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City of Philadelphia Enterprise GIS and Data Collection Using AI and ML

Citywide Update of Square Footage and Sketches

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Talking Points…

- About Office of Property Assessment
- The Project
- Funding
- Project Objective
- RFP Process
- Capture Process
- Utilizing AI and Machine Learning Technology
- Our Internal Simulated Process
- Monitoring Progress and City Review Process

The Office of Property Assessment (OPA) Overview:

- OPA is responsible for discovering, listing, and valuing all real property throughout the City of Philadelphia on an annual basis, in a fair and equitable manner. Additionally, OPA formulates assessment policy, establishes assessment districts, keeps records of assessments and real property data characteristics, maintains surveys and other assessment materials, and provides public and individual notice of assessments. The office reports to the Mayor, City Council, and Board of Education on the aggregate change of assessments on an annual basis.

The Project:

- The City of Philadelphia's Office of Property Assessment (OPA) is seeking a vendor to update OPA's building square footage data using digital solutions and the City's existing geographic information system (GIS) data.
- OPA has recently implemented a Computer Assisted Mass Appraisal (CAMA) system. This implementation has been in conjunction with efforts by OPA to update certain data elements to ensure accuracy and fairness in property valuation.
- OPA is looking to verify and update its building square footage data. Some square footage entries have not been verified in recent years and often, they are missing an associated sketch. If feasible under this project, OPA is also looking to create sketches that can be imported into the CAMA system. In the past, OPA did not have a viable option to create and store property sketches. This tool is now available to us.

Project Objectives…

The Department's objectives for this project includes…

- Obtain accurate square footage data for all residential buildings.
- NOTE: OPA decided data for non-residential buildings was not necessary
- Obtain floorplan sketches for all residential buildings, if feasible within the budget.
- NOTE: Floorplan sketches for all non-residential buildings was not necessary.

The Funding:

- **The Operations Transformation Fund (OTF)** supports transformative projects in City government. These projects focus on providing efficient and equitable services to Philadelphia residents. The fund had $10 million that was distributed over two fiscal years (FY 2022 and FY 2023).
- After applying for and receiving a grant from Operations Transformation Fund (OTF) for transformative municipal projects, The Office of Property Assessment (OPA) decided to use the funding to find a new, innovative way to update square footages and sketches across the City.

Request for Proposal (RFP):

- Via an RFP, OPA sought out a vendor to verify and update building square footage information contained in the OPA's records, using the City's existing GIS data and other digital resources.
- There are approximately 580,000 parcels in Philadelphia including approximately 520,000 parcels containing a residence or commercial building.
- This request is to update the square footage data for residences buildings only.
- The request also includes the creation of sketches for these properties.
- OPA is looking for solutions using technology as much as possible, with limited (if any) manual field work.

Square Footage Capture Process…

Square Footage

- Identify the method for obtaining building square footage without physical access to the inside of the property, and ideally using primarily or entirely digital solutions.
- Identify resources needed to obtain this information. This any requests to use City data or systems. includes
- Conduct a pilot of collecting square footage and present the results to OPA.
- Obtain accurate building square footage data for all residential buildings in Philadelphia.
- Conduct internal quality control and quality review throughout the project on a periodic or iterative basis.

Sketches…

Sketches (if feasible)

- Identify the method for creating sketches without physical access to the inside of the property, and ideally using primarily or entirely digital solutions.
- Identify resources needed to obtain this information. This includes any requests to use City data or systems.
- Conduct a pilot of collecting creating sketches and present the results to OPA.
- Create sketches for each residential building in Philadelphia.
- **BONUS**: Create sketches for each non-residential building in Philadelphia.

NOTE: This presentation is not about the sketches!!

AI and Machine Learning:

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Artificial intelligence (AI) – The science of making machines that can think like humans.

Machine Learning (ML) – the capability of a machine to imitate intelligent human behavior.

- Again, for this project, The Operations Transformation Fund (OTF) was handing out funding for transformative municipal projects. We applied and was awarded funding to use AI and ML to update our square footage data and create sketches.
- **No one has lost their job because of this effort!!** Using federal funds, we are attempting to see if we can perform updates to our CAMA data without hiring boots on the ground to visit each property in the City.

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Word of Caution:

The City of Philadelphia and the Office of Property Assessment entered this project with eyes wide open and a clear understanding of the following…

- This is an innovative and transformative “experiment”.
- An experimental project to determine if we can extract and calculate square footage totals for residential building throughout the entire City using AI and ML and without boots on the ground visiting and entering every building in the City.
- The City is fully aware and prepared to perform some post delivery cleanup of the data.
- If even 60% successful, this project would save the City a tremendous amount of time, money, and effort!!

Building Sq Ft: Foundation for Property Assessment

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Accurate square footage serves as the cornerstone for property assessment, playing a pivotal role in determining the value and appraisal of real estate assets. Here's a detailed exploration of why accurate square footage is indispensable in property assessment:

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- Here's a detailed exploration of why accurate square footage is indispensable in property assessment.

  - Fair Market Value: Square footage significantly influences the fair market value of a property.
  - Assessment of Property Taxes: OPA uses square footage to ensure fair taxation, proportionate to property size and value.
  - Property Comparison: Square footage allows OPA for meaningful comparisons between similar properties in the market.

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Utilizing AI / Machine Learning Technology:

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Introduction to AI Algorithms:

- AI algorithms represent a groundbreaking advancement in how we approach the calculation of square footage. By harnessing the power of artificial intelligence, we are fundamentally transforming the traditional methods of measurement. Through sophisticated data processing and analysis, AI algorithms can interpret complex information and generate square footage measurements with unprecedented speed.

Streamlining the Process:

- We are hoping that AI technology plays a pivotal role in streamlining the square footage calculation process. **By automating various tasks and procedures, AI eliminates the need for manual intervention, significantly reducing the time and effort required for measurement.**
- While AI technology significantly reduces the occurrence of errors in the square footage calculation process, **it's important to note that human intervention remains essential for error correction.** Despite the advanced capabilities of AI algorithms, there may still be instances where manual oversight is required to identify and rectify inaccuracies.

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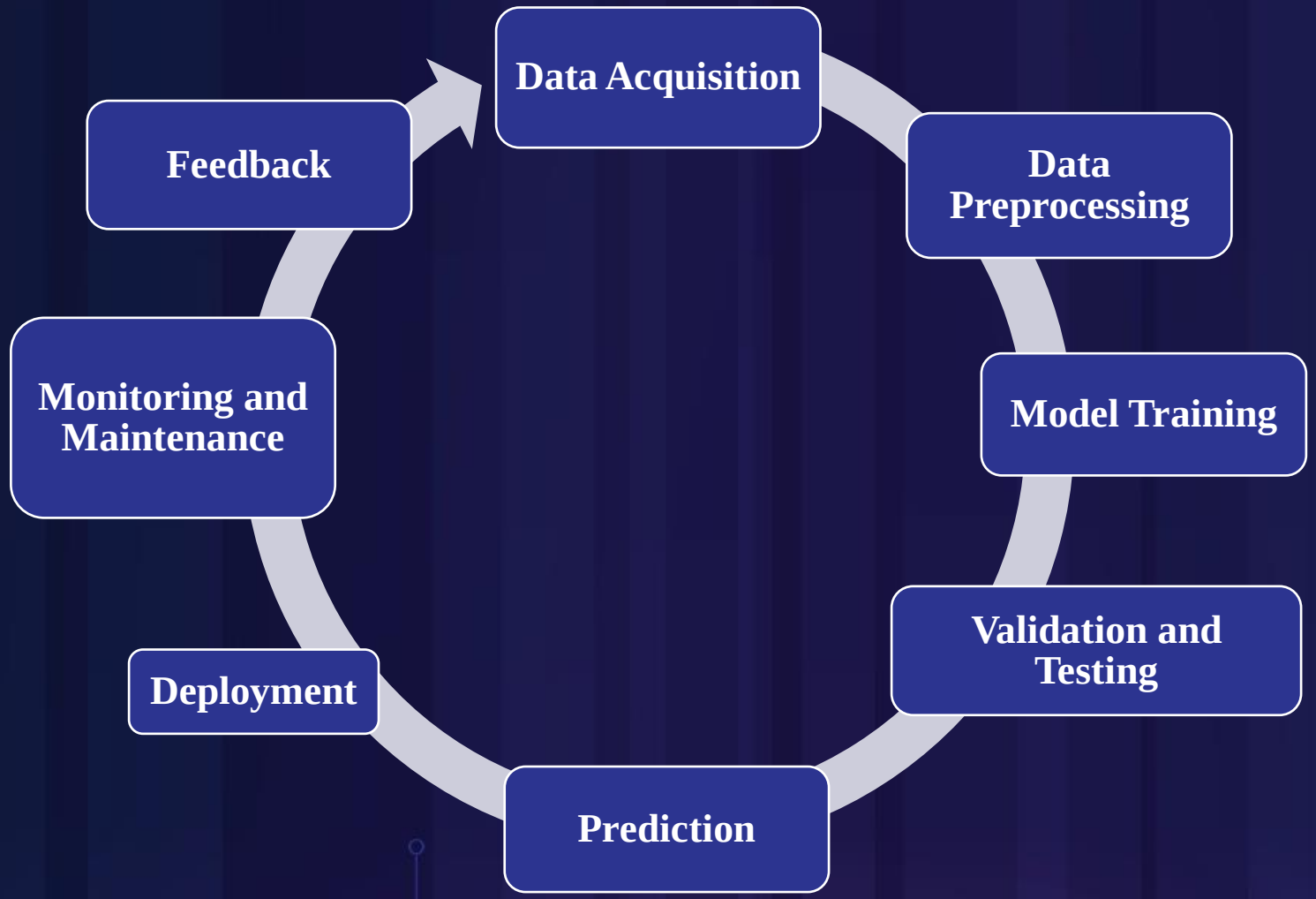
Building Footprints Model Lifecycle:



Tools Used:

- ArcGIS Pro
- Image Analyst
- Deep Learning Tools
- SAM Model
- Building Footprint Model

Data Acquisition & Preprocessing

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Aerial Imagery (2022):

High-resolution satellite imagery captures aerial views of buildings and their surroundings. This data can be used to identify building outlines and estimate their footprint on the ground.

Lidar Data (2022):

Lidar (Light Detection and Ranging) data uses laser scanning technology to create detailed 3D models of buildings and terrain. Lidar data provides accurate measurements of building heights, shapes, and volumes.

Oblique Images:

Photographs or images of buildings captured from various angles can be analyzed to identify building outlines and assess their dimensions. Image processing techniques can help extract relevant information from these visual data sources.

Geospatial Data:

Geospatial data, such as GIS (Geographic Information System) data, provides information about building locations, boundaries, and land use. This data can be used to overlay building footprints onto maps and assess their spatial relationships.

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An In-House Simulated Process

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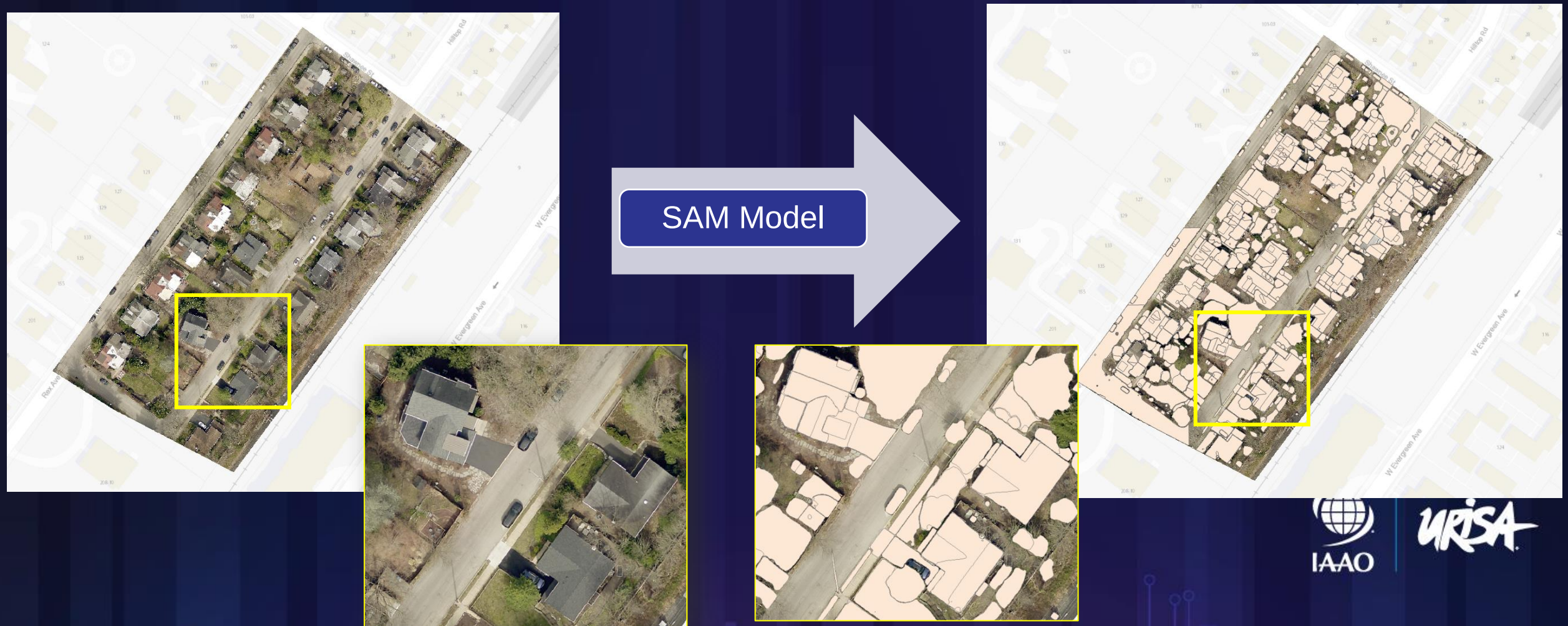
Model Training, Validation and Testing Using ArcGIS Pro

Segment Anything (SAM) is an image segmentation model developed by Meta AI. This model can identify the precise location of either specific objects in an image or every object in an image.



Training SAM to Pre-trained Building Footprint Model

Trained BLDG Sq.Ft Model

Pre-Trained Model Used: ESRI Building Footprint Extraction – USA
https://www.esri.com/en-us/arcgis/deep-learning-models

Regularizing Pre-trained Building Footprint Model

Regularizing Bldg. Footprints

Fine Tuning Pre-trained Building Footprint Model

Fixing Errors

Final Output

Common Issues After Regularizing Building Footprint Model

- Missing bldg. outline
- Bldg. outline not accurate
- Bldg. outline distorted or jagged
- Duplicate bldg. outline captured
- Should be two bldgs., only one captured (Row or Twin)
- Gap between bldgs.(Row or Twin)
- Sq Ft is too high
- Sq Ft is too low
- Sq Ft missing

Calculating Total Square Feet Using LiDAR & 3D Model

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It is important to understand how Colliers calculated the newe total square footage…

- Used 2022 Lidar
- Created a 3D model of the building
- Determined the height of the building using the 3D model
- Divided by approximately 10 feet per floor
- Now we with the number of floor or stories, they multiplied the number of stories by square footage of building footprint

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Monitoring Progress and City Review Process

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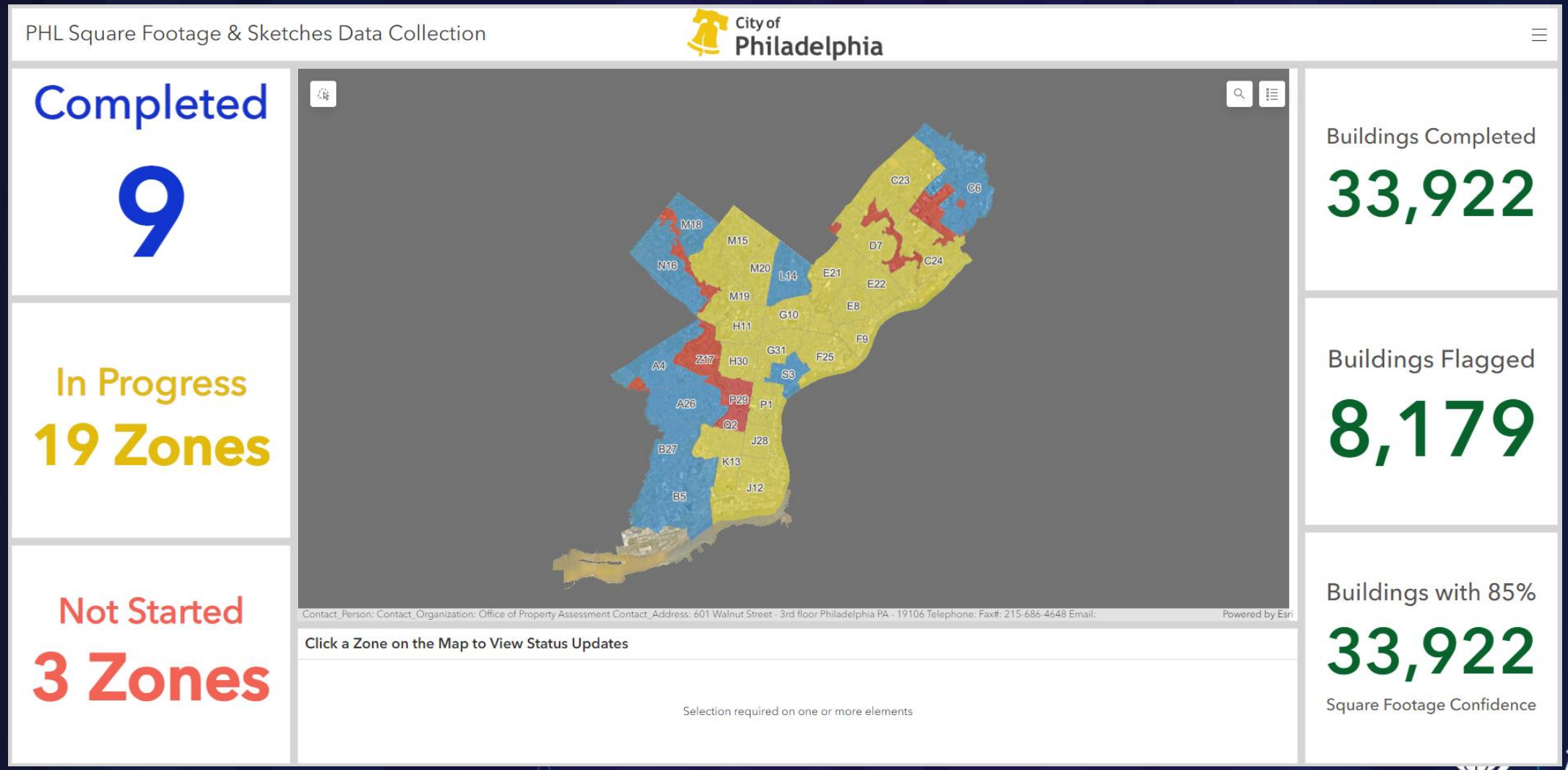
Project Dashboard:



The City requested Colliers to create a dashboard that would allow the City to monitor progress. The deliverables were broken up into 31 areas.

Review Mapping Application:

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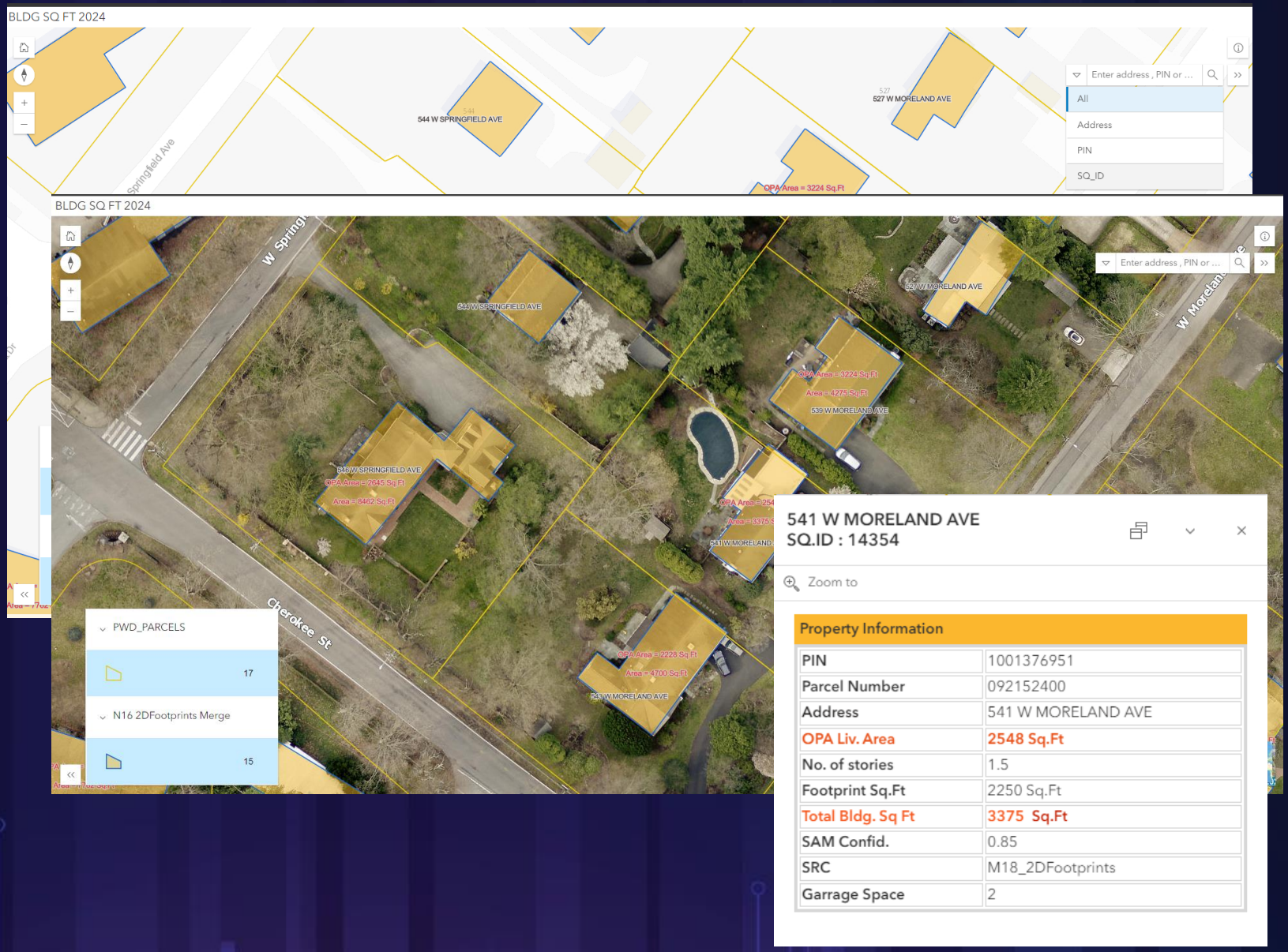
Philip created an Esri Web Application that included…

- The geospatial footprints delivered from Colliers.
- An ability to search by PIN, Address, or OPA ID.
- The ability to toggle on an off the 2022 ortho imagery.
- And click on property for more info.



Shared Review Spreadsheet:

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Philip created an internal shared spreadsheet that include all completed records delivered by Colliers.

Spreadsheet includes OPA data and delivered data, including current OPA square footage field and new square footage field calculated by Colliers.

Reviewers can enter “Issue” found, “Comments” and who reviewed the property.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Checked By	SQ.II	PAR_PIN	PARCEL_NUM	PROPERTY_ID	LOCATION	GARAGE_SP/	OPA_LIV	OPA_Flag	SAM_CONFI	NUM_STR	BLDFT_PRN	NEW ARE	DELIV_ARE/
102	Adonica	101	1001499411	92296100	7418007721	7721 SAINT MARTINS LN	2	3600	1	0.85	4	2493.7	9975	M18
103	Adonica	102	1001376927	92151605	5698000401	401 W MORELAND A								
104	Adonica	103	1001367187	92142500	5568000323	323 W MERMAID L								
105	Adonica	104	1001495480	92155710	7394000404	404 W SPRINGFIELD								
106	Adonica	105	1001367185	92142400	5568000319	319 W MERMAID L								
107	Adonica	106	1001499413	92296300	7418007737	7737 SAINT MARTINS								
108	Adonica	107	1001265960	92176600	4104000600	600 W HARTWELL L								
109	Adonica	108	1001498662	92182232	7400000618	618 SAINT ANDREW								
110	Adonica	109	1001498659	92183155	7400000613	613 SAINT ANDREW								
111	Adonica	110	1001327055	92316800	5078007620	7620 LINCOLN DR								
112	Adonica	111	1001376924	92148600	5698000322	322 W MORELAND A								
113	Adonica	112	1001376926	92151400	5698000329	329 W MORELAND A								
114	Adonica	113	1001251668	92192567	3824000715	715 W GRAVERS L								
115	Adonica	114	1001499415	92296500	7418007811	7811 SAINT MARTINS								
116	Adonica	115	1001376922	92148500	5698000318	318 W MORELAND A								

Issue	Comments
Garage or Tool Shed	Should not have been captured and should be deleted
Garage or Tool Shed	Should not have been captured and should be deleted
Number of floors incorrect	May be 3.5 stories at the most, causing Sq Ft to be too high
Number of floors incorrect	May be 2.5 stories at the most, causing Sq Ft to be too high
Number of floors incorrect	Not sure is number of stories of off or not. I think 2.5
Number of floors incorrect	Number of Stories too high. Should be 2.5
Number of floors incorrect	Should be 2 stories, 2.5 at the most.
Number of floors incorrect	Should be 3 stories at the most, likely 2.5.
Number of floors incorrect	Number of stories should be 2.
Other	Should not have been captured and should be deleted

SECOND SLIDE SHOULD FLY IN.

Conclusion

An AI/Machine Learning Experiment:

- The City did not have complete confidence in many square footage entries and there are no sketches at all.
- The City and OPA applied for and received Operations Transformation Fund (OTF) funding, so why not?
- If only 60% successful, the City will save a tremendous amount of time, effort, and money.
- From what we have seen so far, we are optimistic. There will likely be some internal post processing. We won't be able to measure the success of the project until we complete the post processing which should take 3 to 6 months.


Questions
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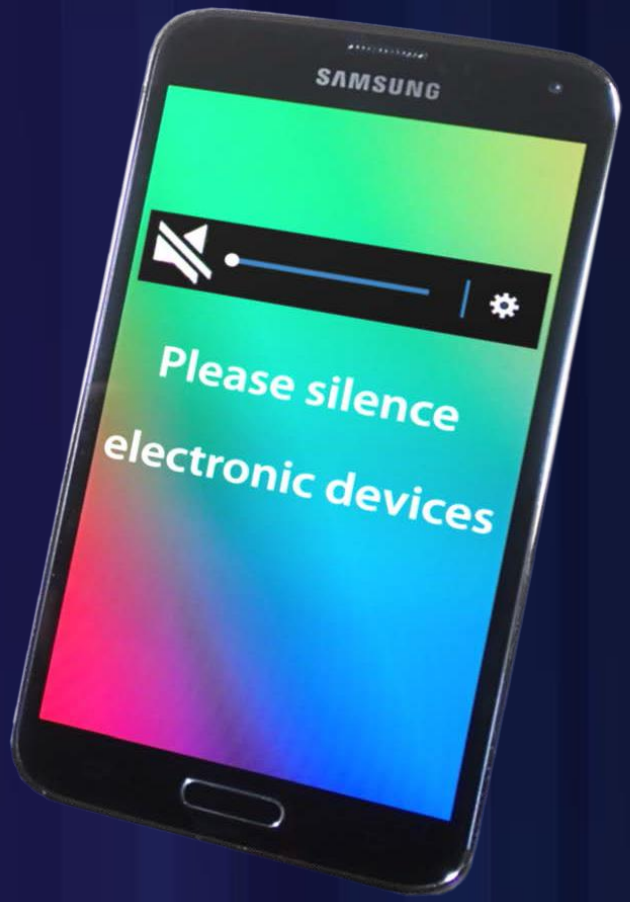
Continuing Education (CE) Credit

Recertification Credit forms for CE credit can be collected from the registration desk on Thursday



Housekeeping

- The conference proceedings will be available approximately 8 weeks after the conference
- Please silence your electronic devices
- Attendance at this conference counts toward GIS Professional (GISP) Certification and Renewal

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