Final to Washington State Legislature

Deliver Final Report of Specifications and Recommendations by May 2, 2023

# Appendix D: Washington aerial imagery technology study stakeholder survey questionnaire

(See the following pages for this appendix.)

## Washington state aerial imagery technology study survey

This survey aims to capture how aerial imagery is, or could be, used in your work. The Washington Department of Commerce is conducting the survey, as part of a larger study required by recent state law (HB-1629). Even if your work does not currently use aerial imagery, but might do so in the future, please take the survey. Your participation is essential to the success of the project. Further information about this study is available at the [study website](#).

The survey has 4 sections (Section 1 is about you, the survey respondent; Section 2 focuses on how you use imagery now; Section 3 explores how aerial imagery could be useful in the future; and the fourth and final section asks for feedback or comments on this study).

The survey asks some specific questions about how you use aerial imagery, associated software, technical specifications, and approximate costs. We recognize that you may not know the answers to some questions right away. Please use this worksheet to collect the details from others in your government, and THEN complete and submit the online survey. Thank you in advance for your help!

# Washington state aerial imagery technology study survey

## About You and Your Sector of Government

\* 1. Full Name

\* 2. Email

\* 3. What government do you work for?

County

Municipality

Special Purpose District

School District

Tribal Government State

Agency

Other (please specify)

## County

\* 4. Please select the County you work for (select from a drop down in the on-line survey)

## Municipality

\* 5. Please select the Municipality you work for (select from a drop down in the on-line survey)

## Special Purpose District

\* 6. Which Special Purpose District do you work for?



## Washington state aerial imagery technology study survey

### School District

\* 7. Please select the School District you work for (select from a drop down in the on-line survey)

### Tribal Government

\* 8. Please select the Tribal Government you work for (select from a drop down in the on-line survey)

### State Agency

\* 9. Which State Agency do you work for?

# Washington state aerial imagery technology study survey

## About You & Your Government (continued)

10. What is the name of your department, division, bureau or office within your sector of government, if applicable?

11. What is your job title?

\* 12. Within your sector of government, what is your current role with regard to aerial imagery sources and aerial imagery technology? Please select all that apply

I decide upon and/or manage acquiring aerial imagery

I advise upon acquiring aerial imagery but do not decide or manage the acquisition of it

I provide information technology support and coordinate resources needed for the use of aerial imagery I work with aerial imagery as part of my normal work

I occasionally or infrequently use aerial imagery as part of my work

Other (please specify)

None, I have no role with regard to aerial imagery or technology at present

## Washington state aerial imagery technology study survey

### Aerial Imagery Today - State & Federal

13. At present, how important are state aerial imagery sources (the statewide imagery program) to your sector of government?

- Not used
- Nice to have
- Essential
- Don't know

14. At present, how important are federal aerial imagery sources to your sector of government?

- Not used
- Nice to have
- Essential
- Don't know

# Washington state aerial imagery technology study survey

## Aerial Imagery Today - Ortho & Oblique

\* 15. Excluding the statewide imagery program does your sector of government purchase **orthoimagery** and/or **oblique imagery**? (If you answer No or Don't know skip ahead to Q. 27)

Yes

No

Don't know

## Aerial Imagery Today - Ortho & Oblique Costs & Characteristics

**Please answer the following questions about the cost and characteristics of the imagery product(s) that you/your sector of government purchase, excluding the state imagery program.**

16. What are the types of imagery purchased? Select all that apply.

Vertical (not corrected, not certified)

Vertical (corrected)

Vertical (certified)

Oblique

17. Your sector of government may purchase several imagery products over the course of several years - what is the annualized cost of these products?

Orthoimagery

Oblique Imagery

18. Please list the providers from whom the imagery is purchased

Orthoimagery

Oblique Imagery

19. Please specify the **extent** of the imagery coverage (e.g. entire county or only urban areas)

Orthoimagery

Oblique Imagery

# Washington state aerial imagery technology study survey

## Aerial Imagery Today - Ortho & Oblique Costs & Characteristics

20. What is the **pixel size(s)** of the imagery? Select all that apply.

Orthoimagery	Oblique
< 3 inch	
3 inch	
6 inch	
9 inch	
1 foot	
0.5 meter	
3 foot / 1 meter	
> 1 meter	
Don't know	

21. What are the **spectral characteristics** of the imagery? Select all that apply.

Orthoimagery	Oblique
Black & White	
Color	
Infrared	
Multi-spectral	
Don't know	

Other (please specify)

22. What is the **collection cycle** of the imagery?

Orthoimagery	Oblique
As needed / irregular	
4-year	
3-year	
2-year	
Annual	
Seasonal	
Don't know	

# Washington state aerial imagery technology study survey

23. What are the **acquisition characteristics** of the imagery? Select all that apply.

Orthoimagery	Oblique
<input type="checkbox"/>	<input type="checkbox"/>
Leaf off	
<input type="checkbox"/>	<input type="checkbox"/>
Leaf on	
<input type="checkbox"/>	<input type="checkbox"/>
Snow cover absent	
<input type="checkbox"/>	<input type="checkbox"/>
Snow cover present	
<input type="checkbox"/>	<input type="checkbox"/>
Flooding absent	
<input type="checkbox"/>	<input type="checkbox"/>
Flooding present	
<input type="checkbox"/>	<input type="checkbox"/>
Cloud and cloud shadow mostly absent	
<input type="checkbox"/>	<input type="checkbox"/>
Smoke / haze mostly absent	
<input type="checkbox"/>	<input type="checkbox"/>
High tide	
<input type="checkbox"/>	<input type="checkbox"/>
Low tide	
<input type="checkbox"/>	<input type="checkbox"/>
Don't know	

24. How is the imagery delivered? Select all that apply.

Orthoimagery	Oblique
<input type="checkbox"/>	<input type="checkbox"/>
Online / streaming	
<input type="checkbox"/>	<input type="checkbox"/>
Physical media (hard drive, USB, etc.)	
<input type="checkbox"/>	<input type="checkbox"/>
Download (ftp, secured file download)	
<input type="checkbox"/>	<input type="checkbox"/>
Don't know	

25. What type of **licensing** does the imagery have?

Orthoimagery	Oblique
<input type="checkbox"/>	<input type="checkbox"/>
Open (freely available)	
<input type="checkbox"/>	<input type="checkbox"/>
Licensed (limited sharing)	
<input type="checkbox"/>	<input type="checkbox"/>
Licensed (no sharing)	
<input type="checkbox"/>	<input type="checkbox"/>
Don't know	

26. Please describe any additional characteristics of the imagery.

# Washington state aerial imagery technology study survey

## Aerial Imagery Today - Lidar

**Many sectors of government are coordinating with the Washington DNR to acquire lidar data as part of a lidar stakeholder group.**

\* 27. Do you/your sector of government purchase lidar data either through the stakeholder group or independently? (If you answer No or Don't know they skip ahead to Q. 33)

Yes

No

Don't know

## Aerial Imagery Today - Lidar Costs & Characteristics

28. How do you purchase lidar data?

Through the lidar stakeholder group

Independently

Don't know

29. If you purchase lidar independently, how often do you acquire lidar?

30. What did you spend on your most recent acquisition of lidar (through the stakeholder group or independently)?

31. Please specify the **extent** of the lidar coverage (e.g. entire county or only urban areas)

32. What is the **quality level** of the lidar?

QL0

QL3

QL1

Don't know

QL2

## Washington state aerial imagery technology study survey

### Aerial Imagery Today - Current Uses

\* 33. How is aerial imagery used in your sector of government? Please check all that apply. (If you pick "None - do not use aerial imagery" answer the next question Q. 34, otherwise move on to Q. 35)

Water quality, quantity, and aquatic resources assessment and management

Natural resources management

Growth management and planning

Site search, suitability, and analysis for development or other uses

Permitting and permit or similar compliance

Property assessment and taxation

Transportation planning and management Public safety planning and management Emergency

management planning Emergency response activities

Scientific inquiry and research

None - do not use aerial imagery

Other Uses

### Aerial Imagery Today - Barriers Preventing Use

34. What barriers or challenges are preventing you from using aerial imagery?



# Washington state aerial imagery technology study survey

## Aerial Imagery Today - Current Uses (continued)

35. Do you use specific software systems (e.g., CAMA, dispatch software) that depend upon aerial imagery?

Desktop Mapping Tools (Esri, QGIS, etc.)

CAMA Systems

Dispatch Systems

Web-Based Applications (Esri, Carto, Nearmap, etc.) Custom

Applications (data viewers, property viewers, etc.) 511

Applications

Image Processing (ERDAS, ENVI, etc.)

Don't know

Other (please specify)

36. What type(s) of derived products do you/your government use? (derived products are data sets that are created from aerial imagery e.g. building outlines)

Planimetrics

Digital Twin

Centerline with address Land

use

Impervious surfaces Delineation

of the shoreline Topographic

data

Contours

Don't know

Other (please specify)

## Washington state aerial imagery technology study survey

### Aerial Imagery Today - Benefits & Barriers

37. Overall, how does your sector of government benefit by using imagery? For example, does it save staff time or speed up workflows?

38. Please describe any barriers or challenges you face in your current use of aerial imagery.

## Washington state aerial imagery technology study survey

### Aerial Imagery In the Future

39. What additional or improved aerial imagery product(s) would be most beneficial to your sector of government in the future?

40. What benefits could this additional or improved aerial imagery product(s) bring to your sector of government (i.e. What could you do that you cannot do now in your work?)

41. If, in the future, a state-run program could provide aerial imagery that met your needs, would you purchase it?

Yes

No

Why or why not?

## Washington state aerial imagery technology study survey

### Your Participation in the Study

42. Would you be interested in participating in a 1 hour focus group in support of this project?

Yes

No

43. Do you have other comments or thoughts about this study? Please feel free to provide them below.

Thank you for taking the time to complete this survey. You can now copy and paste your responses into the on-line survey.

Your information and thoughts will help to make the study thorough and accurate. If you would like to learn more about the study or follow its progress, please visit the [project website](#).

# Appendix E: Focus group summaries

## State of Washington Aerial Imagery Study

### **Focus Group Summaries**

Prepared by:

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12/19/2022



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# Introduction

The State of Washington Aerial Imagery Study aims to identify the business needs and technical requirements of aerial imagery users across the State’s many stakeholder groups in order to prepare a cost benefit analysis of aerial imagery, and provide recommendations on how the state could provide aerial imagery in a cost efficient manner. The study stakeholders include aerial imagery users from state and local governments, special districts and Tribal governments.

At the beginning of the study, the research team surveyed the stakeholders from many sectors of government in order to collect information about imagery costs, current and future use cases, and the perceived benefits of aerial imagery to their sector of government. In the survey, respondents were invited to volunteer to participate in focus groups. These focus group interviews provided an additional opportunity for the research team to collect detailed information and follow up on individual participant’s survey responses.

The research team identified 12 stakeholder groups to interview. These stakeholders were grouped by industry, sector of government, discipline, and departmental role. In some cases a group was split to account for differences between urban and rural sectors of government. The primary goal of each focus group was to evaluate imagery needs, current imagery benefits, imagery costs, and current and potential limitations of the aerial imagery.

The following presents the key findings and research team’s takeaways from each of the 12 focus groups.

## Focus Group #1: GIS Managers

11/2/2022, 11 – 12 pm PST

Respondents to the online survey identifying as GIS managers, coordinators, and administrators, were invited to participate in the GIS Managers focus group. The research team selected GIS Managers for one of the 12 focus groups due to their oversight and knowledge of geospatial data, their use of imagery products in their work as well as their department’s work, and because of they fill the role within their sector of government as technical experts in geospatial and imagery technologies, specifically when it comes to advising or deciding upon imagery during purchasing efforts.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
X	City of Seattle	Seattle Information Technology	Snr Civil Engineering Specialist
X	City of Vancouver	IT	GIS Manager
X	City of Kennewick	Community Planning Department	GIS Technician II
X	Pierce County		
X	City of Tacoma	Information Technology	GIS Supervisor
X	Snohomish County	Information Technology	GIS Supervisor
X	City of Burien	Information Systems Division	Information Systems Manager
X	Skagit County	Geographic Information Services	GIS Manager

Attendance	Sector of Government	Department	Title
	Pend Oreille County	ITS	GIS Manager
X	City of Camas	Information Technology	GIS Coordinator
X	Jefferson County	Central Services	GIS Coordinator/Administrator
X	Mercer Island	Information & Geographic Services Team (IGS)	GIS Coordinator
X	City of Lynnwood	IT	GIS Administrator
X	Yakima County	GIS	GIS Director

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>All participants desired regular / more current imagery capture Countywide collection with a single delivery of imagery High resolution / oblique and orthoimagery.</p> <p>Leaf off requirements varied - in general leaf off is desired but we also heard some who needed leaf on (urban forestry uses, for instance).</p> <p>Oblique imagery was generally a “nice to have” in the opinion of the participants. Some noted that their assessor might want the obliques though.</p>
<b>Current Imagery Benefits</b>	<p>Purchasing from 3rd party imagery providers allows for much more rapid imagery deliveries. Many participants in this focus group are receiving imagery updates 3 times a year from Nearmap.</p> <p>For participants who are part of larger counties, access to imagery has eliminated the need for on-site visits, removing costs due to travel time.</p>
<b>Costs</b>	<p>Cost Sharing programs within counties are beneficial and in some cases are the only way that smaller governments (cities and towns) can get the imagery that they need at an affordable price.</p> <p>For participants whose governments purchase private sector imagery, all seem to have figured out a stable funding path so that imagery doesn’t require an annual “pass the hat” approach.</p> <p>IF a state program provided imagery of comparable quality at a lower cost, most participants in this focus group stated that they would participate.</p>
<b>Current Limitations</b>	<p>The Imagery provided by the state program is typically outdated and loses its efficacy the further from the capture date.</p> <p>The state program does not always provide complete coverage of aerial imagery across the full extent of the county. This means that the state needs to run multiple flights and deliveries of data in order to collect full coverage for a single county. This means that full extent imagery is not from a single year and parts of the county are from different years.</p> <p>Imagery varies in quality and characteristics from year to year</p> <p>The image resolution (6 and 12 inch) of the state program’s imagery was not adequate to meet local govt business needs. But, we did not get unanimity on this point. Tacoma said they loved the 3” but could get by with 6”.</p>



Focus Group Topics of Discussion	Focus Group Findings Summarization
	<p>3rd party imagery providers don't always allow the public to access the imagery. If they do, it comes at an additional cost to the County.</p> <p>The majority of the participants identified the imagery parameters of flight frequency, flight completeness, leaf-on/leaf-off, image resolution, and shadow/obscured features as current limitations in the state imagery.</p>
<b>Potential Limitations</b>	Though many counties are governments that are using cost sharing programs to get the data they need, administration, coordination and management of the program poses an undue burden to those running the programs.

**Currently the statewide imagery program is supplemental for most groups. However, if the statewide program could provide the level of or the majority of imagery characteristics that governments require, the majority would participate in the program, and in some cases reduce or eliminate their purchase of 3rd party imagery.**

**Key Takeaways**

The revenue, cost savings, and support of use cases, far exceeds the initial cost of the imagery. Focus group consensus is that the value of imagery is greater than the upfront cost to purchase imagery.

A state program that can provide full extent imagery coverage to each participating government in a single flight and delivery is a requirement that many governments will need met before investing solely in the state imagery program.

## Focus Group #2: Planning

11/3/2022, 11 – 12 pm PST

Respondents to the online survey identifying as environmental, community development, forestry planners, etc. were invited to participate in the Planning focus group. The research team selected Planners for one of the 12 focus groups due to their experience leveraging imagery products in their day to day activities. Because planners support a wide range of activities including, but not limited to land management, site planning, development permitting, zoning enforcement, urban forestry, transportation, and community development, this focus group was able to provide the researchers a global understanding on how imagery is used to answer different questions, and support varying activities across sectors of government.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	City of Bellevue	Land Survey Division, Facilities and Asset Management	Land Survey Division Manager
<b>X</b>	City of Burien	Community Development	Urban Forest Planner
	City of Lacey	Community and Economic Development	Planning Manager
	City of Mount Vernon	Development Services	Director

Attendance	Sector of Government	Department	Title
	City of Oak Harbor	Development Services	Senior Planner
	City of Roy	Planning Commission	President of Roy Planning Commission
	Clark County	Community Planning Department	Director
	Island County	Public Works	Transportation Planner
X	Kitsap County	Dept of Community Development	Long Range Planner
X	Kitsap County	Department of Community Development	Senior Planner
	Thurston Regional Planning Council, GIS and Modeling Division	GIS and Modeling Division	GIS and Modeling Manager
	Washington State Dept of Ecology	Shorelands and Environmental Assistance	Regional Floodplain Planner, Northwest Region

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>Consistent imagery specifications, frequent/annual delivery of imagery products. Annual deliveries work, but multiple flights per year would be better.</p> <p>Leaf-on and leaf-off imagery in the same year, or if the same year is not feasible, Leaf-on and leaf-off delivered in alternating years to support change detection and canopy assessments.</p> <p>This group did not require the highest resolution of imagery to complete their work. All agreed that 3" imagery would be nice, but 6" is what they need to complete their work.</p> <p>Multi-spectral imagery would be nice for canopy assessments. The group discussed the use of additional spectral bands from the NAIP imagery.</p>
<b>Current Imagery Benefits</b>	<p>Imagery is very important for code enforcement - driving in wetlands, building illegally, etc. Staff issues are such a problem. Many regulations are on private property and without imagery these groups wouldn't be able to do their jobs.</p> <p>The volume of permits and the workload for staff has increased over the past 20 years. Imagery allows for the virtual assessment of properties and buildings, and limits the amount of time that staff need to spend in the field. Imagery increases productivity.</p>
<b>Costs</b>	<p>This group did not have the specifics on costs as they are not involved in the purchasing of imagery.</p> <p>Funding for future imagery acquisitions is not always in the budget.</p>
<b>Current Limitations</b>	<p>Frequency of imagery deliveries, unpredictability of imagery specifications (e.g. leaf-on vs leaf-off).</p>
<b>Potential Limitations</b>	<p>For entities participating in County programs (i.e. King County / City of Burien), the City needs to opt into the program on a bi-annual cycle. They don't always know what they are going to receive in imagery from the County. From a City budget standpoint, there is always uncertainty whether or not they will be able to purchase imagery from King County.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
	<p>This group specifically desired leaf-on and leaf-off in alternating years so that change detection, canopy assessments, etc. could be carried out.</p> <p>The desire for oblique imagery was mixed in this group. Most only required orthophotos. Oblique imagery is nice to have or not necessary to complete their work.</p>
<p><b>Key Takeaways</b></p>	<p>The availability of imagery allows staff to be more efficient and productive. The availability of imagery limits the need for on-site visits, and staff can redirect their time from travel to virtual inspection and permitting.</p> <p>Predictability and consistency of imagery is important, specifically for the time of year the flight occurs, delivery schedule, frequency, technical specifications (leaf-on, etc.), resolution, and budget.</p>

## Focus Group #3: Environment/Natural Resources

11/9/2022, 11 – 12 pm PST

Respondents to the online survey identifying as ecologists, hydrography specialists, and conservation GIS analysts, were invited to participate in the Environment/Natural Resources focus group. The research team selected Environment/Natural Resources for one of the 12 focus groups due to their significant, and sometimes differing use of aerial imagery. Unlike the previous focus groups, attendees of this focus group not only represented local governments, but large State agencies such as the Department of Ecology and Natural Resources, as well as special interest groups such as the Puget Sound Partnership. This focus group was selected because it provided additional opportunities for larger sectors of government to participate in the study and share their organizations needs and current uses of imagery.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	Washington State Department of Ecology	ITSO - GIS	WA State Hydrography Steward
X	King County	DNRP	Senior Ecologist
	Washington State Department of Fish and Wildlife	Private Lands	Private Lands Biologist
	Puget Sound Partnership	Adaptive Systems	Information Systems and Geospatial Manager
	Ecology	Padilla Bay Research Reserve in SEA Program	GIS Specialist
X	Washington State Department of Natural Resources	Washington Geological Survey	Lidar Manager
X	Columbia River Gorge Commission	Columbia River Gorge Commission	GIS Manager

Attendance	Sector of Government	Department	Title
	Island County	Island County Natural Resources	Surface Water Specialist
X	Snohomish County	Conservation and Natural Resources, Surface Water Management	Principal GIS Analyst
	Island County	DNR	Watershed planner
X	Washington State Dept of Recreation and Conservation Office	Information Technology	Chief Information Officer
X	Washington State Dept of Fish & Wildlife		

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>Imagery users need complete statewide coverage that is flown and delivered within a single one year.</p> <p>Need more imagery bands (near-infrared etc.) in their imagery products to support accurate vegetation mapping.</p> <p>Need leaf-off imagery.</p> <p>Though imagery streaming is beneficial to serve data to many users, imagery products need to be stored locally for processing.</p>
<b>Current Imagery Benefits</b>	<p>Used for compliance grant funding (recreational).</p> <p>Used to review existing infrastructure, fishing piers, water access, trails, etc.</p>
<b>Costs</b>	<p>Funding mechanisms for the capture of statewide imagery and LiDAR imagery limit coordination of capture. LiDAR (project by project is often grant funded). Imagery funds are collected and rolled over each year so that imagery can be collected in a single shot.</p> <p>An urbanized County in Puget Sound's annual budget is approx 80K so that they can fly high resolution imagery every other year for 160k</p>
<b>Current Limitations</b>	<p>Size of the imagery data set (DNR 6" resolution is 32 terabytes. Spotty coverage and gaps in statewide imagery coverage (2-3 years) pose significant challenges for analysis and storage.</p> <p>WA State still does not have a single complete statewide LiDAR coverage.</p> <p>Change detection is impacted by gaps in imagery due to full county coverage requiring multiple years for flights, processing and delivery. The difference in image temporality introduces a significant amount of work to manage the difference in image year.</p>
<b>Potential Limitations</b>	<p>Size of imagery data specially when required to be stored on local machines for processing and analysis is burdensome.</p> <p>Temporal gaps in imagery data due to multiple flights over multiple years limits use.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
<p><b>Key Takeaways</b></p>	<p>The size of the datasets are significant, and the effort and time required to process the imagery data is burdensome.</p> <p>The focus group participants are strong proponents and consumers of aerial imagery. They buy their own, participate in the state program, collect their own imagery with drones, and use imagery in all facets of their work. The more imagery they have access to the better.</p> <p>King County has their own program, but would also purchase statewide imagery to round out their resources.</p> <p>Use of existing statewide imagery is limited because it has both spatial gaps (missing areas) and temporal gaps (missing years). Statewide analysis limited by size of imagery.</p> <p>There are lots of organizations across the State that are collecting their own data for specific projects. The group was curious as to if/how that imagery could be made publicly available to others.  “Where is the link or location to all of that publicly available data?”</p> <p>There is a ton of imagery being purchased throughout the state - if we could synthesize how much imagery is being purchased it would be helpful for people to know where it is and who has it. Coordination in the future would be exciting.</p> <p>The group agreed that if the state collects imagery that meets their needs, they could revisit how they spend their imagery funding. The state imagery program is providing 6” in urban, 1ft in rural areas will work for most use cases, however, many participants have access to 3” resolution.</p>

## Focus Group #4: Infrastructure

11/9/2022, 1 – 2 pm PST

Transportation, infrastructure, asset management, utilities, and engineering are related disciplines. Due to the large number of survey respondents whose sectors of government represent those disciplines, the research team decided to divide the focus group participants into two groups, one specifically for Transportation (roads, transit, etc.), and the other for Infrastructure (assets, public works, etc). The research team invited participants from state, local, and special purpose districts to participate in the Infrastructure focus group because they could provide information on the benefits, use cases, and requirements for aerial imagery as it pertained to public works, asset management, utilities, and non-transportation infrastructure.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	Washington State of Department of Commerce	OECD	Governor's Advanced Manufacturing Sector Lead
	City of Ellensburg	Public Works and Utilities	City Engineering Services Manager
	City of Kent	Public Works	Public Works GIS Supervisor
	City of Mount Vernon	Development Services	Development Review Engineering Manager
	Lakewood Water	GIS Department	GIS Coordinator

Attendance	Sector of Government	Department	Title
X	Pullman	Public Works, Engineering	Engineering Tech
	San Juan County Public Works		County Surveyor; CGeog CP GISP RPP PLS
	Silver Lake Water & Sewer District	Technical Services	GIS Analyst
X	US Navy	Asset Management	GIS Analyst

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>Need 3" resolution for impervious surfaces and collection of data that you can't see at 6".</p> <p>Need imagery at a minimum on a three year rotation.</p> <p>Need to have our imagery hosted locally.</p> <p>Need imagery served-up via a web based GIS app behind security.</p> <p>Participants do not utilize obliques. They are pretty to view, but not required for day to day business needs.</p>
<b>Current Imagery Benefits</b>	Having accurate imagery is a revenue generating item.
<b>Costs</b>	For the small city of Pullman their 2018 3" flight w/ 1 foot contours and planimetrics cost 35K. Pullman currently has 45K budgeted for their next flight, and they want to include LiDAR collection.
<b>Current Limitations</b>	<p>Unable to use current WA State imagery at 6" to get their job done. Pullman requires 3" resolution.</p> <p>Even with leaf-off it is hard to get accurate corners of surfaces and planimetrics from existing state imagery.</p> <p>Need to do leaf-off flights due to the urban forest.</p> <p>Currently there are no coordinated imagery flights between the City of Pullman, the County, and Washington State University. If they can get the quality of data that they currently have, and there were cost savings, they would be interested, however, past coordination with the county and university have been tough. All parties need to be in agreement.</p>
<b>Potential Limitations</b>	<p>For the Navy, imagery from a statewide program would only be supportive and secondary for us, unless the imagery could guarantee 3" resolution.</p> <p>In regards to an enhanced WA State imagery program, there is a sense of skepticism of anything requiring organization between large government entities.</p>
<b>Key Takeaways</b>	<p>Past coordination efforts locally have been tough; all parties need to be in agreement. If there was a state imagery program that could provide the level of imagery product that they currently have (3") AND could eliminate the administration, coordination costs, and the efforts needed to renew on an annual basis, that go into putting together a local imagery program, there would be significant interest in switching to a statewide program.</p>

## Focus Group #5: Transportation

11/10/2022, 9:00 – 10:00 am PST

Because of organization-wide reliance on aerial imagery to collect data, plan and design transportation projects, and monitor and manage transportation assets at State Departments of Transportation, the Washington Department of Transportation (WSDOT) is a significant user of Washington State aerial imagery, and a key stakeholder in the aerial imagery study. Due to the volume of respondents representing multiple departments within the WSDOT, as well as transportation practitioners at the local level, the research team selected Transportation for one of the 12 focus groups.

## Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	Chelan County	Public Works	GIS & Road Log Manager
X	City of Tumwater	Transportation and Engineering	GIS Program Coordinator
X	Washington State Dept of Transportation	WSDOT, Development Division, GeoMetrix Office	Computer Aided Engineering (CAE) Support Manager
	Washington State Dept of Transportation	Project Development and Design	Transportation Engineer 4 - Design Trainer
X	Washington State Dept of Transportation	Information Technology Division	GIS Database Administrator
	Washington State Dept of Transportation	Development Division\GeoMetrix\Survey and Mapping	GeoMetrix Survey and Mapping Manager
X	Washington State Dept of Transportation	Headquarters Design	Asset Data Manager

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>WSDOT has imagery needs that vary in specifications by department and by project. 3" to 6" imagery is typically what they need to complete their projects, and collect their roadway data. In some cases the DOT has access to 2" imagery, but only for small project extents.</p> <p>DOT staff in the NW need custom frequent flights for traffic management. Traffic change detection. Could not wait for Hexagon. All other departments and regions have been happy with the state imagery program.</p> <p>Engineers need the ability to interact with the data locally. Streaming data is not an option.</p> <p>Need imagery to be provided more than once a year.</p> <p>3" Imagery is a core requirement for all participants.</p>
<b>Current Imagery Benefits</b>	<p>3" resolution imagery allows for Tumwater staff to work remotely, being more productive by eliminating travel costs. Additionally, access to imagery eliminates roadway safety concerns as staff do not need to work in the roadway to collect the location of their assets. They can do this offsite with the imagery.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Costs</b>	<p>For smaller sectors of government like the City of Tumwater, budget is always an issue. It is their biggest barrier.</p> <p>The City of Tumwater spends \$5000 a year on their Nearmap imagery program (orthos and obliques). However it costs too much to purchase licenses that will allow the imagery to be available to the public.</p> <p>Tumwater was previously paying \$2500 a year to participate in the state imagery program.</p>
<b>Current Limitations</b>	<p>For smaller sectors of government on the state program - the 6", leaf-on, shadowed imagery wasn't meeting their needs, the update cycle was also a challenge. With huge amounts of growth within urban areas, Tumwater requires more recent data so that work can be completed in a timely and efficient manner.</p>
<b>Potential Limitations</b>	<p>Tumwater needs flights every 5 years to support leaf-on imagery collection for urban canopy. Currently the Nearmap product does not offer that, but will do the urban canopy analysis for a fee. They want to process the urban canopy data in house to remove potential for analytical discrepancies.</p> <p>Tumwater currently does not have a relationship with Thurston County. They are not currently using the county's Pictometry. Coordination and cost are the barriers to cooperation with the county.</p>

**This focus group provided a great example of the dichotomy between sectors of government that have the resources that allow them to acquire whatever imagery products they need to complete their work, compared to smaller entities that need to be more selective with the limited budgets that they have.**

**All focus group attendees agreed that 3" imagery would be ideal with more frequent collection or annual collection with leaf off and shadows removed.**

**Key Takeaways**

**For WSDOT, before the state program the DOT was maintaining a department of resources, paying for storage costs, processing costs, and an internal flight. Switching to the state program made sense from a cost perspective. WSDOT costs were happening on a project by project basis, and it is less expensive to do a larger collect.**

**Smaller sectors of government struggle to afford the imagery products that they require. In order to get the most important specifications of imagery that they need (resolution), they are prepared to sacrifice other imagery specifications (locally hosted data, accuracy).**

## Focus Group #6: Public Safety

11/15/2022, 1:00 – 2:00 pm PST

Respondents to the online survey identifying as GIS analysts, coordinators, and administrators for emergency management, PSAP, and 911 organizations, were invited to participate in the Public Safety focus group. The research team selected Public Safety for one of the 12 focus groups due to their use and reliance on geospatial data and aerial imagery to manage and build County and Statewide emergency response applications, and databases. With GIS being a significant use case for NG911 systems, the public safety focus group provided an opportunity to understand how aerial imagery in Washington State is consumed to support 911 applications.



## Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	Whatcom County	Whatcom County 911 PSAP	GIS Systems Analyst
X	Grant County	Multi Agency Communications Center (MACC 911)	Technical Services Manager
X	Grant County	Multi Agency Communications Center (MACC 911)	
X	Regional Consolidated 911 Emergency Communications Center	South Sound 911 - Technical Services	GIS Analyst
	Washington Military Department	Emergency Management Division	911 GIS Coordinator
X	Washington State Department of Health	Data and Systems Modernization office in Office of Innovation and Technology	GIS Data Analyst

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	Interested in knowing about available Imagery options. Currently use WA State Imagery and available ESRI Imagery. Need the best imagery available to study algae blooms. PSAPs in rural areas need to be able to follow goat trails, see existing fire hydrants or other smaller geographical details with the imagery they currently have.
<b>Current Imagery Benefits</b>	Using imagery as a visual reference for maps. Used by stormwater teams for verification prior to heading into the field. WA State Imagery is used by PSAPs for address point placement and updating building info within CAD 911 systems. PSAPs are able to work with the County in order to make sure the centerline and address points are consistent between both organizations. PSAPs also use Google Street Map for address verification. Obliques and street views are used to confirm sea level data.
<b>Costs</b>	WA State Military Dept. Military provides WA State Program imagery free of cost to all PSAPs (Public Safety Answering Point). County imagery access is limited unless 911 is willing to pay for it. Drone imagery acquisition costs - \$1,500 for drone, \$500 annual software subscription, plus labor allows for one development to be captured per month.
<b>Current Limitations</b>	Imagery is not directly loaded into CAD Systems due to size and its effects on CAD System performance. Imagery viewed on a separate monitor from the CAD system monitor. The state imagery program has no tiled imagery service available which is detrimental to the use of the imagery. Having obliques would be good, but often they cannot be integrated into most CAD systems. WA State's imagery resolution is not consistent across their service area. Need better image resolution than currently available. PSAPs cannot follow goat trails, see existing fire hydrants or other smaller geographical details with the imagery they currently have. Google often does not accept their street and address changes.

Focus Group Topics of Discussion	Focus Group Findings Summarization
	Drone Imagery is quite large and time consuming to integrate into GIS. Rural PSAPs have very outdated CAD systems. 911 PSAPs in rural areas currently do not have the basic information and technology in order to work successfully.
<b>Potential Limitations</b>	Worried about the WA State Military Depts. continued funding of WA State program imagery provided free to all PSAPs

**Key Takeaways**

**Resolution of WA State Imagery inconsistent across service areas. Often dependent on free commercial imagery providers like Google Street View and Bing Maps.  
Drones used to acquire new imagery when no current imagery is available.  
PSAPs currently do not have the image resolution they need especially in rural areas.**

## Focus Group #7: Emergency Preparedness

11/16/2022, 9:00 – 10:00 am PST

Respondents to the online survey identifying as GIS analysts, operations managers, and administrators for public schools, emergency and resilience offices, and emergency management divisions, were invited to participate in the Emergency Preparedness focus group. The research team selected Emergency Preparedness for one of the 12 focus groups due to their use and reliance on geospatial data and aerial imagery to prepare for emergency response activities, and leverage imagery in their response to emergency and disasters.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
	Department of Health	Data and Systems Modernization office in Office of Innovation and Technology	GIS Data Analyst
	Department of Commerce	Energy Resilience & Emergency Management Office	Operations Manager
	WA MIL	PA/FMAG group within the recovery section of EMD	Closeout Manager
<b>X</b>	Seattle Public Schools 1	Capital Projects and Planning	K-12 Planner
	Department of Ecology	Water Resources - Dam Safety Office	Dam Safety Engineer
<b>X</b>	Washington Military Department	Emergency Management Division	911 GIS Coordinator

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>Rural counties are heavily dependent on the state imagery program.</p> <p>Before and after imagery is helpful when assessing damage from wildfires.</p> <p>6" or better imagery resolution is good enough.</p> <p>Index of historical imagery would be useful to compare the past to the present.</p> <p>Oblique imagery is helpful especially when determining where a tree sits and on whose property it resides on. Tree management uses obliques and are currently relying on BING Maps.</p>
<b>Current Imagery Benefits</b>	<p>WA will use GIS 911 data for routing. Address points have to sit on buildings. Without the imagery they cannot accurately and completely place the addresses on the buildings. Also focused on mapping road centerlines, intersections, at grade roadways.</p>
<b>Costs</b>	<p>The State NG911 office works with WaTech and pays for a very large portion of the imagery program. The goal is to make sure imagery is available to all counties if they are working on 911 data.</p>
<b>Current Limitations</b>	<p>Some potential imagery stakeholders are not aware of the state imagery program, or programs within their county.</p>
<b>Potential Limitations</b>	<p>In rural and forested areas, imagery allows for people to map roadways especially when they don't receive roadway data from timber companies. In some cases companies will share data or sell it or not share it at all.</p>
<b>Key Takeaways</b>	<p>Desire for training and communication for people to know how best to use imagery and be aware of other resources.</p>

## Focus Group #8: Western Assessors

11/17/2022, 10:00 – 11:00 am PST

Assessors from Washington's 39 counties, represent a significant stakeholder group in the Aerial Imagery Study. Not only do Assessors rely on aerial imagery to review properties, assess structures, and provide their counties a consistent revenue stream, but they are the stakeholder group that identified the need for, and worked with the state legislature to establish the Aerial Imagery Study. The assessing stakeholder group embodies the dynamics between urban vs. rural, and populated vs. unpopulated. In order to understand the needs of county assessors that require significant aerial imagery resources, because of their population size and the financial ability to acquire that aerial imagery, the research team selected Western Assessors for one of the 12 focus groups.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
X	Thurston County	IT - GeoData Center	GIS Analyst

Attendance	Sector of Government	Department	Title
X	Clark County	Assessing	Assessor
X	Grays Harbor County	Assessing	Assessor
X	Thurston County	Assessing	Assessor
	Skamania County	Assessing	Assessor
	San Juan County	Assessing	Assessor
	State of Washington	Revenue	GIS Architect & Lead

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>State imagery doesn't meet County's property assessment needs so they currently use NearMap obliques.</p> <p>Need to have visual angle imagery in order to assess homes and structures.</p> <p>Need to have the ability to make accurate measurements of the sides of buildings.</p> <p>Imagery access was also needed to do property assessment in rural areas.</p> <p>Need to meet IOO Standards – which allows you to have an oblique and street photo to replace actual physical onsite inspection.</p> <p>From an assessment standpoint need 1 flight or 2 flights per year; 3" ortho, 6" oblique.</p> <p>Change finder every 5 years – Assessors do (property) inspections every 6 years.</p> <p>Spatial accuracy is huge.</p> <p>Need to provide some available software for counties and entities that don't have any GIS capabilities (like EagleView solution) to take advantage of new imagery (if it becomes available).</p> <p>Need alternate leaf-on and leaf-off every other flight.</p> <p>Need 3 flight cycles - intervening flights is really critical in the urban areas.</p> <p>Counties that are both Urban and Rural switch up resolution based on where they are 3" vs. 6". They are also not concerned about national forests within the County boundary.</p>
<b>Current Imagery Benefits</b>	<p>Additional Assessor staff is not in the budget - so imagery provides a cost effective solution to get property assessment jobs done.</p> <p>High resolution imagery eliminates a portion of physical inspections.</p> <p>IAAO standard for physical inspection and alternate inspection; part of the recent WA State legislation - different from physical inspection.</p> <p>If you have a clear oblique and imagery and if you don't find any incidents of structures that are not in your diagram then you are able to complete your inspection via imagery. This is a huge time savings. Look at section 3.3.5 for alternative inspections <a href="https://www.iaao.org/media/standards/StandardOnMassAppraisal.pdf">https://www.iaao.org/media/standards/StandardOnMassAppraisal.pdf</a></p>
<b>Costs</b>	<p>Imagery purchasing through the state would be more cost effective.</p> <p>6" imagery from NearMap costs \$45,000 per year.</p> <p>In 2015 (highly urbanized?) counties they're spending 3 million dollars on imagery acquisition.</p> <p>Flights every 2 years. 70K (annually).</p> <p>Snohomish -150K, Thurston, 127K. In the I-5 assessing group all counties have supplemental imagery.</p> <p>Pricing is correct but it is 128K only every other year.</p> <p>64K a year to 205K a year in two equal payments so 102K a year - winter only leaf-off ortho photo, change detection, plus 100 seats Eagleview connect.</p>
<b>Current Limitations</b>	<p>Adding more staff is not an option. Too much development and too much property assessment work.</p> <p>Gated communities - have to set appointments - wreaks havoc with schedules.</p> <p>Very inefficient - some people do not allow you to get on their property.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
Potential Limitations	<p>Properties that have unpermitted changes - this is a political issue.            There are unintended costs for some of these things e.g. hardware - if you are using it internally. Services are slow and you can't put imagery into the products you want it in. Smaller counties might not have the infrastructure or the budgets to get the infrastructure.</p>
Key Takeaways	<p><b>Counties are not getting all county imagery acquisition costs - maybe they could do a public records request.</b>  <b>Counties need a complete set of data (all the costs) so that there are no holes. Spokane, Yakima, Benton, I-5 corridor. They need to press the Assessors to get the imagery cost information they need - they need to get to the right person.</b>  <b>Acquisition of high resolution oblique imagery occurs every two years - but could be augmented by WA State Imagery Program in off years.</b>  <b>Geospatial accuracy is still an issue - Hexagon has leeway up to 30' - Parcels don't line up with the imagery.</b>  <b>When the imagery is off from the parcel it makes it more challenging to determine if someone has actually built on the wrong property line, or if it is just an issue with the data.</b>  <b>Stability in a statewide program is key.</b>  <b>Street view was not part of the study in the actual legislation. It's important to add that in - it is an imagery product. State agencies might be interested too. Could there be a partnership?</b>  <b>Eagleview Licensing: Counties can cost share to other agencies (they can't sell to the state) – Counties can share cost on a per tile price and can sell to the cities. This is accepted by Eagleview.</b></p>

## Focus Group #9: Eastern Assessors

11/18/2022, 9:00 – 10:00 am PST

Assessors from Washington's 39 counties, represent a significant stakeholder group in the Aerial Imagery Study. Not only do Assessors rely on aerial imagery to review properties, assess structures, and provide their counties a consistent revenue stream, but they are the stakeholder group that identified the need for, and worked with the state legislature to establish the Aerial Imagery Study. The assessing stakeholder group embodies the dynamics between urban vs. rural, and populated vs. unpopulated. In order to understand the needs of county assessors that require significant aerial imagery resources, but struggle due to their population size and financial capacity to acquire that aerial imagery, the research team selected Eastern Assessors for one of the 12 focus groups.

### Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
X	State Dept of Revenue	Location Services and GIS Architect	Senior Specialist
X	Franklin County	Assessing	Assessor
X	Adams County	Assessing	Assessor
X	Spokane County	Assessing	Assessor

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
Imagery Needs	<p>The 6 inch imagery for Franklin County is very important - even for rural areas. Franklin County “thought” that their contract/agreement with the WA State Imagery program allowed all cities access to the purchase of state imagery. (Note: It actually depends on whether or not the county purchased a multi user vs single user imagery license)</p> <p>Adams County (Rural) is ok with the WA State Imagery Program’s imagery refresh rate. Spokane County (which is highly urbanized) has flown imagery every other year for the last 12-15 years and the resolution of our imagery is 6” rural and 3” urban. It would be ideal to have 3” in rural areas but we “make do” with 6”.</p> <p>Franklin County currently has no requests for oblique imagery among Public Works, Planning, and Assessing within our County.</p> <p>Spokane County is dependent on obliques for assessment, and it is absolutely critical that oblique imagery works with their existing assessor software (CAMA).</p>
Current Imagery Benefits	<p>Franklin County has users who use both ESRI and QGIS desktop software so having the ability to stream imagery is beneficial for their workflows.</p> <p>The State Imagery program has been very beneficial for Adams County’s metro areas. They are ok with rural areas being refreshed every 2 years.</p> <p>They do not have an issue with Adams County getting split over imagery flights.</p>
Costs	<p>Franklin County has a small regional interagency imagery consortium with their PUD and irrigation district with whom the cost of the imagery is shared.</p> <p>Franklin County can budget annually and the prices from the state are better than what they can get from a private vendor - they save a lot of money with the state imagery program.</p> <p>Spokane County’s private sector utility, Avista, (electric &amp; gas) was a former member of our imagery consortium and paid 1/3 of our total imagery acquisition costs. Avista utilities recently asked to be dropped from the County’s imagery program. The reason they discontinued their partnership was that they needed consistent imagery coverage across their entire service area. Besides Washington State, the utility also provides services in selected areas of Idaho and Oregon.</p> <p>Adams County does not have any cost sharing of imagery with the Cities within the County.</p>
Current Limitations	<p>The Dept of Revenue can’t find much current info on the WA State’s imagery program on their OCIO website.</p> <p>Adams County (Rural) currently uses State imagery via a local hard drive. They would prefer to use the WA State Imagery program’s streaming service; however, their broadband/internet is too slow.</p>
Potential Limitations	<p>The inconsistent nature of Imagery consortium members can significantly affect future imagery funding.</p> <p>The Dept. of Revenue needs portability of imagery and assessment data in remote areas of Washington where wireless connectivity is poor.</p>

Key Takeaways	<p><b>The OCIO website regarding the statewide imagery program has out-of-date information and needs to be updated.</b></p> <p><b>This is a current topic with the WA State’s Geographic Information Technology committee.</b></p> <p><b>Franklin County does not provide 911 PSAP with imagery because that is managed by a different county.</b></p> <p><b>For Spokane County it is absolutely critical that oblique imagery works with our existing assessor software (CAMA).</b></p> <p><b>The unpredictable nature of local/regional Imagery consortium members can significantly affect future imagery funding.</b></p> <p><b>Counties need better consistency of 6” imagery across the entire state of Washington. This needs to be a priority.</b></p>
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Focus Group Topics of Discussion	Focus Group Findings Summarization
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Franklin County can budget annually and the prices from the state are better than what they can get from a private vendor - they save a lot of money with the state imagery program.

## Focus Group #10: Tribal Governments 1

11/29/2022, 9:00 – 10:00 am PST

The 29 Tribal Governments in Washington State represent a significant stakeholder group in the Aerial Imagery Study. Not only do Tribal Governments rely on aerial imagery to create and manage their own geospatial data, in many cases consuming aerial imagery through the State’s aerial imagery program, but this stakeholder group represents sectors of government that rely heavily on both ortho and oblique imagery to support their ongoing research, environmental protection, and conservation efforts specifically along Washington’s coasts, rivers and waterways, and salmon breeding areas. Due to the size of this stakeholder group, and the use cases and requirements of imagery that vary by the geographic location of the Tribal Government, the research team selected Tribal Governments for two of the 12 focus groups.

### Focus Group Invitees and Attendees (x)

Attendance	Tribal Government	Department	Title
X	Puyallup Tribe	GIS Department	Director
X	Jamestown S’Klallam Tribe	Natural Resources	GIS Specialist
X	Lower Elwha Klallam Tribe	Natural Resources / GIS / Planning	GIS Manager

### Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
Imagery Needs	<p>Lower Elwha Klallam Tribe needs imagery to manage ongoing changes to river systems.</p> <p>Additional thermal bands and spectra would be beneficial for Tribal fisheries and water resources programs.</p> <p>Getting statewide imagery at 6” resolution vs the current 1 foot in rural areas would benefit rural Tribal Governments.</p> <p>Lidar for coastlines and watersheds is expensive and would be helpful to have.</p> <p>Would like higher resolution imagery than what is currently available.</p>
Current Imagery Benefits	<p>Lower Elwha Klallam Tribe uses imagery for everything; property acquisition for environmental planning, carbon sequestering efforts, to wetland and shoreline management.</p> <p>Tribal Governments use imagery for land use planning, economic development, structure assessment, roads, casino site planning.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
	<p>Tribal Governments use imagery for burial location mapping and to locate and illustrate how burial locations were selected thousands of years ago.</p> <p>Thermal imagery collected over the rivers (unsure the collector) that Northwest Fisheries acquires is heavily used by the Tribal Governments.</p> <p>Lidar and aerial imagery is used by Tribal Governments for tree stem density, woody debris analysis and utilities mapping (hydrants, poles).</p> <p>Imagery was used by the Lower Elwha Klallam Tribe to understand the effects on the river basin after the removal of the Elwha hydroelectric dam.</p> <p>Lower Elwha Klallam Tribe has used WA State DNR's imagery archive back into the 1930's, 1950's, 1970's, to the present day to show changes to the river over time.</p>
<b>Costs</b>	<p>Lower Elwha Klallam Tribe acquires imagery any way possible; Maxar digital globe imagery available for free to tribes; also acquires WA State OCIO imagery through the Northwest Fisheries Commision.</p> <p>Puyallup Tribe worked with Pierce County (2008) to cost share in image acquisition in the past. This has been replaced with a cheaper solution through the Northwest Indian Fisheries Commission at \$1,000/year.</p> <p>The majority of Jamestown SKlaal Tribe's imagery is funded via existing and new grant programs.</p>
<b>Current Limitations</b>	<p>Free imagery's resolution is often not very good. There is no control over the timing of the imagery acquisition; in a perfect world it would be monthly.</p> <p>It is time consuming for the Puyallup Tribe to process imagery for use within its web maps. Northwest Indian Fisheries Commission sends the tribe 7 TB of imagery.</p>
<b>Potential Limitations</b>	<p>Ability of Tribal Governments to process large amounts of imagery data is limited. Tribal Governments ability to use imagery streaming services varies by Tribal Government.</p>

**Tribal Governments need 1 foot resolution that covers the entire state, the Olympic peninsula, and all headwaters.**  
**Counties do not collaborate or inform the Tribes of upcoming imagery flights. The Tribes have had similar experiences with WSDOT when they are capturing imagery of roads within the tribal borders.**  
**Puyallup Tribe does not currently have a major use for oblique imagery.**

**Jamestown S'Klallam Tribe uses the Dept. of Ecology oblique imagery apps to look at coastlines.**

**Key Takeaways**

**Imagery based Web maps would mostly be for Tribal Governments not so much the general Washington public.**

**Tribal Governments would benefit from streaming imagery services that provide access to imagery data to remove the need for Tribal Governments to publish and store imagery.**

**Many Tribal Governments have existing drone programs for project specific imagery needs.**

**In regards to imagery collaboration Jamestown S'Klallam Tribe does not collaborate much with neighboring governments but they do partner with nonprofits.**

**The Jamestown S'Klallam Tribe needs would be amenable to an enhanced statewide imagery program.**



Focus Group Topics of Discussion	Focus Group Findings Summarization
	<p><b>More collaboration and communication about imagery would be beneficial to all Tribal Governments.</b></p> <p><b>There needs to be an easy way to inform and invite others to join in upcoming imagery flights.</b></p>

# Focus Group #11: Tribal Governments 2

11/30/2022, 2:00 – 3:00 pm PST

The 29 Tribal Governments in Washington State represent a significant stakeholder group in the Aerial Imagery Study. Not only do Tribal Governments rely on aerial imagery to create and manage their own geospatial data, in many cases consuming aerial imagery through the State’s aerial imagery program, but this stakeholder group represents sectors of government that rely heavily on both ortho and oblique imagery to support their ongoing research, environmental protection, and conservation efforts specifically along Washington’s coasts, rivers and waterways, and salmon fisheries and breeding environments. Due to the size of this stakeholder group, and the use cases and requirements of imagery that vary by the geographic location of the Tribal Government, the research team selected Tribal Governments for two of the 12 focus groups.

## Focus Group Invitees and Attendees (x)

Attendance	Tribal Government	Department	Title
X	Skokomish Indian Tribe	Skokomish Department of Natural Resources	Restoration Biologist
X	Shoalwater Bay Indian Tribe	Natural Resources	Director
X	NW Indian Fisheries commission	Environmental Protection	SSHIAP Program Manager

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<p><b>Imagery Needs</b></p>	<p>Frequent imagery of the coast and salmon areas is hugely important for Tribal Governments.</p> <p>Tribal Governments have a strong need for real time imagery. Several Tribal Governments have fixed wing and chopper drone programs for imagery capture for specific projects. Some Tribal Governments also have lidar collection capabilities to meet their project needs.</p> <p>Imagery is used by Tribal Governments for documenting &amp; management of watersheds, salmon producing rivers and changes to channel geometry and forested areas.</p> <p>Shoalwater Bay Indian Tribe needs imagery to manage their very dynamic shorelines.</p> <p>Shoalwater Bay Indian Tribe owns many aquatic lands. They need imagery to see aquatic vegetation and map the presence of certain wildlife and plants especially for habitat impact assessments.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
	Shoalwater Bay Indian Tribe also need high resolution imagery to map low tide vs. high tide for the management of aquatic vegetation.
<b>Current Imagery Benefits</b>	<p>Tribal Governments are using imagery for change detection projects.</p> <p>Tribal Governments are using imagery to monitor urban sprawl and how it impacts the landscape.</p> <p>Tribal Governments are using obliques for shoreline assessments (provided to the Puget Sound Partnership). This is very important for impacts to the shoreline and salmon rivers. Obliques allow one to see under the trees.</p> <p>Leaf-on and leaf-off both have benefits especially for riparian projects.</p>
<b>Costs</b>	<p>NW Indian Fisheries Commission has a purchase agreement with WA State OCIO to acquire statewide imagery so that they can provide it to Tribal Governments. One goal of working with the NW Indian Fisheries Commission was to relieve pressure on the OCIO office.</p> <p>NW Indian Fisheries Commission's cost of imagery does not vary by Tribal Governments- 32 groups can participate.</p> <p>Skokomish Indian Tribe gets its imagery from the NW Indian Fisheries Commission.</p> <p>Shoalwater Bay Indian Tribe gets affordable imagery from NW Indian Fisheries Commission as well.</p>
<b>Current Limitations</b>	<p>GIS seems to be a fairly new thing at the Skokomish Indian Tribe.</p> <p>The lack of GIS software and knowledge is a barrier to adopting GIS and leveraging imagery.</p> <p>Pacific County is very remote and it doesn't get a lot of good imagery, and they do not get 6" imagery.</p> <p>Imagery collected along coastal locations on the Olympic peninsula often have significant cloud cover and/or fog which makes it hard to collect imagery in June, and the fall is a bad time to fly for the imagery capture based on the imagery needs of the tribe.</p> <p>Would need someone to be very focused on picking the right day to fly the area to prevent weather from impacting the imagery.</p>
<b>Potential Limitations</b>	<p>There is more potential use for imagery and GIS than what's currently being used today at the Skokomish Indian Tribe.</p> <p>It is a challenge to collect good imagery on the Olympic peninsula which is often obscured by significant cloud cover and/or fog.</p>

**Availability of affordable imagery from NW Indian Fisheries Commission is a great benefit to Tribal Governments.**

**Tribal Government's erosion programs are highly reliant on imagery to monitor coastal shorelines.**

**40% of shoreline structures in King County were not permitted and imagery is key to finding and documenting those structures.**

**"You cannot put a price tag on the value of salmon to Tribal Governments".**

**Commerce should have reports on the economic benefits to the State of Washington and the Tribal Governments.**

**It is a challenge to collect good imagery on the Olympic peninsula which is often obscured by significant cloud cover and/or fog.**

**Key Takeaways**

## Focus Group #12: WaTech Imagery Program

12/9/2022, 12:00 – 1:00 pm PST

Coordinating with imagery resellers, and managing and supporting a partnership of over 50 sectors of government who participate in the state imagery program, including the Department of Natural Resources, Northwest Indian Fisheries Commission, the State 911 office, and others, the State GIS Coordinator at WaTech administers and oversees the statewide imagery program. In order to understand the current state of the imagery program, the contract terms and conditions, and the administrative requirements and costs of the imagery program, the research team selected the WaTech Imagery Program for one of the 12 focus groups.

## Focus Group Invitees and Attendees (x)

Attendance	Sector of Government	Department	Title
X	WaTech	OCIO/ Strategy & Management	State GIS Coordinator

## Focus Group Summary and Key Takeaways

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Imagery Needs</b>	<p>The Hexagon imagery acquisition contract is a 3 year term with fixed prices, with an option for 4 optional years. The first optional year will start in April May 2023; Ascent GIS is the reseller for Hexagon. Contract is written to allow only 1 year at a time renewals. 2 year SLAs with partners coincide with state partners (state budget timing).</p> <p>Stereo pairs are an important driver for Hexagon (not all vendors can do this). DNR Forestry uses these for digital surface models.</p>
<b>Current Imagery Benefits</b>	No limit on users. License allows for direct access to imagery for contractors on a per-project short-term basis. Can make print products. Can put on web applications, but cannot distribute digital pixels.
<b>Costs</b>	<p>It takes roughly 2 weeks of time to administer the program (full-time, but the work is not full-time).</p> <p>Hexagon imagery per year = \$255K. in the last year of a 3 year contract. Next year will be \$300k (first year of option year).</p> <p>DNR does a lot of post-processing. A lot of the DNR processes are scripted, but it is a lot of work to prep the data for all of the partners. They do it for free right now. DNR gets digital stereo pairs out of this at a discounted rate.</p> <p>Servers in the WaTech cloud environment are where they host the data for the state agencies - probably \$30,000 per year - everytime they increase the resolution of imagery they would need to increase the size of the servers.</p>
<b>Current Limitations</b>	<p>Statewide imagery is delivered every 2 years, but consistent imagery across the whole state is lacking. Would need another 1/2 FTE to really administer the program.</p> <p>In 2023 they are not getting a new flight - just keeping what they currently have because it was too expensive and they couldnt agree to the contract terms - gaps are all that they are getting.</p> <p>Takes about a year to get updated imagery in the hands of the imagery partners. Flights, processing, and data delivery takes time.</p> <p>Currently WaTech pays full price for state imagery regardless if it is statewide or incomplete. Going forward with future contracts, if they don't receive a complete statewide imagery delivery they do not want to pay full price. This is a modification that WaTech would want to incorporate into any contract moving forward.</p>

Focus Group Topics of Discussion	Focus Group Findings Summarization
<b>Potential Limitations</b>	<p>The program is fragile because the partner funding fully funds the purchase of the subscription. So if a partner drops it jeopardizes the subscription.</p>
<b>Key Takeaways</b>	<p><b>Program funding is partner dependent. If a large partner i.e. a 10K state agency chooses to leave the program they will not have enough money to keep the program going. Financially unstable. This scenario has not come up yet, but it could happen.</b></p> <p><b>The imagery contract is with the reseller Ascent GIS. Ascent provides Hexagon imagery to the state and coordinates directly with Hexagon. The state does not plan and administer flights. WaTech has no control on timing, technical parameters (leaf on or off) outside of resolution. WaTech has limited control over the deliveries and imagery it is purchasing from Ascent.</b></p> <p><b>WaTech wants to be on a two year cycle to align with the State's 2 year budget. They would love it if the state could pay for the baseline imagery product and allow the partners to opt into additional imagery products.</b></p>

# Appendix F: State summaries and comparisons

As part of our methodology to understand the current landscape of aerial imagery programs across the country, We contacted 6 states to learn about their aerial imagery programs, documenting information about their funding sources, their base programs and technical parameters, and information about the overall cost. We researched 6 states. We selected these states based on size, population, geographic similarities, and technical and administrative aspects of their programs. Utah and Texas are similar to Washington in that they license imagery through a vendor. Oregon, Indiana, Kentucky, and Wyoming all own (purchase) imagery outright. Kentucky and Wyoming gather both orthoimagery and oblique imagery; all other states collect orthoimagery only. Oregon and Utah fund imagery through a coalition, Indiana, Kentucky and Wyoming pay for it at the state level, and Texas calculates cost based on end-user usage.

## State Table Summaries

For each state a table was created that summarizes the information collected for that state which is shown below.

State of Oregon Aerial Imagery program	
<b>Program Administration:</b> Oregon Dept of Administrative Services/Oregon Geospatial Enterprise Office and Oregon Imagery Framework Implementation (FIT)	<b>Point of Contact:</b> Brady Callahan Geospatial Lead, sUAS Coordinator, Oregon Imagery FIT Lead
Funding Sources: The Oregon Statewide Imagery Program (OSIP) is currently funded through a cooperative community based effort. The resulting partnerships lower costs, reduce duplication of effort, provide greater standardization, and make more data available to government, private, and commercial users. Funding contributions come from tribes, county government, regional and state government entities, federal agencies, and non-governmental organizations. <a href="https://www.oregon.gov/geo/Pages/imagery_participate.aspx">https://www.oregon.gov/geo/Pages/imagery_participate.aspx</a>	
State Geography: Oregon is a Pacific Northwest state with an area of 98,381 square miles, comprising 36 counties and a population of 4.2 million. Most of the state’s population is clustered around the Portland metropolitan area and along the Interstate 5/ Willamette Valley corridor. Oregon’s topography is highly varied and consists of mountainous regions, large valleys such as the Willamette and Rogue, high elevation desert plateau, dense evergreen forests as well as redwood forests along the coast. The highest point in Oregon is Mount Hood at 11,249 feet. It is a part of the Cascade Mountain Range – a volcanic range stretching from northern California into British Columbia.	
<b>Program Narrative:</b> Various stakeholders in the state have been considering a statewide program since 2000. There is a recognition that the demand for data is outpacing what can be provided by the current statewide program. Currently they are operating on a partnership model which requires a lot of work and goodwill - partners have been generally supportive since 2005, but it is not a sustainable model. There are plans to request funding for statewide imagery from the state legislature. The current program does not work for the Assessing community, and so they are also putting a proposal independently before the legislature to get funding. Ideally the GIO and the OSACA (Oregon State Association for County Assessors) would work together, but there hasn’t been much progress in that regard.	
They did contract directly with NV5 6 years ago, but that was a very expensive project. In 2022 they utilized the federal contract through NAIP to purchase imagery. The contract requires committing the funds up front which can be a challenge, but it has worked out for the time being. The imagery is bought out right, and is owned by the state - it is not a licensed product.	
The State has put together several surveys to identify the needs of the stakeholders. Currently, the 1ft NAIP imagery is what works for most stakeholders. While this does not satisfy everyone, given the current funding approach it meets the stakeholders needs.	
Data is freely available as image services and data download in standard coordinate systems.	

## State of Oregon Aerial Imagery program

Governance is volunteer based - the GIS council is a volunteer organization. The State GIO and staff are paid. The imagery program coordinator is not a paid position, but is being filled by a volunteer. The imagery program team focuses on specifications, QC, standards, while the state GIO office manages contracting and hosting.

In the future the State would like to stabilize the 1ft statewide collect and bring the Assessors back into the conversation.

### Historic Collection:

2017 (eastern OR) & 2018 (western OR) - NV5

2020 and 2022 - NAIP (Hexagon) - not a subscription; owned outright - leaf on summer collect

NV5 is using Amazon Web Services to host their data. The state has contracted with NV5 for hosting.

### Additional Note:

The State contract cost for licensed 6 inch imagery with 4-way obliques is \$225/mile. A couple of State agencies that buy-in to the oblique contract to just view off-the-shelf imagery and not acquire any new data.

### Base Product:

#### Technical Specifications

Collection Date	Single season - summer
Resolution	1 ft
Update Cycle	Every 2 years
Spectral Bands	Tile 4 -Band (R,G,B, NIR) Imagery
Vertical/Oblique	Vertical
Characteristics	Leaf on
Product(s)	1ft imagery and statewide point cloud/DSM
Hosted products	2 ArcGIS Web services for each of the 11 years of statewide imagery, one service is a dynamic 4-band service (provides use of the NiR band) and the other is tiled for performance. <a href="https://www.oregon.gov/geo/Pages/imagery_data.aspx">https://www.oregon.gov/geo/Pages/imagery_data.aspx</a>
Cost	\$2 million; hosting costs \$50K/year

## State of Utah Aerial Imagery program

### Program Administration:

Utah Geospatial Resource Center (UGRC)

### Point of Contact:

Matt Peters, Director of the UGRC

### Funding Sources:

A coalition of state, regional, and local government agencies

### State Geography:

Utah is a mountain west state of 84,899 square miles, comprises 29 counties and has a population of 3.2 million residents. The northern and north eastern 1/3 of the state is dominated by the rugged Wasatch Range and Uinta Mountains and the Great Salt Lake. This is also where the most populous parts of the state are with cities like Brigham and Salt Lake City. Western Utah is mostly arid desert with a basin and range topography. The southern and southeastern parts of the state make up the Colorado plateau carved out by the Colorado river and are dominated by national parks, monuments, reservations, and a large mining industry.

### Program Narrative:

From the UGRC website:

At the beginning of 2015, a coalition of state, regional, and local government agencies purchased a license to Google's state-wide, high-resolution (6-inch pixels) aerial photography. Google regularly updated the urban areas over the next few years, but some rural areas of the state were left with years-old imagery.

## State of Utah Aerial Imagery program

Google announced in 2019 that they would no longer be offering their program, so the state switched to Hexagon Geospatial and their high-resolution imagery. The first delivery included state-wide 30cm (~12-inch) coverage flown in 2018 (a higher resolution version of the 2018 NAIP) and 15cm (~6-inch) coverage of the Wasatch Front, Logan, and St. George flown in November 2019. The 2021 delivery will provide 15cm coverage of the entire state.

The Utah Geospatial Resource Center provides access to the licensed imagery free of cost to Utah's cities, counties, special districts, state agencies, school districts, colleges/universities, and tribes to use the imagery in web and desktop mapping applications either from our streaming web service or from locally-stored files. The imagery is hosted on the Google Cloud Platform and delivered as WMS and WMTS Open Geospatial Consortium (OGC) services via UGRC's [Discover](#) (GIZA) basemap and imagery server. Qualified users can sign up to receive access to the imagery.

From Discussion with Matt Peters:

Geospatial data fund - \$250,000 earmarked to purchase imagery. Requested various agencies for the cost of the imagery

Their initial Hexagon contract was for \$296k; They had \$250k from the legislature (Geospatial Data Fund earmarked to purchase imagery); requested \$40k from UDOT, and others from the coalition were requested to contribute in range of \$2k. 911 was an initial heavy user of imagery and contributed early on but has not been a big contributor lately. Going forward Hexagon will cost more - approximately \$340K/year. Additional costs of about \$53K are for Google Cloud storage, maintenance, and delivery system (Giza \$20K) which are covered by UGRC.

This is very affordable for the state but they do not have much control since they are the secondary buyers of the imagery. In contrast, according to Matt North Carolina pays \$3M annually for 50% of the state (they fly every other year).

The current program costs about \$1M for over 3 years (about). During each 3 year period there will be at least one statewide collection flight for 15cm;

Matt said that managing a formal funding coalition would take him (or his office) a lot of time. He also agreed that if one made the imagery a pay to play program, in which government sectors have to buy in to get access, many of the benefits of a consistent imagery base would be lost "Let's not fight over the data, let's fight over the science."

### Base Product: Technical Specifications

Collection Date	Single year collection
Resolution	6"
Positional Accuracy	48 inches at 95% confidence
Update Cycle	3 years
Spectral Bands	Tile 4 -Band (R,G,B, NIR) Imagery
Vertical/Oblique	Vertical
Characteristics	no clouds, cloud shadows, or other ground obscuring conditions covering more than 5% of any image. Snow/ice cover less than 3% per 5 km by 5 km block, and less than 5% per km <sup>2</sup> image. Any detail obscured must not be of high significance, e.g. any urban area and housing or roads in rural areas. In mountainous areas this may be relaxed to 10% obscured per 5 km by 5 km block, provided only small amounts of ground detail are affected.
Product(s)	GeoTIFF
Cost	\$1,000,000 over a three year contract. ~\$300,000 annually.

State of Texas Aerial Imagery program	
<b>Program Administration:</b> Texas Natural Resources Information System (TNRIS)	<b>Point of Contact:</b> Gayla Mullins, StratMap Program Manager
<b>Funding Sources:</b> Costs for the Service are distributed across state, regional, and local government. State agency cost is based on the amount of data usage in 'levels'. Regional and local agencies pay a flat rate.	
<b>State Geography:</b> Texas is a large and diverse state covering 268,596 square miles (695,662 km <sup>2</sup> ), with more than 30 million residents in 2022. It can generally be divided into 5 regions - in order from southeast to west, Gulf Coastal Plains, Interior Lowlands, Great Plains, and Basin and Range Province. The Gulf Coastal Plains region with thick piney woods wraps around the Gulf of Mexico on the southeast section of the state. The Interior Lowlands region consists of gently rolling to hilly forested land and is part of a larger pine-hardwood forest. The Great Plains are dominated by prairie and steppe and the Basin and Range is the largest and most varied including Sand Hills, the Stockton Plateau, desert valleys, wooded mountain slopes and desert grasslands. It has 15 major rivers and 5 cities that have a population close to or over a million with Houston at the top.	
<b>Program Narrative:</b> The goal of the Texas Imagery Service is to serve orthoimagery at full statewide coverage every other year. Flights of 15 urban areas were purchased in "off" years to consistently provide current imagery in densely populated areas.  AppGeo helped TNRIS to establish Texas' imagery-as-a-service program in 2015 when Google began licensing its 6 inch imagery content. In 2019, Google announced the phase-out of their imagery program, and AppGeo facilitated the move to Hexagon's HxGN Content Program as the successor to Google Imagery. Instrumental to Texas' ongoing success with imagery content programs was AppGeo's development of Giza, the imagery-streaming appliance that was implemented for TNRIS in 2016. 11 years of imagery can be viewed by subscribers.	
<b>Base Product:</b> <b>Technical Specifications</b>	
Collection Date	Winter-Spring of each Acquisition Year (Jan-Mar)
Resolution	6"
Positional Accuracy	48 inches at 95% confidence
Update Cycle	2 years
Spectral Bands	Tile 4 -Band (R,G,B, NIR) Imagery
Vertical/Oblique	Vertical
Characteristics	no clouds, cloud shadows, or other ground obscuring conditions covering more than 5% of any image. Snow/ice cover less than 3% per 5 km by 5 km block, and less than 5% per km <sup>2</sup> image. Any detail obscured must not be of high significance, e.g. any urban area and housing or roads in rural areas. In mountainous areas this may be relaxed to 10% obscured per 5 km by 5 km block, provided only small amounts of ground detail are affected..
Product(s)	GeoTIFF Consuming WMTS/WMS streams coming from Hexagon
Cost	Total agreement - \$5,818,209.54 (Four-year Statewide Program for the State of Texas - payable over four years.)



**State of Indiana Aerial Imagery program**

<b>Program Administrator:</b> Indiana Geographic Information Office	<b>Point of Contact:</b> Shaun Scholer, GIS Program Director
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**Funding Sources:**  
The project is singly owned and solely funded (legislated funding) by the Indiana Geographic Information Office in the Indiana Office of Technology, though the data is shared across all agencies, and with the public. Counties/Cities have the opportunity to purchase additional imagery through a buy-up program. For the buy-up program, the State will pay for a portion of the cost, equivalent to the per mile cost of the base imagery. The Counties/Cities will pay the difference.

**State Geography:**  
Indiana is a midwestern state of 36,000 square miles, comprises 92 counties and has a population of 6.8 million residents. The northern 2/3 of the state is flat agricultural land, with a portion of its north western boundary extending into Lake Michigan. The southern 1/3 of the state consists of hilly terrain and dense forests. Indiana has several large population centers and cities scattered across the State, most notably Indianapolis in central Indiana, Fort Wayne in northeast Indiana and Evansville in southwestern Indiana.

**Program Narrative:**  
Beginning in FY21 and running through FY24 with the option for 4 additional years, the State of Indiana Geographic Information Office (GIO) contracted the Sanborn Mapping Company (Vendor) to acquire custom statewide aerial imagery. The program aims to fly 1/3 of the state in a single year on a north/south trajectory. It will take three years to collect 6" orthoimagery for the entire state. The state acquires and the cities/counties receive a base imagery product from the vendor. Counties/cities have the ability to acquire additional imagery products from the vendor at an additional cost through a buy-up program. A 4th year is provided to support this buy-up portion of the program. QC of the imagery is completed by the GIO's partner, the Indiana Department of Transportation and their Aerial Surveys Team.

**Base Product:  
Technical Specifications**

Collection Date	Spring of each Acquisition Year
Resolution	6"
Positional Accuracy	Accuracy of 2-pixels (12-inches) RMSE, 29-inches at 95% confidence
Update Cycle	4 years - 1/3 of the state flown each year, 4th year for buy-ups
Spectral Bands	Tile 4 -Band (R,G,B, NIR) Imagery
Vertical/Oblique	Vertical
Characteristics	Snow free, leaf off, no clouds, cloud shadows, or other ground obscuring conditions covering more than 5% of any image. Water bodies within natural banks.
Product(s)	GeoTIFF Uncompressed ECW & MrSID compressed County Mosaic MrSID 3-Band WMTS
Cost	\$2,000,000 total for FY21-FY24

**Buy-up Product:  
Technical Specifications**

Higher-resolution orthophotography	3-inch spatial resolution
True orthophotography	Orthorectified buildings
Airborne LiDAR	Quality Level 2 (2 pts/m <sup>2</sup> ) or Quality Level 1 (8 pts/m <sup>2</sup> )
Oblique Imagery	4 oblique views (45 degrees) + 1 vertical Vertical image is 4-band RGB/NIR Available resolutions from 2 inches to 12 inches 2- to 3-pixel accuracy Licensed product with no restrictions

State of Indiana Aerial Imagery program	
Cost	<p>Cost of 3"</p> <p>Cost dependent on pre-agreed contracts with the state. State contribution available on a per square mile basis for orthoimagery. State will contribute \$51.39 per square mile. County will cover the remaining cost.</p> <p>Independent contract arrangements directly between Sanborn and the procuring agency.</p>
<b>Buy-up Product: Derived Products</b>	
Contours	Derived from lidar or imagery-derived DEM's Created at the desired interval
Planimetric Mapping	Vector mapping of visible features
Land cover/land use/impervious surfaces mapping	Available on request
3D buildings and infrastructure modeling	Available on request
Cost	Quote dependent on scope

State of Kentucky Aerial Imagery program	
<p><b>Program Administrator:</b> Commonwealth Office of Technology, Division of Geographic Information</p>	<p><b>Point of Contact:</b> Jim Barnhart, Deputy Chief Information Officer</p>
<p><b>Funding Sources:</b> Biennial Operating Budget (\$17 million dispersed over two fiscal years FY23/Y24) Contributions totalling ~ \$4 million dollars from statewide partners for imagery buy-ups.</p>	
<p><b>State Geography:</b> Kentucky is a midwestern state of 40,408 square miles, comprises 120 counties, and has a population of 4.5 million people. The state's northern border runs along the Ohio river, while its western border is bound by the Mississippi River. The state is made up of varied terrain from high plateaus and a mountainous region in the east at the Appalachian mountains, to hilled, and valleyed terrain running west from the high plateaus. The northern and central portions of the state are home to the state's largest cities, Louisville, Lexington, Frankfort, and Richmond.</p>	
<p><b>Program Narrative:</b> Kentucky contracted with a vendor to collect statewide 3" orthophoto and 3" oblique imagery in a two year cycle. The state was divided into four geographic extents, with flights scheduled in the Fall and Spring. One of the extents will be collected in the Fall of 2022, two in the Fall and Spring of 2023, and the remaining extent in the Fall of 2024.</p>	
<b>Orthophoto Base Product: Technical Specifications</b>	
Collection Date	Fall (Nov); Spring (End of Jan-April) spanning over 2 years
Resolution	Statewide Base Resolution: 3"
Update Cycle	2 year
Spectral Bands	4-Band RGB and NIR
Vertical/Oblique	Vertical
Characteristics	Leaf-off, sun angle 30 degrees above the horizon, cloud, shadow, smoke, snow, foliage, flooding free imagery
Product(s)	Imagery Acquisition Thumbnails or photo centers 3" 4-band ortho rectified tiles in TIF format with mosaics

State of Kentucky Aerial Imagery program	
Total Cost	\$17,000,000 (\$8,500,000 each year for 2 years) includes Orthophoto and Oblique imagery
Orthophoto Base Product: Technical Specifications	
Collection Date	Fall (Nov); Spring (End of Jan-April) spanning over 2 years
Resolution	3"
Update Cycle	2 years
Spectral Bands	3-Band RGB
Vertical/Oblique	Oblique
Characteristics	To be determined by the contractor during the flight
Product(s)	Imagery Acquisition Thumbnails or photo centers 3" 3-band oblique imagery in jpeg format and storage
Total Cost	\$17,000,000 (\$8,500,000 each year for 2 years) includes Orthophoto and Oblique imagery

State of Wyoming Aerial Imagery program	
<b>Program Administrator:</b> Department of Revenue	<b>Point of Contact:</b> Brenda L. Henson Director, Wyoming Department of Revenue
<b>Funding Sources:</b> State budget	
<b>State Geography:</b> Wyoming covers 97,914 square miles. Almost all of the state is above 5000' in elevation. Major mountain ranges run north-south in the northwestern quadrant of the state, with lower ranges throughout the rest of Wyoming.	
<b>Program Narrative:</b> Wyoming Department of Revenue working with all of Wyoming's county assessors designed an aerial photography program that captures 3" oblique imagery in densely settled areas and 6" oblique imagery in sparsely settled areas. Unsettled areas are not covered by the acquisition program and orthoimagery from Microsoft Bing web services is used by the State and counties for these areas. Approximately 10% of the state is covered by imagery acquisition, collected every two years. The initial 3"/6" program is now (2023) moving to a 2"/6" collection.	
<b>Technical Specifications and Cost</b>	
Collection Date	Spring, over 2 years
Resolution	Approximately 10% of state total, mix of 3" (2" beginning in 2023) and 6"
Update Cycle	2 year
Spectral Bands	4-Band RGB
Vertical/Oblique	Vertical and oblique
Characteristics	Leaf-off, above the horizon, cloud, shadow, smoke, snow, foliage, flooding free imagery

State of Wyoming Aerial Imagery program	
Product(s)	Orthoimagery and oblique imagery served by the vendor under license and integrated with county CAMA systems. Additional derived products are available for individual purchase by counties or the State.
Total Cost	\$2,000,000 per acquisition cycle

## Statewide Aerial Imagery Programs Summary Table

The following State Summary Table summarizes the information collected in the detailed individual state summaries above.

	Oregon	Utah	Texas	Indiana	Wyoming	Kentucky
<b>Base Product</b>	12" orthos	6" orthos	6" orthos	6" orthos	2" and 6" orthos and 10% of state obliques	3" orthos and obliques
<b>Licensing</b>	State owned	Licensed from Hexagon	Licensed from Hexagon	State owned	State owned with restrictions	State owned
<b>Frequency</b>	Every 2 years	Every 3 years	Every 2 years	Every 4 years	Every 2 years	Every 2 years
<b>Distribution Details</b>	Hosted web services	WMTS/WMS streamed through GIZA	GeoTIFF WMTS/WMS streamed through GIZA	GeoTIFF Uncompressed; ECW & MrSID compressed; County Mosaic MrSID; WMTS	Orthoimagery Web based oblique viewer Integrates with CAMA	Orthorectified GeoTIFF Web based oblique viewer
<b>Base Product</b>	12" orthos	6" orthos	6" orthos	6" orthos	2" and 6" orthos and 10% of state obliques	3" orthos and obliques
<b>Annual Cost</b>	\$1,000,000	~\$300,000	\$1,450,000	\$666,666	\$1,000,000 Note: 10% of state by area	\$8,500,000
<b>Cost Breakdown</b>	\$2,000,000 over a two-year contract cycle \$50,000 annually for hosting	\$1,000,000 over a three-year contract	\$5,818,209.54 over a four-year contract period	\$2,000,000 over a three-year period (FY21-FY24). Fourth year costs on a buy-up basis	\$2,000,000 (current cycle)	\$17,000,000 over a two-year period
<b>Cost Sharing Approach</b>	50% funded through cooperative community-based effort; 50% federal	A coalition of state, regional, and local governments	Costs distributed across sectors of government based on usage	State-funded program (legislative funding)	State-funded program (legislative funding)	State-funded program (single 2-year cycle)

# Appendix G: Yakama Nation letter

(See the following pages for this appendix.)



Confederated Tribes and Bands  
of the Yakama Nation

Established by the  
Treaty of June 9, 1855

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October 20, 2022

Jeremy Walker  
Local Government Division  
Washington State Department of Commerce  
1011 Plum Street SE  
Olympia, WA 98504-2525

**Subject: WA State Aerial Imagery Study**

Dear Mr. Walker,

I recently attended a digital workshop regarding the use and need of aerial imagery by tribes and other stake holders. I wanted to memorialize the comments provided and reiterate the concerns raised in the meeting as follows. Detailed aerial imagery is a necessary tool required for best management practices in the modern world. This tool has been commoditized for profit by sponsoring agencies all while the tribes are not positioned as co-managers as they should be. To further explain, tribes are not being freely provided the information to manage lands which they have ancestral ties and/or Reserved Rights to. Aerial imagery is often purchased or acquired by funding provided by state or federal government agencies. Today modern aerial images are available in digital formats which can easily be transferred. However, selling and purchasing of aerial images between state or federal agencies amongst one another, the selling and purchasing of aerial images to and from these agencies to tribes or tribal partners, and reducing the resolution of images available are all methods used to profit from the aerial commodity. This does a disservice to the management of Yakama Nation lands. This practice is not only inefficient, it is a misuse of funds, and creates a barrier to tribes whom seek the best management practices. These ancestral lands are sacred to tribes and they must be provided the tools necessary to actively and meaningfully engage in the management of them – as they have done since time immemorial.

Sincerely,

Noah Oliver, Geographer/Archaeologist  
Yakama Nation Cultural Resource Program

cc:

Casey Barney, Yakama Nation Cultural Resource Program  
Jerry Meninick, Yakama Nation Director of Cultural Programs  
Casey Wallahee, Chairman of the Yakama Nation Cultural Committee