Winter 2026

ArcUser

The Magazine for Esri Software Users

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Adapt and Evolve

The world of GIS has always been one of shifting ground, cutting-edge technological advancements, and constant change. But owing to factors as varied as generative AI tools and changing climate patterns, things are now moving faster than ever and show no signs of slowing. Some changes require vigilance; others mandate staying ahead of the curve by familiarizing yourself with new technologies and workflows. What they all demand is adaptation.

In the winter 2026 issue of *ArcUser*, adapting to change takes center stage. Like many cities around the world, Sydney, Australia, is enduring a pattern of ever-increasing urban heat and using GIS to better understand and react to changing temperature patterns. In New York City, rat mitigation efforts require new, geospatial ways of thinking in response to evolving information about the efficacy and safety of traditional rodenticides. The Renewable Water Resources district in South Carolina has developed an in-depth geospatial system of record to keep track of its expanding property holdings. Saudi Aramco, faced with increased desertification across the Kingdom of Saudi Arabia, is leveraging GIS capabilities to retain the last drops of water from the country's 5,000-year-old river basin.

Technology itself is also evolving rapidly. Articles in this issue cover new ways to organize data within ArcGIS Hub and ArcGIS Pro, as well as workflows to ensure that ArcGIS Field Maps apps function offline—an essential capability when working in environments of shifting connectivity. And within the ArcGIS ecosystem, developer tools are transitioning to the use of map components, a vital step in enabling you to future-proof your custom apps.

Change is constant. We can map it or try to stop it, but often what is most useful is making an effort to understand efficient and productive ways you can adapt to change. When the ground moves underfoot, you have to move with it. That nearly always means making substantial changes of your own, as in St. Johns County, Florida, where the county's GIS division has transitioned from analog solutions to a system of dashboards to track derelict vessels. Adaptation is a tough, ongoing process, but in an industry that moves as quickly as this one does, few things are more important than learning how the world is evolving, and how to evolve with it.

Ben Van Voorhis
ArcUser Editor

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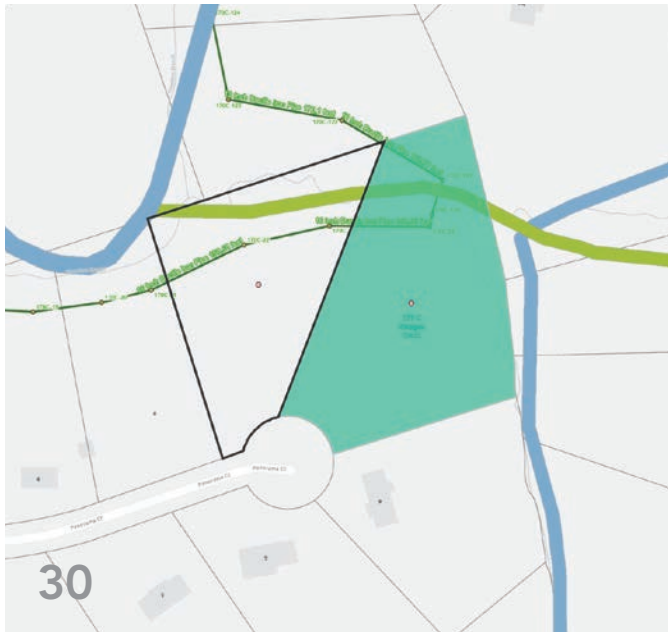

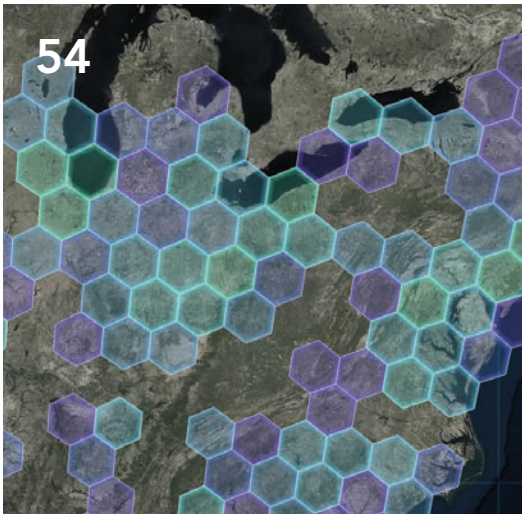

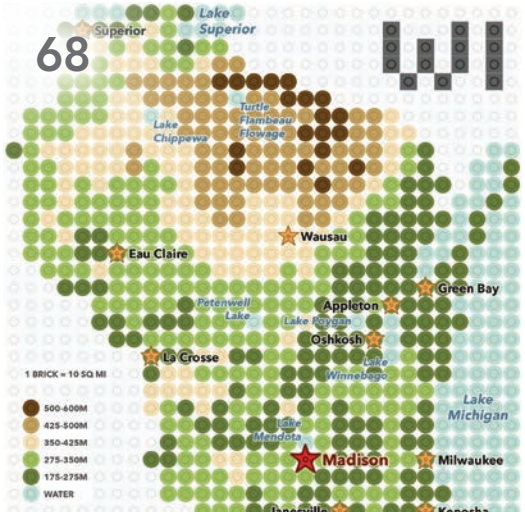

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Briefly Noted

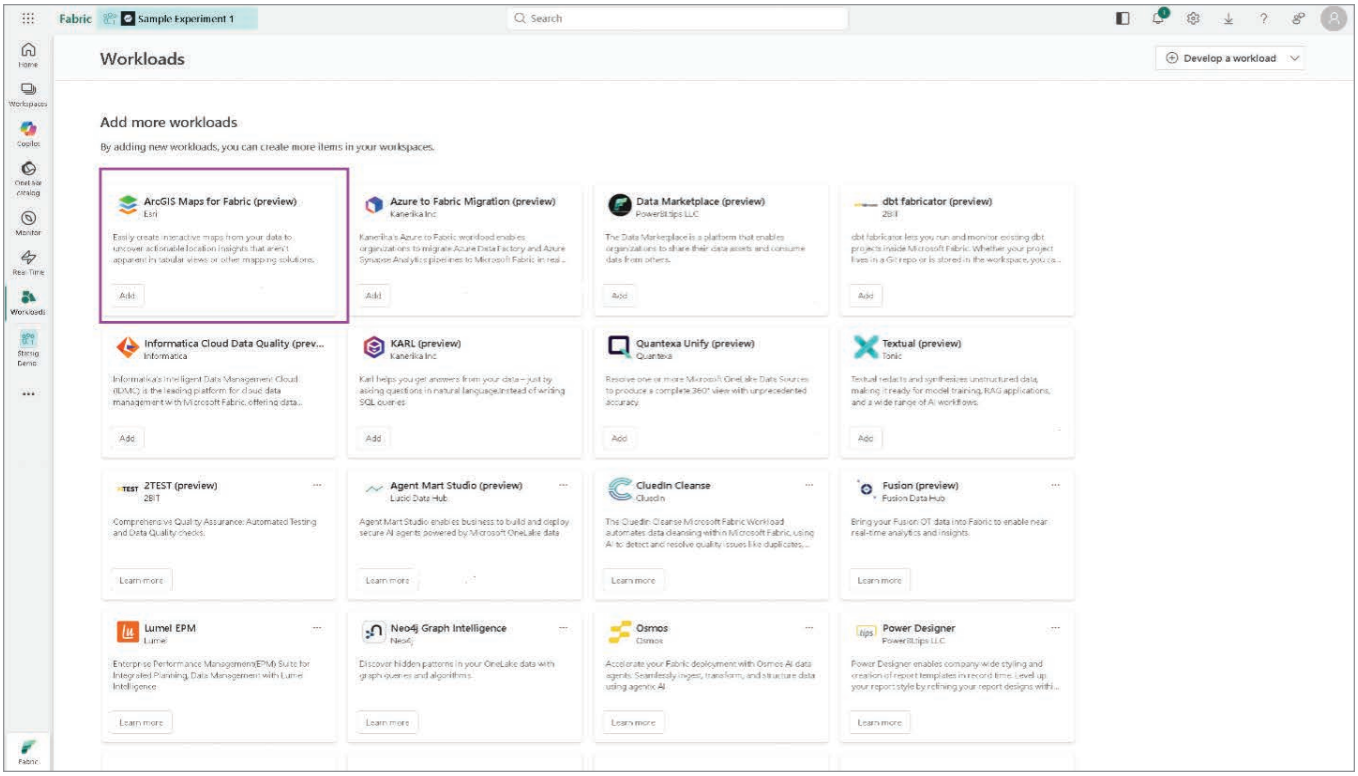
New ArcGIS Integrations for Microsoft Fabric

In response to growing demand among data scientists, data engineers, business analysts, and executive stakeholders for spatial analytics and mapping, ArcGIS for Microsoft Fabric brings together three ArcGIS integrations: ArcGIS for Power BI, ArcGIS Maps for Microsoft Fabric, and ArcGIS GeoAnalytics for Microsoft Fabric. These integrations enable users to transform, enrich, and analyze geospatial data of any size, as well as visualize, explore, and share insights through interactive maps and BI reports.

With ArcGIS GeoAnalytics for Microsoft Fabric, users can now directly access sophisticated spatial analytics tools and functions, as well as an extensive library of authoritative and curated spatial data, to discover where things are, how they relate to each other, what they mean, and which actions to pursue. ArcGIS Maps for Microsoft Fabric, currently in public preview and available via the Fabric Workload Hub, empowers organizations to create interactive and insightful maps that reveal patterns, relationships, and trends that are invisible in tables or charts.

GeoAnalytics for Fabric is now generally available for Microsoft users, alongside ArcGIS for Power BI. The integrations continue to expand, with Maps for Fabric having entered public preview and being prepared for general availability in the near future.

To learn more, visit links.esri.com/fabric.



↓ ArcGIS Maps for Microsoft Fabric, now in public preview, can be accessed through the Workload Hub in Microsoft Fabric.

New Session Usage Pricing for Basemaps

↑ The new session usage pricing model for basemaps complements the existing tile usage pricing, which customers can still choose based on their needs.

A new session usage pricing model for basemaps, available through ArcGIS Location Platform, gives developers and organizations a more predictable and cost-effective way to integrate Esri basemaps into apps and business systems by aligning pricing with user interactions like panning, zooming, and searching. This session usage model is especially valuable for high-traffic apps or those with extended user sessions, such as real estate search portals, rideshare apps, or delivery tracking systems. It complements the existing tile usage pricing, which customers can still choose based on their needs.

The new pricing model is available to both new and established users of ArcGIS Location Platform. It is designed to meet the needs of developers, CTOs, and product leads across a wide range of industries, including real estate, financial services, health care, e-commerce and retail, media, and logistics. It enables organizations to easily integrate data-powered maps into the systems they use.

To learn more about the ArcGIS Basemap Style service and explore pricing options, visit links.esri.com/basemaps.

NbE GeoPortal for Students, Teachers, and Conservationists

In a joint venture with the International Union for Conservation of Nature (IUCN), Esri is making a $10 million in-kind donation to expand access to data, maps, and GIS technology in support of Nature-based Education (NbE). The donation will help IUCN stand up the new NbE GeoPortal, which will allow students, teachers, and conservationists worldwide to explore maps, collaborate on conservation, and develop technical skills.

NbE places nature at the core of learning. By blending environmental education, Indigenous knowledge, and outdoor and experiential learning, it fosters a deep connection between humans and nature. This approach treats nature as a learning environment, cultivating systems thinking; empathy; responsibility; and the skills needed to address changing climate conditions, biodiversity loss, and planetary health across formal and informal settings. Combining GIS and NbE allows students, teachers, and conservationists to visualize the world around them using the critical context of location. This provides a holistic, geographic framework to better understand what is occurring, how it is changing, and—most importantly—where action is needed to protect and conserve nature.

Seamlessly Swap Data Sources in ArcGIS Dashboards

By Shakthi Bharathi Murugesan

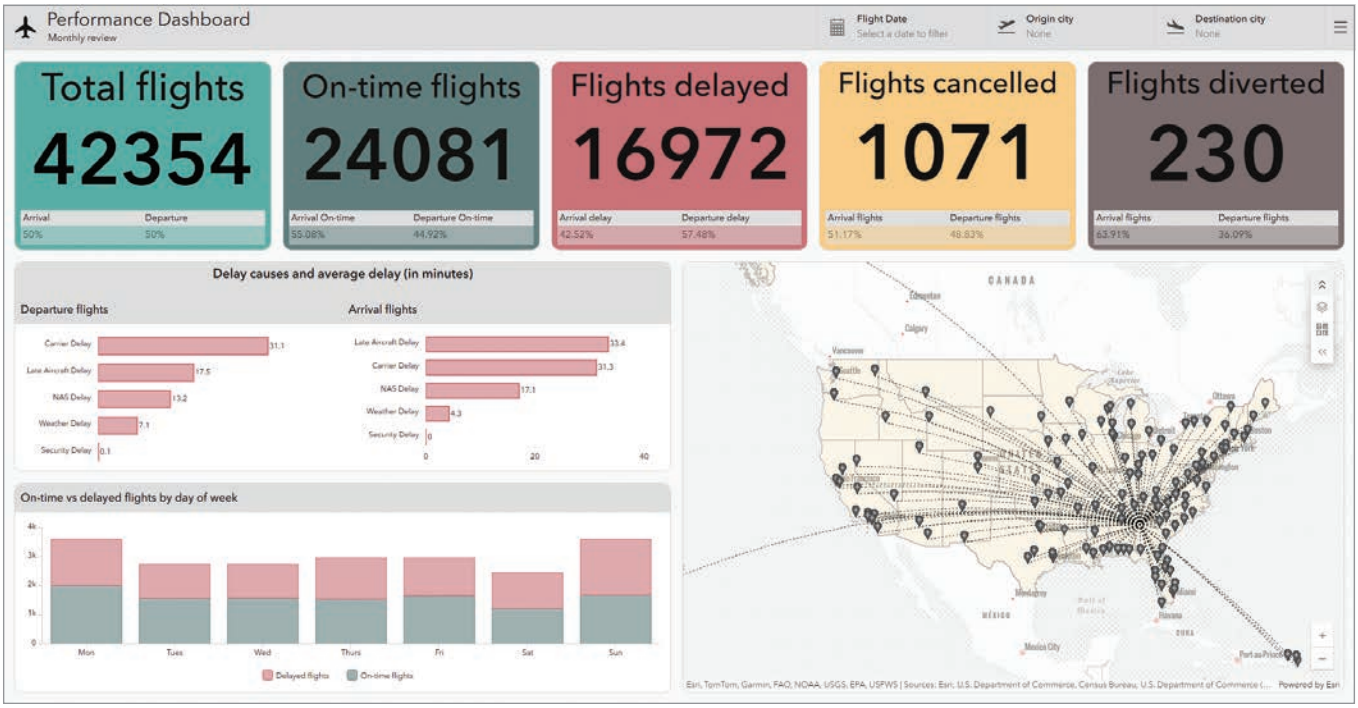
When working with evolving data, creating and maintaining a dashboard comes with plenty of challenges. Maybe you want to reuse your carefully crafted dashboard designs for another project, only to find it's not as easy as it should be—and nothing is more frustrating than that yellow warning triangle signaling a data source error, knowing how tedious it is to fix.

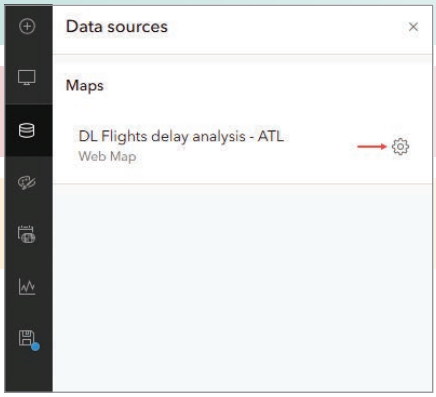
As of the October 2025 ArcGIS Online release, the process of working with data sources within ArcGIS Dashboards has become a lot simpler and faster. Data source replacement has been one of the most requested features for ArcGIS Dashboards, and with this upgrade, authors can easily update or replace data sources, ensuring that dashboard creation, reuse, and error resolution is faster, smarter, and more intuitive.

Here are some of the things you can now do as a dashboard author:

- Review all data sources—maps, layers, and data expressions—in one centralized location.
- Reuse a dashboard's layout and configurations across multiple dashboards by simply replacing or remapping data sources.
- Repair broken data sources by reconnecting them to valid ones—no need to start from scratch.
- Spot issues quickly with cues that guide you to the fix.
- Edit data expressions independently outside of element configuration, so your element configuration stays intact.

↓ This Performance Dashboard provides a monthly performance review of an airline's operations at its Atlanta hub.





← The Configure icon displayed in the Data sources panel.

↓ You can easily replace data sources within the Configure data source window.

↓↓ Layers and fields are automatically matched based on their names and types.

Located under the action bar on the left, the Data sources panel gives you a bird's-eye view of all your data sources—web maps, web scenes, stand-alone layers, and data expressions—all in one place. Using the Configure data source option, you can update or replace a data source in just a couple of steps.

Reusing a design layout and repairing a broken dashboard are two common scenarios for which this capability might come in handy. It's worth understanding the workflow for both scenarios in detail.

Reuse Your Design Layout

Whether you're building annual performance dashboards or creating similar dashboards for multiple clients across different regions, reusing your design and interactivity are key.

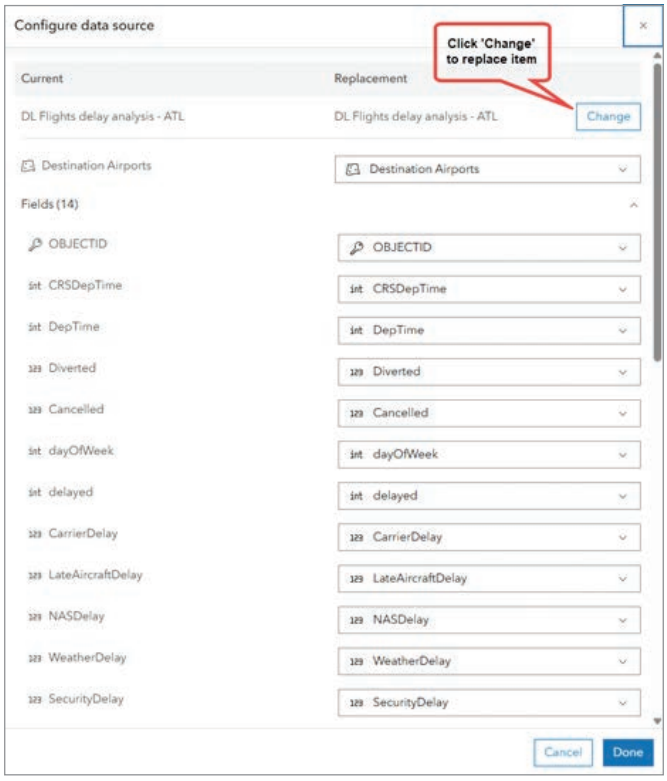
Take the Performance Dashboard on page 8, for example. This dashboard provides a monthly performance review of an airline's operations at its hub in Atlanta (ATL). It tracks key flight metrics such as total flights, on-time flights, delays, cancellations, and diversions. Below the indicators, two bar charts effectively display average delay times categorized by cause and flight direction. Additionally, a stacked chart shows delay patterns by day of the week.

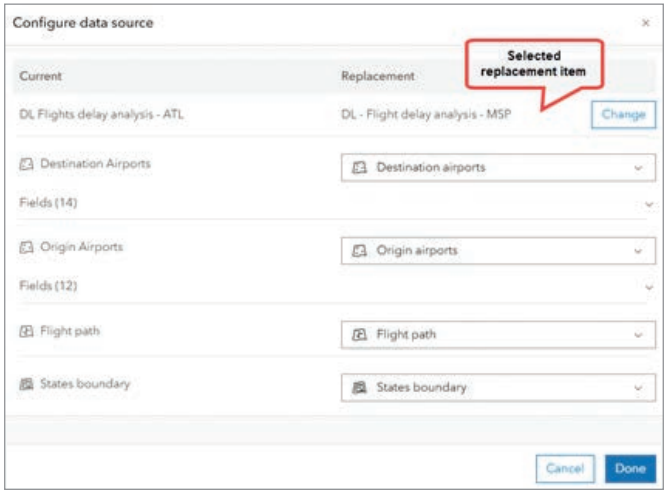
This dashboard has been carefully built with considerable time and effort. If you want to build a dashboard with a similar layout design for a different airline hub, such as Minneapolis (MSP), you can now streamline the process using the capabilities introduced in the October 2025 ArcGIS Online update.

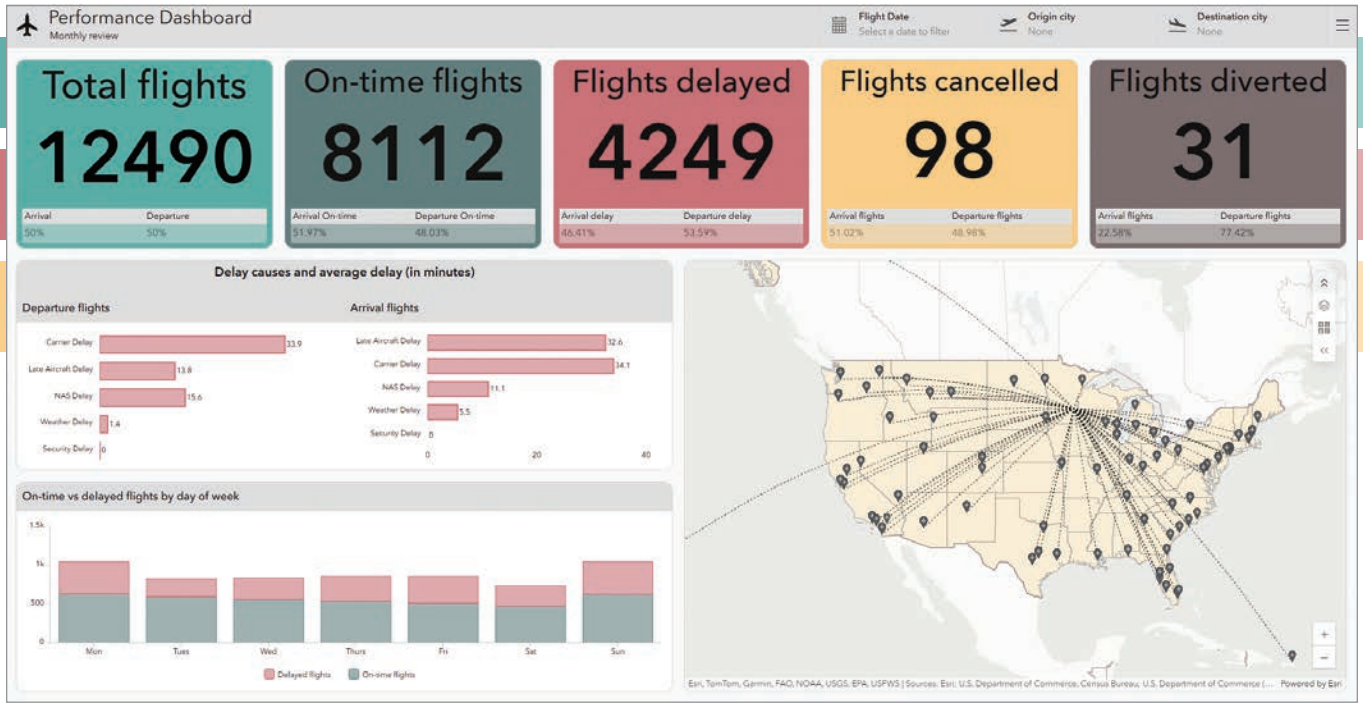
With the Data sources panel, you can easily swap out the existing data source for a new one in just a few clicks. This allows you to maintain the integrity of the dashboard while updating the data.

1. In the Data sources panel, click the Configure icon next to the current data source.
2. A window opens showing side-by-side columns: the current data source on the left and the replacement on the right. Click the Change button under Replacement to browse and select a new item.
3. Layers and fields are automatically matched based on their names and types. Otherwise, manually map any unmatched layers and fields, then click Done.

That's it! The dashboard preview updates with the new data, and the Data sources panel reflects the changes. In the example







↑ This iteration of the Performance Dashboard uses the Atlanta version as a template, but displays information about the MSP hub instead.

on page 10, the dashboard now shows the airline's performance at the MSP hub, created by reusing the original Atlanta version of the dashboard as a template. Same layout, new insights—made possible with minimal effort.

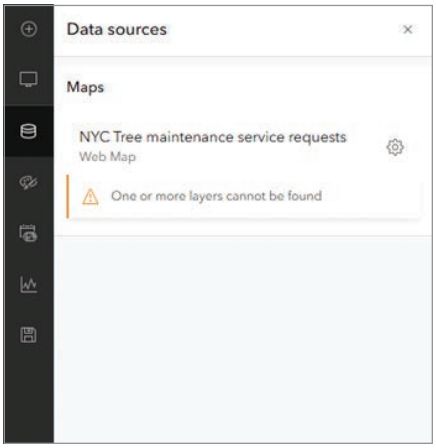
Repair a Broken Dashboard

If everything's working fine with your dashboard, that's great. But if something's off, the Data sources panel will show visual cues and meaningful error messages to help you fix issues quickly and confidently.

Here's another example—a review dashboard that displays information about New York City tree maintenance service requests, including request status, total requests over time, and request types (page 11). However, this dashboard is currently broken.

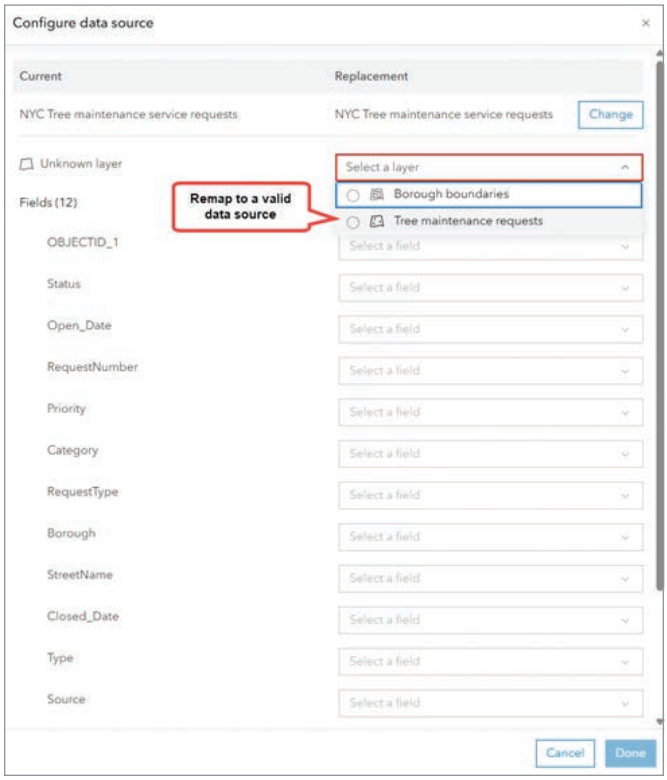
One of the required layers is missing. As data evolves, this can happen for a variety of reasons—such as the layer being deleted, permissions being modified, or the layer being republished.

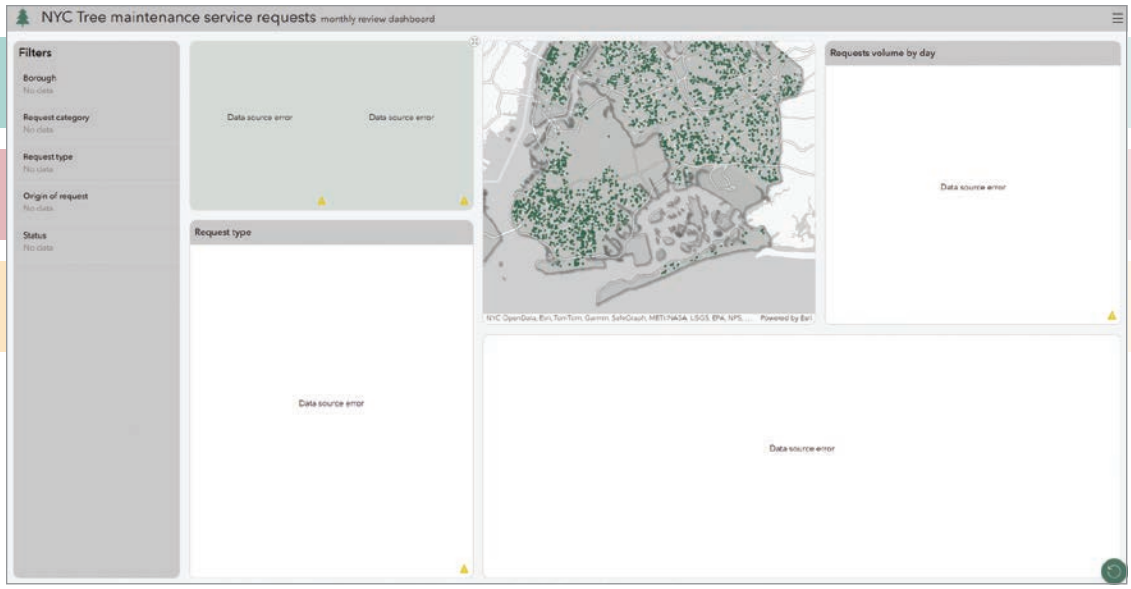
Previously, fixing this meant manually investigating and updating each element—often leading to fully rebuilding the dashboard.



→ The Data sources panel can immediately highlight what's wrong with a dashboard in need of repair.

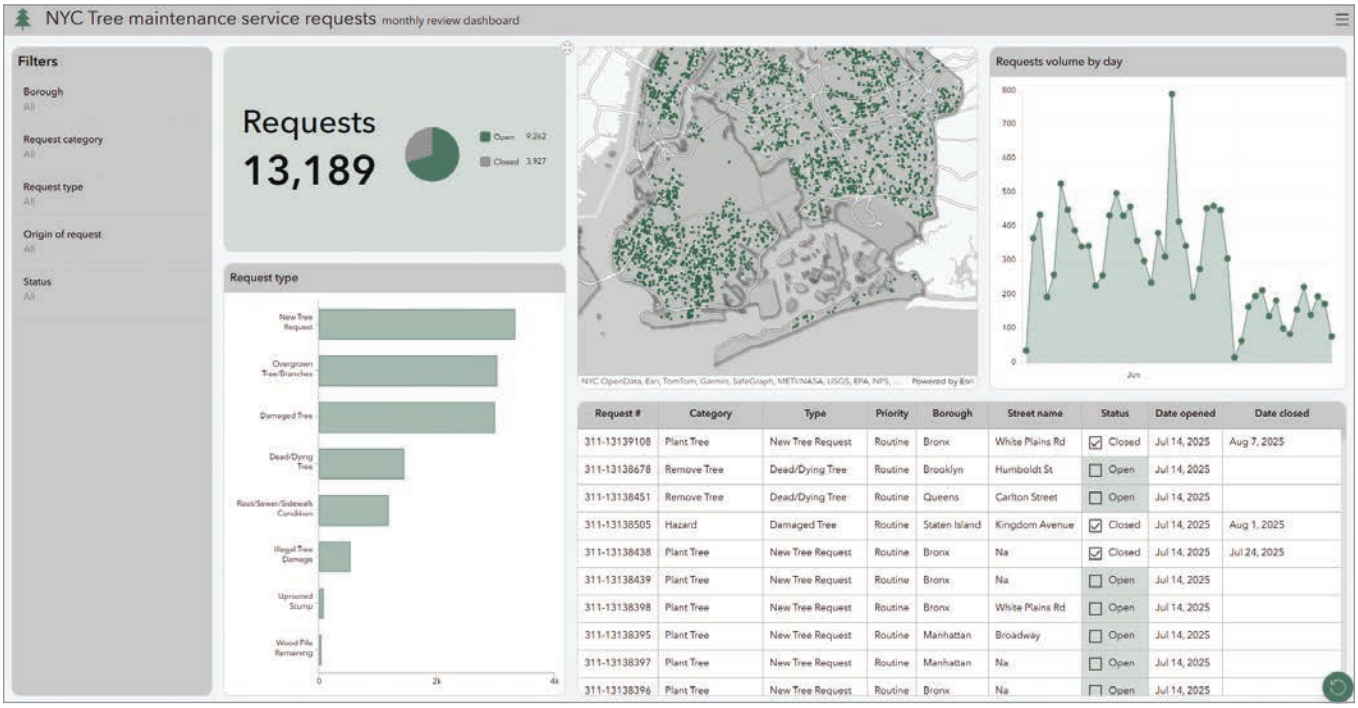
→→ Broken data sources can be remapped in the Configure data source window.





← This NYC tree maintenance service requests dashboard has a broken data source.

↓ The dashboard is now populated with the formerly broken data sources.



Now, the Data sources panel can immediately highlight what's wrong—whether it's an inaccessible item, a missing layer, or a mismatched field—giving authors a clear starting point for troubleshooting.

Here are the steps to repair the dashboard:

1. Open the Data sources panel and click the Configure icon.
2. Replace the entire item or remap broken layers/fields to valid data sources.
3. Click Done.

With just a few clicks, the dashboard is restored, and there is no need to rebuild elements from scratch.

This update is all about saving you time, reducing frustration, and making dashboards more flexible than ever. Whether you're building dashboards for your stakeholders or adapting to a schema change, you'll now spend less time troubleshooting and more time creating.

About the Author

Shakthi Bharathi Murugesan is a product engineer on the ArcGIS Dashboards team, with a background in GIS and computer science. She's passionate about exploring data and turning insights into compelling visualizations. When she's not building dashboards, she's likely reading about photons, black holes, and everything in between.

Organize Your Data with ArcGIS Hub Catalogs

By Ikechukwu Christian-Ezeofor and Jill Saligoe-Simmel

↑ The configurable catalog in ArcGIS Hub enables you to organize content and customize the experience for your site visitors.

The addition of configurable data catalogs to ArcGIS Hub gives Hub users and content curators more control over how they share open data and organize and showcase content.

If you're familiar with the content library on sites created in the classic edit mode, think of this as an upgrade—the new Hub catalog offers more flexibility over how you organize and discover spatial data and content. Plus, you can use the catalog to create tailored collections for specific stakeholders, audiences, and your community and find content that matters most.

While the classic content library has limited customization options, configurable Hub catalogs provide greater flexibility and ease of customization for data sharing. Additionally, Map Viewer now enables users to add content directly from ArcGIS Hub catalogs, making it easier to incorporate curated datasets into your workflows.

Here are some of the capabilities that catalogs offer:

- Configure catalog content to decide exactly what appears in your catalog by using groups.
- Easily organize collections by grouping similar content or events together, so users can navigate more quickly to what matters most.
- Adjust catalog search appearance with an instant preview. Catalogs will also integrate with more search attributes that will allow greater customization.

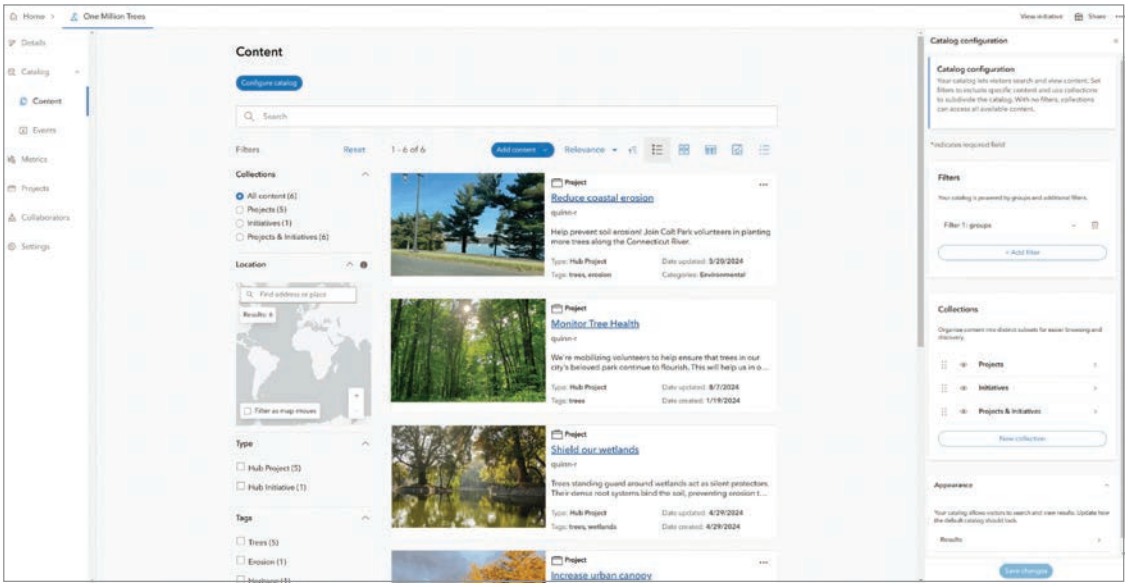
Configuring Catalog Content

Like the classic content library, Hub catalogs are configured in workspaces by adding one or more groups. As needed, go to the site workspace, select Catalog and Content, and select Configure catalog. Then use the Select groups button to configure the catalog content.

Content shared with groups is indexed by your catalog. The items' share settings are respected, which supports GIS data management and content governance. This allows you to create public open data catalogs, secure private catalogs, or mixed-privacy catalogs.

Catalog Collections

Unlike catalog searches that dynamically filter all available content, collections let you create custom groupings within the catalog. These groupings serve as an additional way to organize content based on theme, purpose, or topics you define. The default collections in Hub organize content by documents, data, maps and apps, and sites. Site managers can show or hide, rename, and reposition the order of these default collections.



← Sites created in classic edit mode have a content library, which becomes a Hub catalog in the upgraded experience.

↓ Configure your Hub catalog by selecting groups that contain shared content.

↓↓ Get inspired by the State of Washington Geospatial Open Data Portal and other examples in the ArcGIS Hub gallery.

Configurable collections offer even more control to expand these groupings. ArcGIS Hub Premium users can configure up to 10 collections per catalog using advanced filters. This makes it easier and faster for users to find specific resources based on their objectives.

Search Appearance

Hub Premium users will soon be able to determine how catalogs appear to visitors, including the ability to configure the following:

- Default layout (grid, list, table, map, compact)
- Default sort order
- Default card appearance
- Default search facets

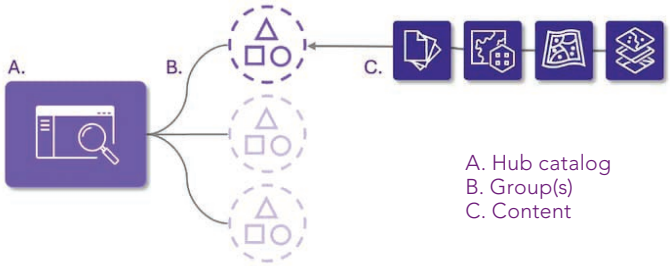
Additionally, a major bonus with the configurable catalogs is the introduction of an instant preview function. This means you can configure your catalog on the fly; visualize how content, collections, and appearance settings will display before saving; and eliminate guesswork, making customization more intuitive.

Using Curated Data from ArcGIS Hub Catalogs in Map Viewer

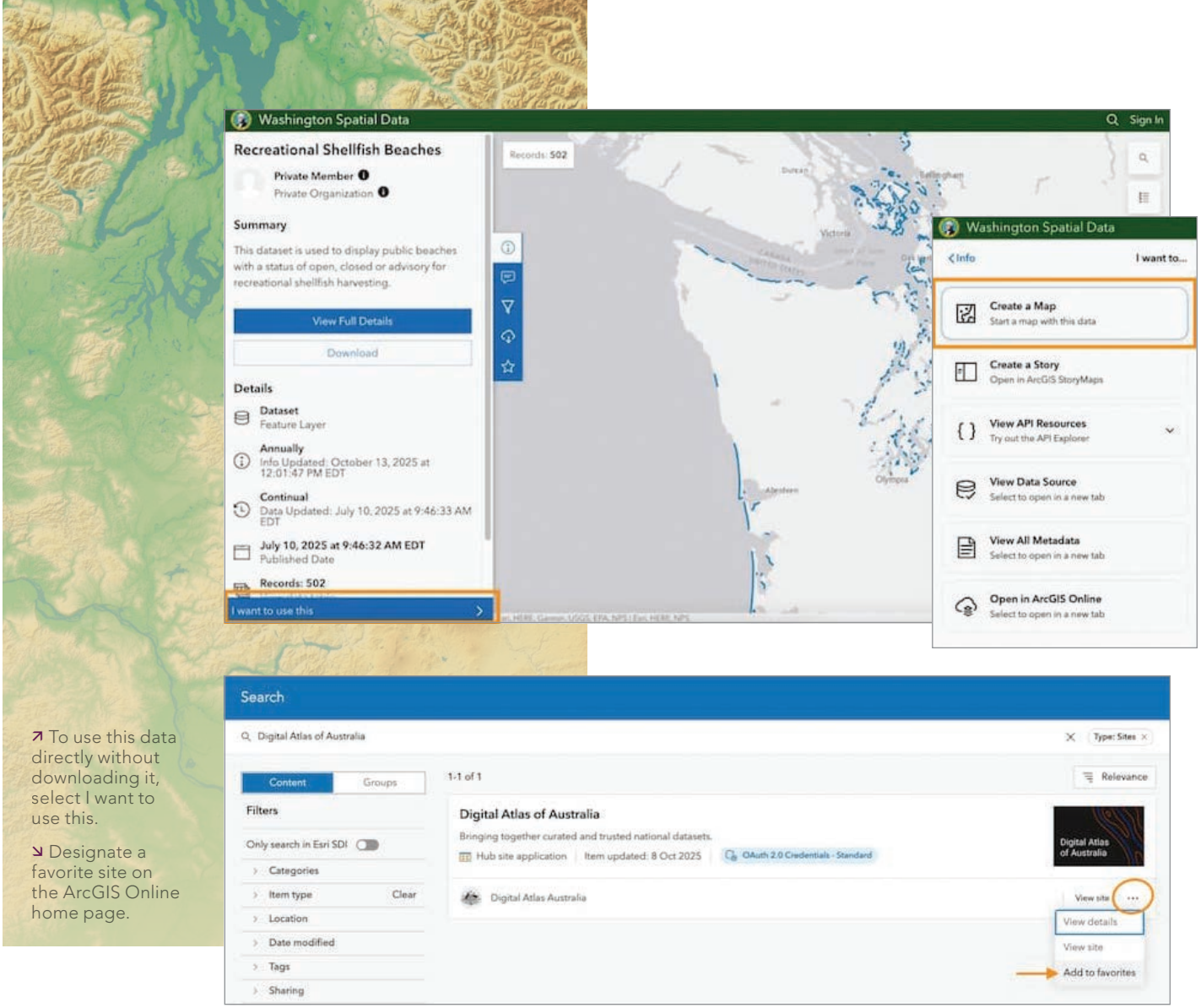
Finding and using curated data collections in maps and applications can be challenging. Even when your community's data catalog contains valuable data, there can be a frustrating disconnect in putting that data to use. Additionally, it often feels like data analysts spend up to 80 percent of their time wrangling data from various sources, leaving only 20 percent for actual analysis. This is where ArcGIS Hub comes in.

As of the October 2025 update to ArcGIS Online, Map Viewer users can add layers directly from ArcGIS Hub catalogs. This integration makes it possible to browse and use curated datasets with ease, enhancing both accessibility and usability for data providers and users alike.

Data providers can increase the reach and impact of their data by sharing content through interoperable, standards-based Hub catalogs. When users explore your data in a Hub catalog, they can create a map using Map Viewer and, if signed in, save the maps they create. Users can now view and add content from Hub catalogs when browsing layers in the Map Viewer item browser. Moreover,



A. Hub catalog
B. Group(s)
C. Content



↗ To use this data directly without downloading it, select I want to use this.

↘ Designate a favorite site on the ArcGIS Online home page.

you can designate favorite hub sites from your ArcGIS Online home page, making it easy to return to your curated content.

Here's how you can browse layers directly in Map Viewer from Hub sites that you recently visited and marked as favorites.

Begin by browsing, searching, and exploring content in a Hub site. For instance, a researcher investigating beach access in the Pacific Northwest might explore the Washington State Geospatial Program Office's State of Washington Geospatial Open Data Portal, which provides agencies, businesses, and residents with readily accessible, high-quality geographic information.

By searching for keywords like "beach," users can find relevant datasets, such as Recreational Shellfish Beaches. After previewing the data, simply select I want to use this. Then, click the Create a map button to open the data directly in Map Viewer.

Previously, adding additional curated layers from a hub site required returning to the catalog and manually searching for each item. Now, Map Viewer integrates Hub catalogs, allowing users to browse and add layers from recently visited sites directly within the mapmaking environment. The browser cache keeps track of recently visited sites and can be cleared if needed.

Users who frequently visit Hub sites can mark them as favorites on their ArcGIS Online home page. By marking a favorite Hub site, users automatically include its catalog, making it easier to add content from favorite catalogs in Map Viewer.

To designate a favorite Hub site, find the site item on the home page, click the more actions menu (three dots), and select Add to favorites.

Configurable catalogs are now available using workspaces, the default Hub management experience. Existing sites must upgrade their catalog to leverage this expanded functionality. Hub Premium users can also configure focused catalogs for events, projects, discussion boards, and initiatives.

About the Authors

Ikechukwu Christian-Ezeofor is a senior product engineer at Esri who works on ArcGIS Hub.

Jill Saligoe-Simmel is a professional geographer dedicated to applying a geographic approach to help create vibrant, healthy, and sustainable communities worldwide. She is a product manager on Esri's ArcGIS Hub and open platform teams.

Understanding the Self-Service Mapping, Analysis, and Sharing System Pattern

The ArcGIS Well-Architected Framework provides IT and GIS professionals with a comprehensive set of ArcGIS system patterns to assist in designing an ArcGIS deployment tailored to an organization's needs. ArcGIS system patterns are abstractions of actual systems, describing the most common types of geospatial systems that organizations implement with ArcGIS software and services.

The Self-Service Mapping, Analysis, and Sharing system pattern is a web-centric, services-based system that empowers individuals and teams to create, share, and use geospatial content without significant technical expertise or GIS knowledge. This system supports self-service spatial analysis and serves as a creative hub for the enterprise.

Applications and Use Cases

A wide variety of GIS users can leverage this system pattern for many purposes to access and visualize data. Content creators, for instance, can build and share maps and applications using a no-code or low-code approach. Application developers can develop custom solutions by writing code using mapping APIs and SDKs. Additionally, data analysts and GIS professionals can use the system to perform complex spatial analysis and create insightful visualizations.

Whether you're a business analyst looking to inform decision-making or a GIS expert seeking to streamline workflows, this system pattern can be tailored to meet your needs. By providing a range of applications, including a portal website, application builders, and native mobile applications, the Self-Service Mapping, Analysis, and Sharing system pattern empowers users to work more efficiently and effectively.

The system pattern enables a majority of services supported by ArcGIS. This includes full support for visualization services and a majority of data and analysis services. Data editing and management is possible in this system pattern, but might be better addressed with a data editing and management system. The same is true for big data and real-time analytics. These services are more commonly provided by a big data analytics system or real-time data streaming and analytics systems.

Some of the spatial analysis capabilities provided by self-service mapping, analysis, and sharing systems rely on location services provided by a location services system. These include network analysis and data enrichment services, which can be integrated into the self-service mapping, analysis, and sharing system as utility services.

Industry-specific capabilities and solutions are supported in sectors such as commerce, health and human services, insurance, and national government.

Self-service mapping, analysis, and sharing systems work with just about every type of data and data store supported by ArcGIS, including file and object stores, databases, cloud data warehouses, and NoSQL stores. Data from these sources may not be managed in this system, but are connected to this system for web access and use in mapping, analysis, and sharing workflows.

A System for Many Industries

The Self-Service Mapping, Analysis, and Sharing system pattern leverages the full suite of ArcGIS applications, app builders, and mapping SDKs, enabling a wide variety of geospatial workflows across an organization, and delivering suitable apps to just about every type of user.

Benefits of the system pattern are evident across various industries. JLL Real Estate Services, for instance, uses it to create map-based information products that inform business decisions across departments. The Kansas Public Health Collaborative's overdose response strategy team uses it to identify overdose hot spots and prioritize resource allocation. With this system pattern, the Republic of Colombia's Instituto Geográfico Agustín Codazzi, the country's national geographic data authority, has created a public-facing tool enabling residents to access their nation's geographic data. Organizations like the Connecticut Department of Transportation use it to provide users with access to past assets and current project data.

Learn more about the value and versatility of the Self-Service Mapping, Analysis, and Sharing system pattern at links.esri.com/selfservice.

Tracking Derelict Vessels with Dashboards, Not Whiteboards

By Ivy Lee and Michael Campbell

Florida, with its warm weather and abundant access to freshwater and salt water, is sometimes called the boating capital of the world, with over one million registered recreational vessels in the state. Some owners, however, neglect or abandon their boats when they can no longer afford to maintain them. Severe weather or accidents can also damage the boats, leading to abandonment or dereliction.

↑ One of the derelict vessels found abandoned in the waters of St. Johns County, Florida.

In Florida, a vessel is considered derelict when it is left stored or abandoned in a wrecked, junked, or substantially dismantled condition on public waters or on private property without the consent of the property owner. These vessels threaten boater safety, pollute the water, damage marine resources, and cost taxpayers millions of dollars each year in removal and disposal costs.

St. Johns County—located in the northeast portion of the state, between the St. Johns River and the Atlantic Ocean—is home to over 337,000 residents, 17,443 of whom were registered boat owners in 2024. But until recently, the county had no process or system in place to monitor which derelict vessels were being investigated and which agency was investigating them.

The solution was the Derelict Vessel Tracker, an application created with ArcGIS Dashboards and ArcGIS Survey123 that has streamlined the way that city, state, and county agencies investigate these vessels. In the process of creating the app, the St. Johns County GIS Division staff realized they could do more—much more.

A Decentralized Investigation

Previously, abandoned or derelict vessels could be processed by either the St. Johns County Sheriff's Office, the St. Augustine Police Department, or the Florida Fish and Wildlife Conservation Commission. Each investigating officer kept a notepad with information about the derelict vessel for their specific investigation. They might meet with the other agencies every few weeks or run into another agency on the water while patrolling and compare notes, but there was little or no information sharing. When they came upon a new vessel at risk, they might spend 30 to 45 minutes making phone calls to other officers to see whether anyone might have already started working the vessel.

← Sgt. Aaron Braddock of the St. Johns County Sheriff's Office Marine Unit. (Photo courtesy of St. Johns County Office of Public Affairs.)

↓ The survey created in ArcGIS Survey123 for capturing the information that is displayed in the Derelict Vessel Tracker.

"A list on a whiteboard at the office did not help when in the field. It was always an ordeal, especially when multiple agencies were working the same area or even the same vessel," said Sergeant Aaron Braddock of the St. Johns County Sheriff's Office Marine Unit.

Braddock submitted a request to the county's GIS division to create an application that would assist in keeping track of the derelict vessels, which the unit is responsible for maintaining.

The GIS division staff had created surveys and dashboards for other projects and felt confident that they could create a solution that every participating agency could take advantage of.

"[It had to be] something that would unify all our efforts and present the information in a way we could all use," Braddock said.

The GIS division first created a survey with ArcGIS Survey123 that captures information such as a vessel's name, registration number, type, make, Hull Identification Number (HIN), and location, as well as photos of the vessel. Also collected are the vessel owner's information, current status of the vessel (At Risk, Derelict Vessel, Ready for Removal, Vessel Removed, and In Compliance), course of action, report number, officer's name, and agency making the report.

Next, the team created a dashboard with ArcGIS Dashboards to display the information collected in the field. The dashboard consists of a map of the location of the vessels, along with lists and charts illustrating the information from the surveys. The map pop-up shows information pertaining to the individual vessel, including photos taken in the field and a hyperlink to send updated vessel information back to the survey, as well as a link to create a new survey.

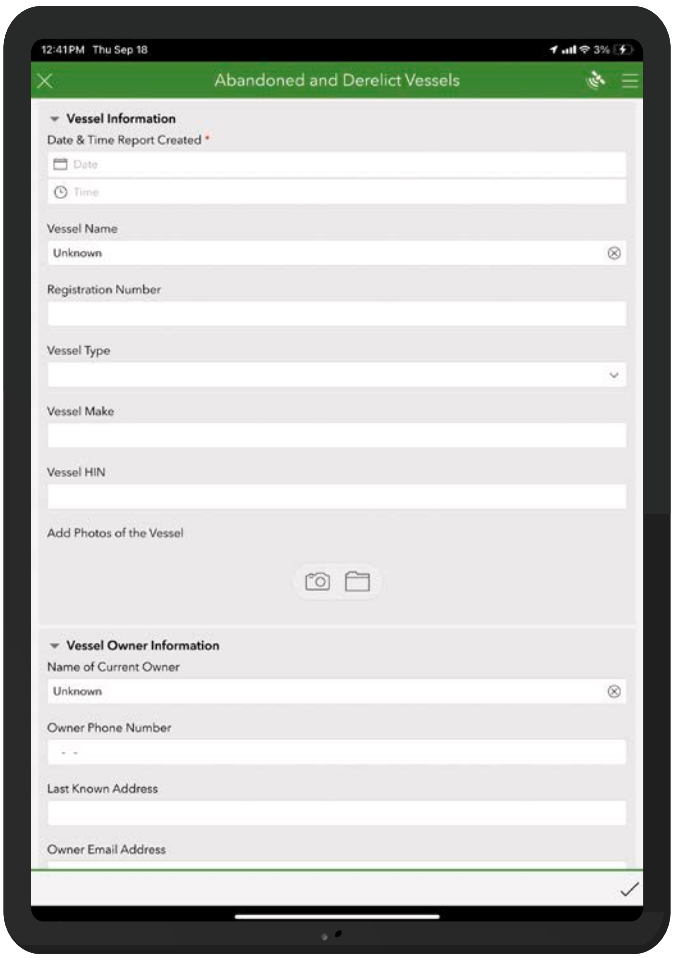
A second dashboard, which does not include the ability to edit an existing survey or create another survey, is for other agency members who simply want to view the information collected in the field.

In less than a month, the survey and dashboards were completed. After a testing period, the app went live for the agencies to start entering information about abandoned and derelict vessels.

Expanding the Operation

Shortly before the Derelict Vessel Tracker went live, Braddock had another request for the GIS division. The marine unit needed a reliable way to monitor vessels on the St. Johns County waters before and after storm events. The solution was another GIS application—the Hurricane Vessel Tracker.

Prior to a storm, the St. Johns County Sheriff's Office Marine Unit, St. Johns County Fire/Rescue Department, St. Augustine Police



Department, St. Augustine Fire Department, and the Florida Fish and Wildlife Conservation Commission survey vessel owners to determine if they will be leaving or staying on their vessel during the storm. Like the Derelict Vessel Tracker survey, this survey records vessel and owner information and includes photos and the location of the vessel.

After the storm, the vessels are checked and an update on their condition is provided. Before and after images of the vessels that attempt to ride out the storms are often heartbreaking, and many of these vessels ultimately end up listed in the Derelict Vessel Tracker.

As the project evolved, the marine unit identified the need for a feature to record the condition of both public and private boat ramps after a storm. The GIS division created an additional survey to record the inspection date, the inspector's name, photos, and the condition of the boat ramp (Functional, Obstructed, Damaged, or Unchecked).

Later, a third survey was integrated into the application to allow the tracking of debris that found its way into the water during the storm. This survey includes the type, description, photos, location, and size or dimension of the debris.

The information collected in the three surveys is shown in a single dashboard. Again, like the Derelict Vessel Tracker app, the Hurricane Vessel Tracker has two dashboards: an editor dashboard with links to create and update surveys, and a viewer dashboard that does not have survey-editing capabilities.

The agencies involved saw the possibilities unfold with each app, and after the completion of the Derelict Vessel Tracker and Hurricane Vessel Tracker came the Marine Sanitation Device Investigation Tracker application.

A marine sanitation device is a piece of machinery or a mechanical system that is dedicated to treat, process, or store raw, untreated sewage that can accumulate onboard water vessels—not including devices such as portable toilets. Discharging raw sewage is prohibited in Florida waters. As with the previous applications, the GIS division created a survey and dashboards to record information and keep track of the status of vessels' compliance.

The St. Augustine Port, Waterway & Beach District then requested a public-facing dashboard to display the information, status, and locations of derelict vessels, hoping to reduce the number of inquiries received about them. This resulted in a new dashboard called the Derelict Vessel Viewer. This dashboard uses the same data as the Derelict Vessel Tracker but doesn't include sensitive information used by law enforcement agencies to conduct investigations.

"In addition to helping keep boaters and residents informed, it has significantly reduced the number of follow-up calls that we receive for derelicts," said Matt Brown, chair of the St. Augustine Port, Waterway & Beach District. "Once people know where to look for the information, they can just keep referring to the Derelict Vessel Viewer for updates as vessels make their way through the process. It's been a game-changer."

A Common Picture

The new process of using surveys and dashboards to track derelict vessels has resulted in creating a common operating picture for all agencies involved. As staff start compiling information about a vessel, they can track who is working on the investigation and

→ The St. Johns County Sheriff's Office Marine Unit proactively patrols the waterways in a 31-foot SJSO SAFE boat. (Photo courtesy of St. Johns County Sheriff's Office.)

at what stage they are in the process. Approximately 65 vessels have been removed since creating the Derelict Vessel Tracker survey and dashboard.

"Where the dashboard really comes into play is that the community and the networking of the local law enforcement agencies [are] on the same page to accomplish these investigations," said Braddock. "It also benefits the community by not wasting taxpayer money on resources trying to track down information that we can easily get off of the dashboard. I think that law-enforcement- and community-wise, the use of the app in the dashboard is a great benefit all the way around."

With the success of the initial application to track derelict vessels, St. Johns County GIS Division requested other agencies' ideas and created additional applications to support their tasks. With a blueprint to follow, additional applications could be created in a short time frame. And as the applications see more use in the field, the division continues to refine the tools in response to requests for enhancements and minor modifications.

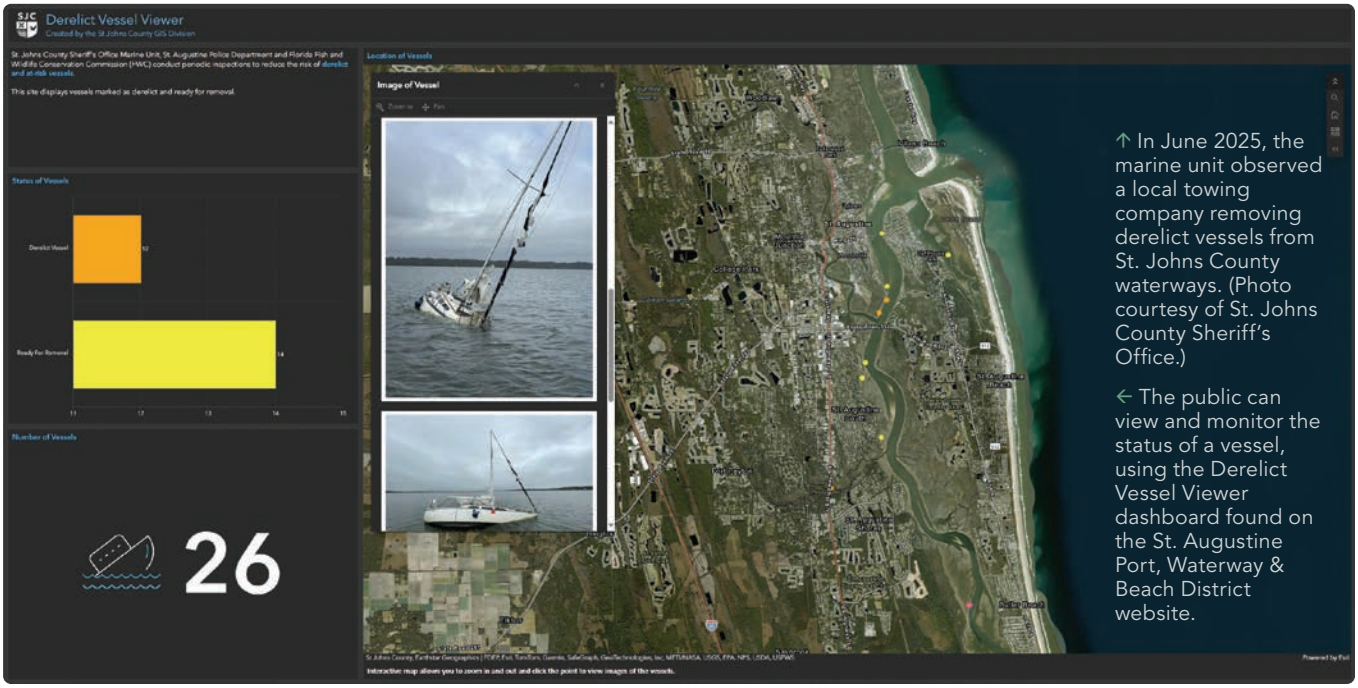
This collaboration between the GIS division and local agencies has not only streamlined interagency communication but also enhanced transparency, accountability, and public trust. What began as a simple tracking tool has evolved into a comprehensive, adaptable application that continues to grow with the needs of the community.

For more information, contact the St. Johns County GIS Division at gis@sjcfl.us.

About the Authors

Ivy Lee, GISP, is a senior GIS coordinator for St. Johns County, Florida, with over 26 years of experience in GIS. Throughout her career, she has managed GIS databases and assisted with the implementation of mobile solutions for various county departments and offices. Lee earned her degree in computer and information science from the University of North Florida.

Michael Campbell, GISP, is the GIS manager for St. Johns County, Florida. He has over 30 years of experience in the field of GIS, creating data layers, designing maps, and implementing solutions for the county's various departments and offices. Campbell graduated with honors from the University of Florida with a bachelor's degree in surveying and mapping.



↑ In June 2025, the marine unit observed a local towing company removing derelict vessels from St. Johns County waterways. (Photo courtesy of St. Johns County Sheriff's Office.)

← The public can view and monitor the status of a vessel, using the Derelict Vessel Viewer dashboard found on the St. Augustine Port, Waterway & Beach District website.

ArcGIS Monitor Brings New Insights to New Complexities

By Brian Cooke

For the North Central Texas Council of Governments (NCTCOG), rapid regional growth brought opportunity—but it also introduced operational complexity. As the organization's GIS footprint expanded from a handful of licenses into a full enterprise deployment, the NCTCOG GIS team found its critical infrastructure increasingly difficult to manage.

This expansion created an urgent need for a monitoring tool that could provide clear, real-time insight into the entire enterprise framework. The solution, ArcGIS Monitor, enabled NCTCOG to shift from a reactive GIS management approach to a proactive one.

A Full Enterprise Deployment

Serving a 16-county region anchored by the Dallas–Fort Worth metropolitan area, NCTCOG is a voluntary association that promotes cooperation among more than 250 local governments serving more than 8.7 million residents.

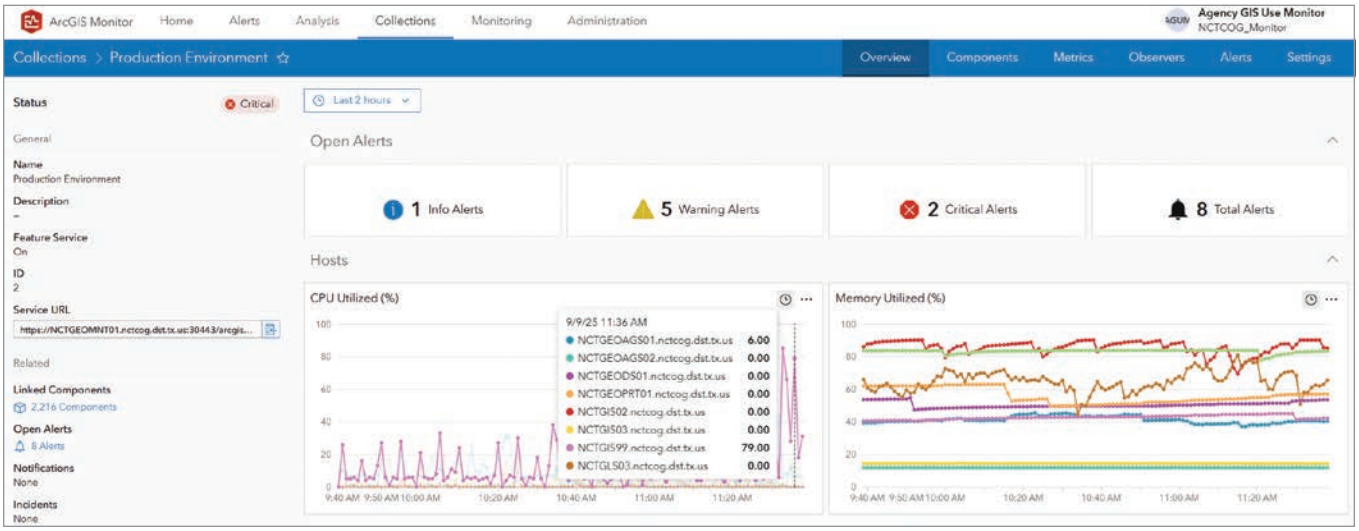
Established in 1966 and currently with a staff of more than 400 people, NCTCOG is one of many regional planning organizations found across the United States, explained Donna Coggeshall, senior manager of data and analytics for the Information and Innovation Services Department at NCTCOG.

"Our goal is to coordinate between different governmental organizations in ways that benefit the region," Coggeshall said. "For example, we find efficiencies by identifying duplication of efforts and providing opportunities for communication for all kinds of planning, like for transportation or water management."

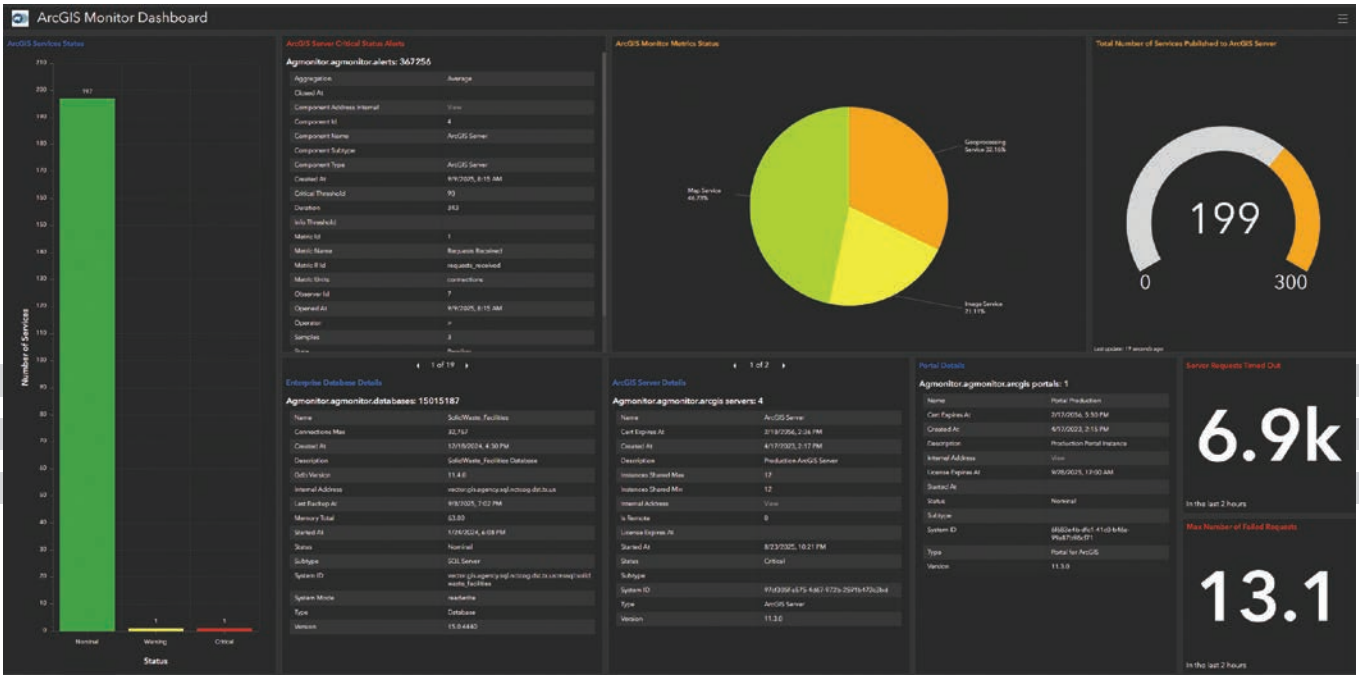
A key part of NCTCOG's mission involves collecting and generating vast amounts of publicly available information. This makes the agency's enterprise GIS infrastructure a mission-critical asset across north Texas.

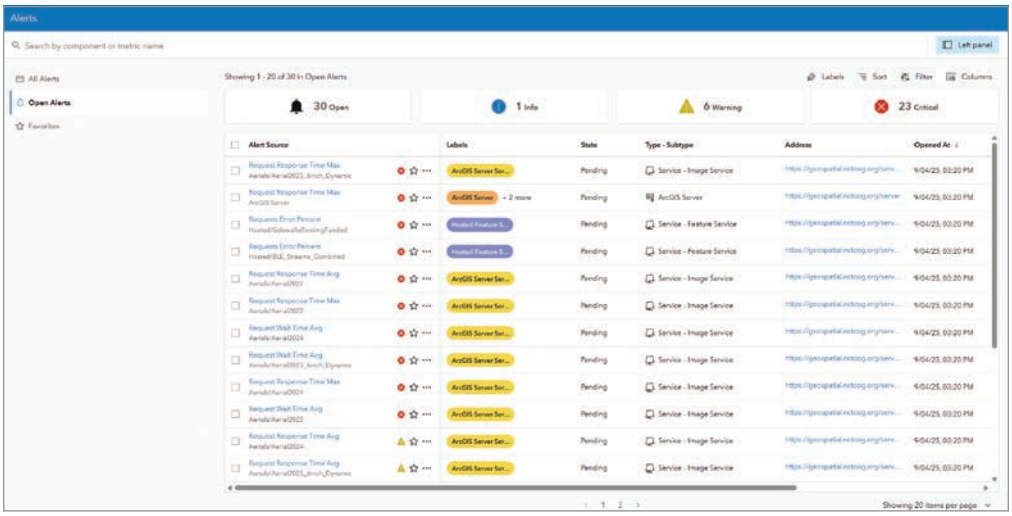
To no one's surprise, the agency's GIS operations have grown dramatically in recent years. The catalyst for this expansion was a decision to move to an enterprise agreement (EA) with Esri.

"Before the EA, we just had a few licenses and just one server," said Ruchi Basnet, GIS systems architect for NCTCOG's Information and Innovation Services Department. "But with the



↓ The production environment collection groups all production components together in ArcGIS Monitor so that NCTCOG admins can track uptime, performance, and alerts in one place.





↑ A dashboard turns the raw system metrics from ArcGIS Monitor into interactive, shareable visuals for NCTCOG's GIS admins, IT, and leadership.

← NCTCOG's customized Monitor app shows pending alerts that were automatically generated and have not yet been resolved, highlighting issues that may require attention.

EA we got a lot of ArcGIS products and some additional infrastructure to better monitor our GIS."

This expansion introduced new capabilities—along with new complexities.

"We needed this kind of monitoring solution for a while," Coggeshall said. "We tried a couple of tools from other software companies, but we have not had something that was able to give us this sort of information, especially not in real time like Monitor does on system performance."

A Holistic View

Monitor, an extension to ArcGIS Enterprise, collects metrics on asset health, performance, and usage. Monitor helps administrators and managers ensure that their ArcGIS Enterprise deployments are working efficiently by reducing system downtime.

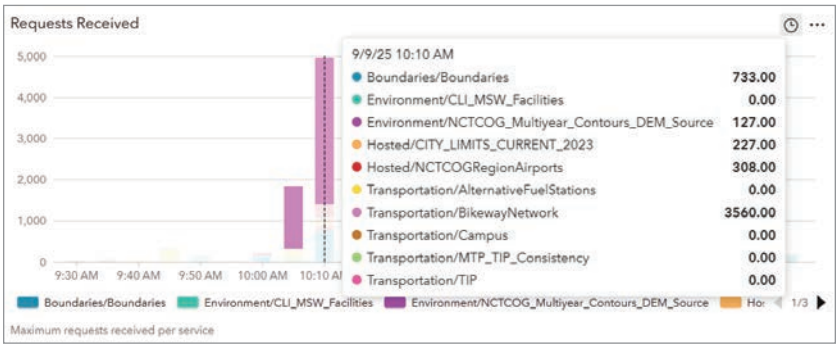
"Now we're tracking two enterprise portals, three ArcGIS Server [deployments], 21 databases, nine host machines, more than 600 services, and more than 18 storage sites on different host machines," Basnet said. "With Monitor, we can track and see if a particular GIS service or infrastructure piece is down and what the performance is, along with where bottlenecks are. We've never been able to do that in the past."

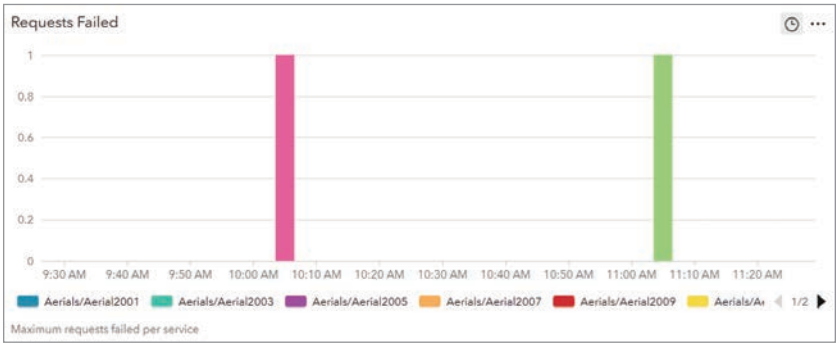
Monitor works with ArcGIS Enterprise on Windows or Linux, deployed on-premises or on cloud environments. And if an organization has multiple ArcGIS Enterprise deployments or is using different release versions, Monitor provides a single console where users can view key performance indicators across all deployments

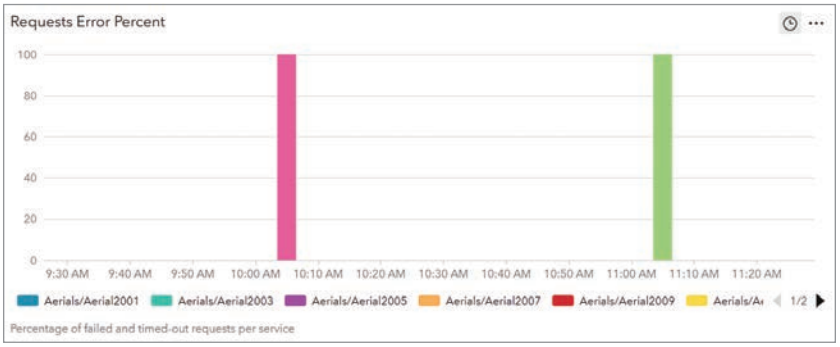
> "The catalyst for this expansion was a strategic decision to move to an enterprise agreement with Esri."

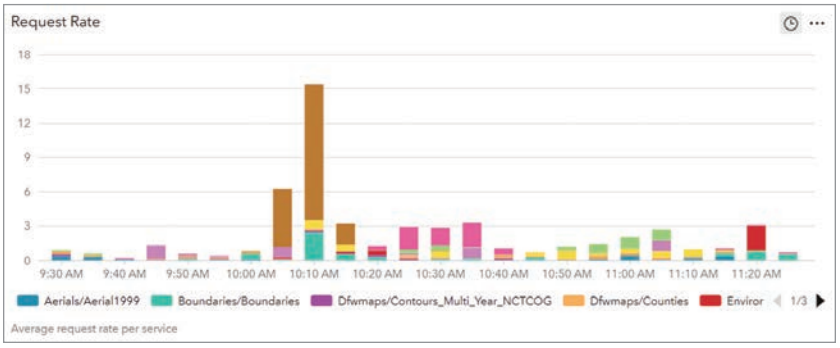
↓ NCTCOG's Monitor app shows requests received, failed requests, overall request rate, and the percentage of errors, providing a clear view of service performance and reliability.

as well as a single user interface to help manage and optimize an enterprise GIS and its underlying infrastructure. This functionality has allowed the NCTCOG GIS team to think more proactively about its services.









"We can identify exactly which service is causing a performance issue and then address that without our users even knowing about it, because we've already dealt with it," Coggeshall said.

Data-Driven Decisions

For Basnet, implementing and customizing Monitor required time and effort, but resulted in major upgrades to GIS management—and her job.

"Initially, when we got Monitor with the EA, we didn't have any expertise in-house to figure out what Monitor is and what it can do," she said.

After studying on her own, as well as attending Esri-led training sessions, she began tailoring the tool to NCTCOG's specific needs.

"There are some out-of-the-box analysis tools in Monitor, but we've made lots of customizations, like to our home page, which Monitor users see after they log in," Basnet said. "Using Monitor has even changed my job description. Before, I was a principal GIS analyst; now, I'm more of a GIS systems architect. In my new role and with Monitor, I can go to my manager and say, 'Our GIS is stressed and so we need to increase the number of servers, RAM, processors, or CPU.'"

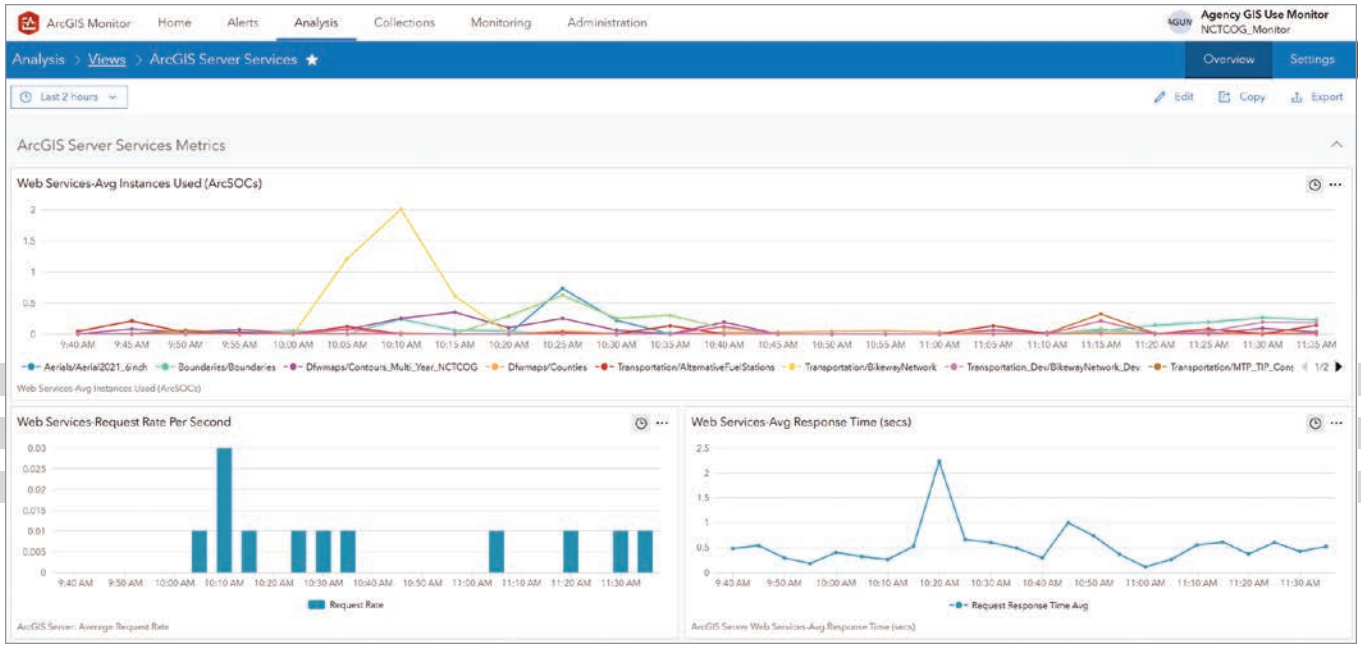
One of the most powerful benefits of Monitor has been its ability to provide objective data to justify infrastructure changes.

"I really like the infrastructure analysis view in Monitor, which showed us whether we needed to increase or decrease our server resources," Basnet said. "It also gave us the information we needed to implement workload separation in order to optimize processing so that instead of having one server do everything for us, we have a dedicated image server, map service server, and hosting server."

This data-driven approach extends to communication with other departments. The ability to share concrete evidence of system stress has been a key benefit.

"From time to time I tell my director and my IT lead to log into Monitor to see everything that we're tracking at the server level," said Basnet. "It's been an eye-opener for them, and it has helped me to justify suggested changes to our GIS resources," such as rightsizing NCTCOG's server environment.

Basnet also set up email alerts every hour for critical or pending issues. This proved crucial during a recent vacation, when she was able to



↑ The analysis view in Monitor details NCTCOG's service metrics, including incoming request rates per second and average response times in seconds, providing insight into overall service performance.

← Ruchi Basnet, GIS systems architect for NCTCOG's Information and Innovation Services Department, reviews the organization's customized ArcGIS Monitor dashboard.

spot server issues from afar and quickly coordinate a solution.

Looking ahead, NCTCOG plans to delve deeper into the capabilities of Monitor. The team is exploring using it for license tracking to inform departmental budgets and plans to use JMeter, an open-source load-testing tool, to further analyze system performance.

For Coggeshall, the advantages of using Monitor are clear.

"It's helped to know when particular GIS processing is reaching critical stages and to right-size our infrastructure," she said. "That's been one of the real benefits."

> "It's been an eye-opener for them, and it has helped me to justify suggested changes to our GIS resources."

About the Author

Brian Cooke is a writer and contributing editor for the Esri publications team. He helps readers stay informed about ArcGIS technology and tells compelling stories about how Esri partners and users apply Esri technology. Cooke has worked as a marketplace researcher, an enterprise technology analyst, a technical writer and editor, and an environmental science writer for clients such as the US National Park Service and the US Forest Service. In addition to a bachelor's degree in science writing from Lehigh University, he has a master's degree in natural resource stewardship and a certificate in conservation communications—both from Colorado State University.

Empowering a University with Smart Campus GIS Solutions

By Jeffrey Ulricksen

At the University of Rhode Island (URI), transitioning from a legacy computer-aided facility management (CAFM) system to ArcGIS Indoors in 2022 marked a pivotal shift in how spatial data was managed, visualized, and shared across campuses. Today, the university's spatial services team and other key stakeholders are taking the next steps to embed GIS in the fabric of URI campus operations.

↑ URI's contribution to the Community Maps program.

→ URI's Botanical Gardens web app was created with ArcGIS Experience Builder.

A legacy computer-aided facility management system served the university well for decades, supporting URI's needs for space inventory and tracking movable assets. However, its limitations—especially regarding user-friendliness and interoperability—became increasingly apparent. ArcGIS Indoors offered a modern alternative, enabling URI to unify spatial data across colleges and divisions and provide intuitive access via desktop, mobile, and kiosk platforms.

Migrating to Indoors first required an enterprise GIS solution that would support not just Indoors but also a robust, enterprise-wide GIS implementation. This foundational work set the stage for deeper GIS integration across the campus, including developing a geospatial strategy, hiring a full-time GIS specialist, and publishing a basemap through the ArcGIS Community Maps program.

Building a Scalable Enterprise GIS

To enable these GIS efforts, URI needed a resilient and scalable system with capabilities that could expand with the university's growing spatial technology needs. The spatial services team partnered with two university groups—URI Information Technology Services and the URI Environmental Data Center—to build and manage an ArcGIS Enterprise instance. These two groups built a fully scalable ArcGIS Enterprise instance in the Amazon Web Services cloud, currently running ArcGIS Enterprise 11.5 with Microsoft SQL Server 2022.

The ongoing ArcGIS Indoors implementation started with an Indoors pilot project in May 2022. The project was supported by Esri partner Paratum Solutions. The legacy CAFM system used proprietary floor plan editing software, so the implementation started without CAD data. After working through the process of migrating the floor plans to CAD and establishing CAD standards, Coast2Coast was hired to convert the floor plans in March 2024. The company is experienced in providing as-built and modeling services. The entire process took about five months.

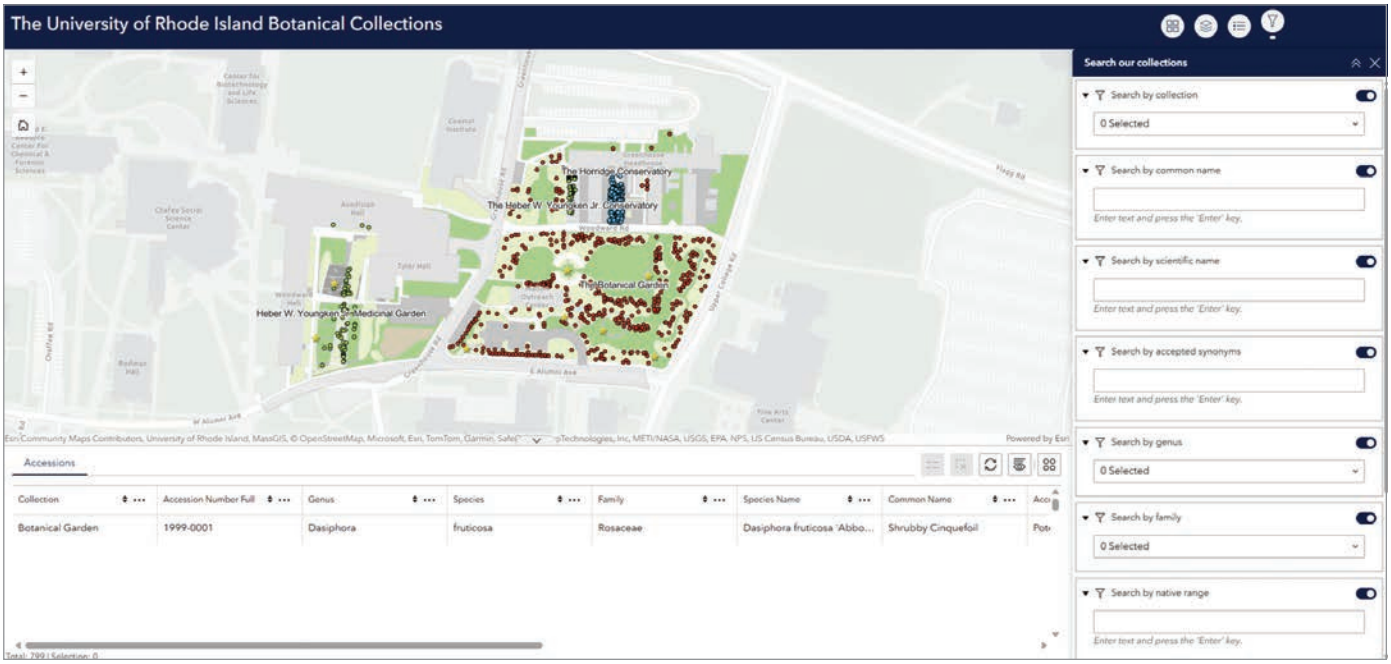
The spatial services team performed quality control checks and imported the floor plans into the Indoors data model as the converted CAD files were received. During implementation, the Indoors data was already being used by public safety staff to manage university events such as commencement.

With support from Esri Professional Services, the team completed migrating the legacy CAFM data using the techniques developed during the pilot project. Overall, the Indoors implementation was less expensive than three years of licensing for the legacy CAFM system.

Supporting Campus Operations

With the geospatial foundation in place, the spatial services team then looked to support the needs of university departments that were focused on campus operations: the public safety department, the transportation and parking department, and the facilities group. The spatial services team built several GIS applications to manage authoritative data using tools such as ArcGIS Experience Builder, ArcGIS Field Maps, and ArcGIS Survey123. The resultant tools significantly improved URI's ability to share authoritative data that is critical to campus operations across departments.

URI's public safety department relies on a situational awareness dashboard that monitors emergency blue light phones in public areas, as well as security cameras and automated external defibrillator locations. The department also uses campus maps and Indoors floor plans to manage university athletic events, residence hall move-ins, and commencement.



The transportation and parking department migrated URI's parking inventory from Excel spreadsheets to ArcGIS and now manages the inventory using ArcGIS Field Maps.

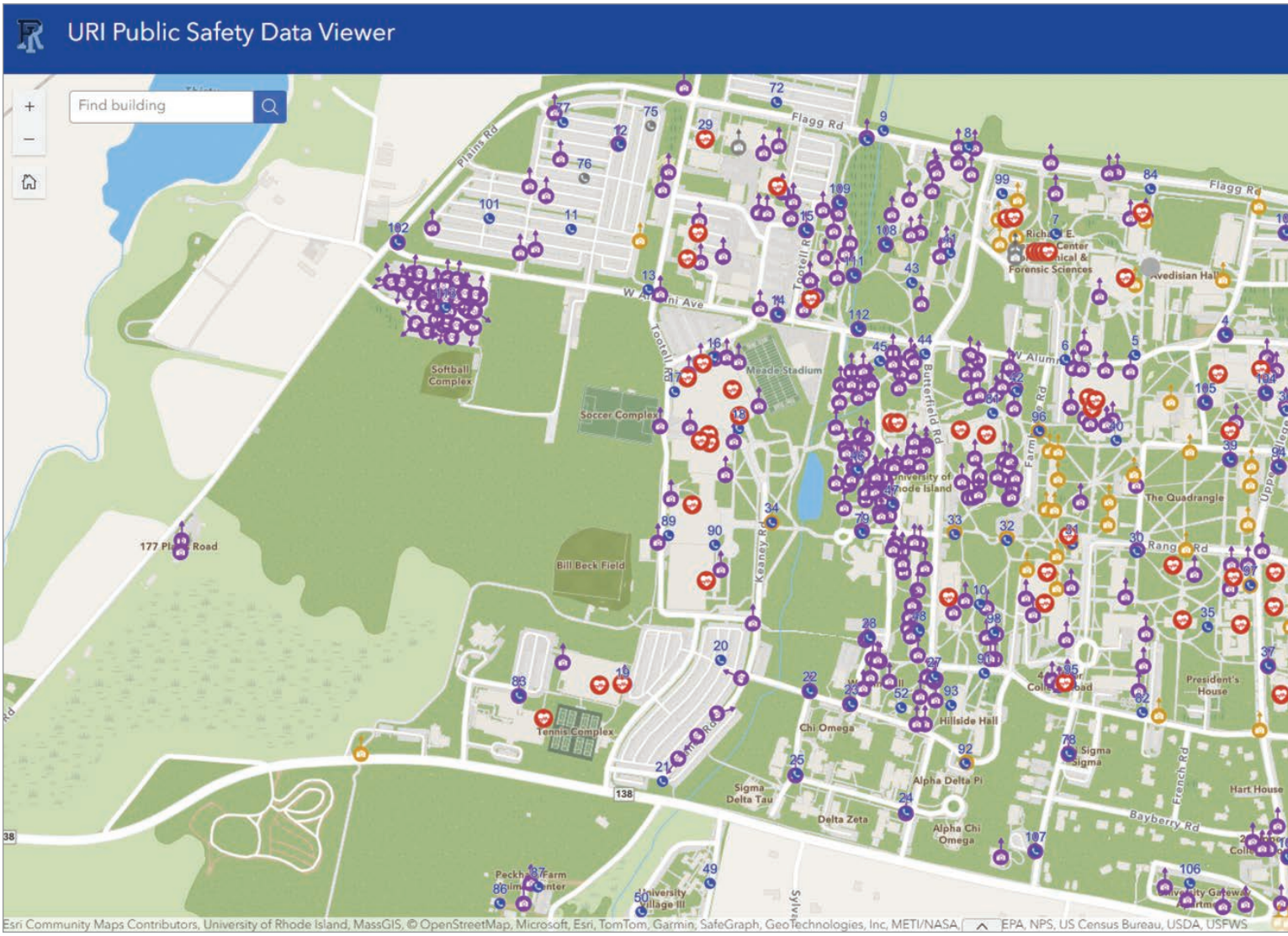
The facilities group uses ArcGIS to track landholdings, manage utilities data, maintain construction maps, and integrate Smartsheet APIs to distribute updates on projects managed by URI's Office of Small Projects through web applications.

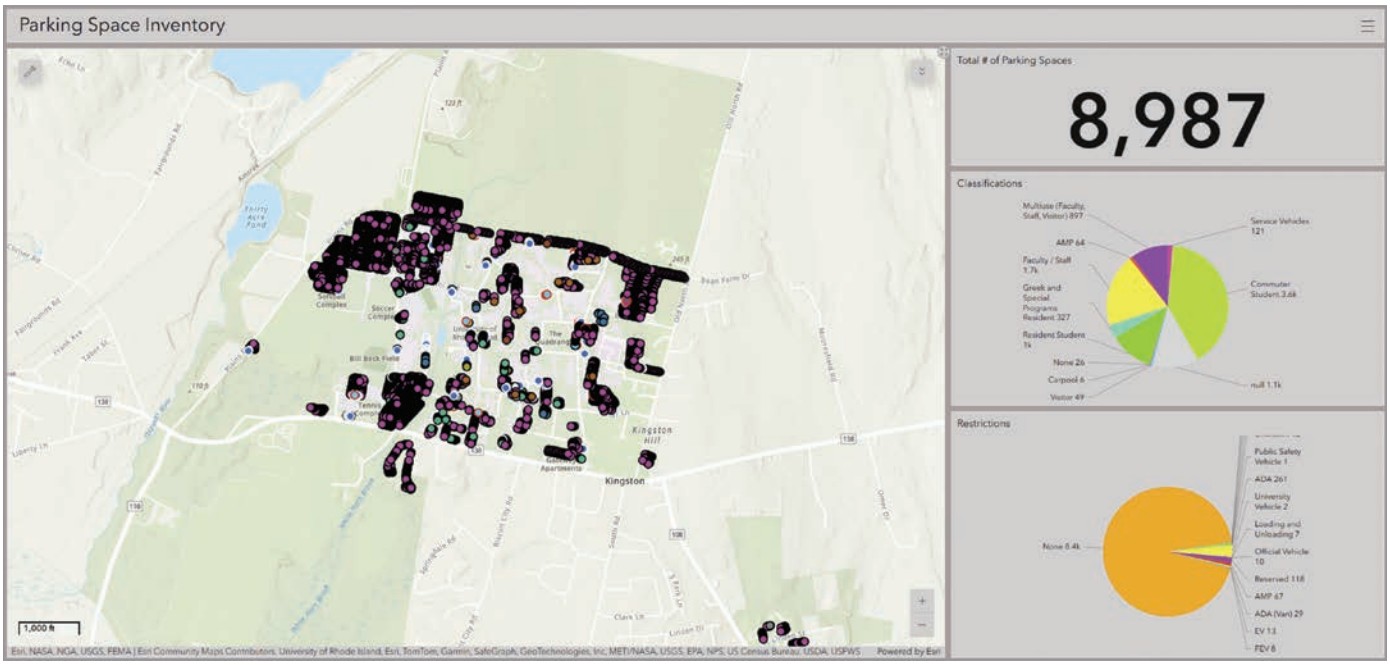
Instead of manually managing siloed data in external locations, URI stakeholders are now managing and sharing authoritative data across the ArcGIS platform digitally. These capabilities are elevating ArcGIS as an anchor enterprise business system technology.

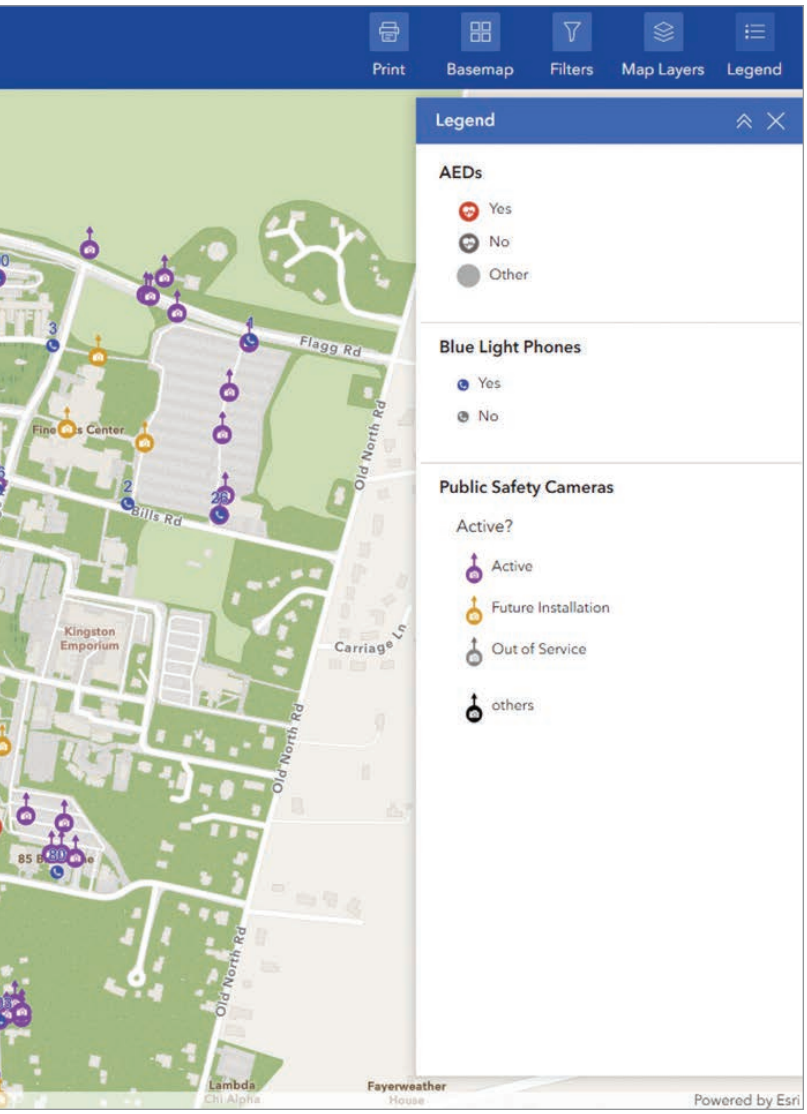
As URI built momentum tackling campus operations challenges, the spatial services team wanted to start solving problems for the broader campus community by taking advantage of distributed collaborations between ArcGIS Enterprise and ArcGIS Online instances. This allows the team to create public-facing web applications based on authoritative data managed in URI's ArcGIS Enterprise instance—sometimes in an enterprise geodatabase.

The first public-facing achievement was helping URI's College of Pharmacy and College of the Environment and Life Sciences map the URI Botanical Garden collections. An enterprise geodatabase replaced an older database and underpins a public web mapping application for visitors to spatially view and interact with the data.

The spatial services team has also provided the university's external relations and communications team with access to authoritative GIS data via the Adobe Illustrator plug-in. ArcGIS Maps for Adobe Creative Cloud enables the team to access and design with data-driven maps in Adobe Illustrator and Photoshop. The team uses the plug-in to generate a campus parking map. This provides URI's publishing team with access to authoritative geospatial data such as basemaps, building footprints, parking data, sidewalks, trees, and pavement lines—while allowing for artistic license.







↑ The transportation and parking department at URI manages its parking inventory using ArcGIS Field Maps and ArcGIS Dashboards.

← URI's public safety department uses campus maps and Indoors floor plans to manage university athletic events, residence hall move-ins, and commencement ceremonies.

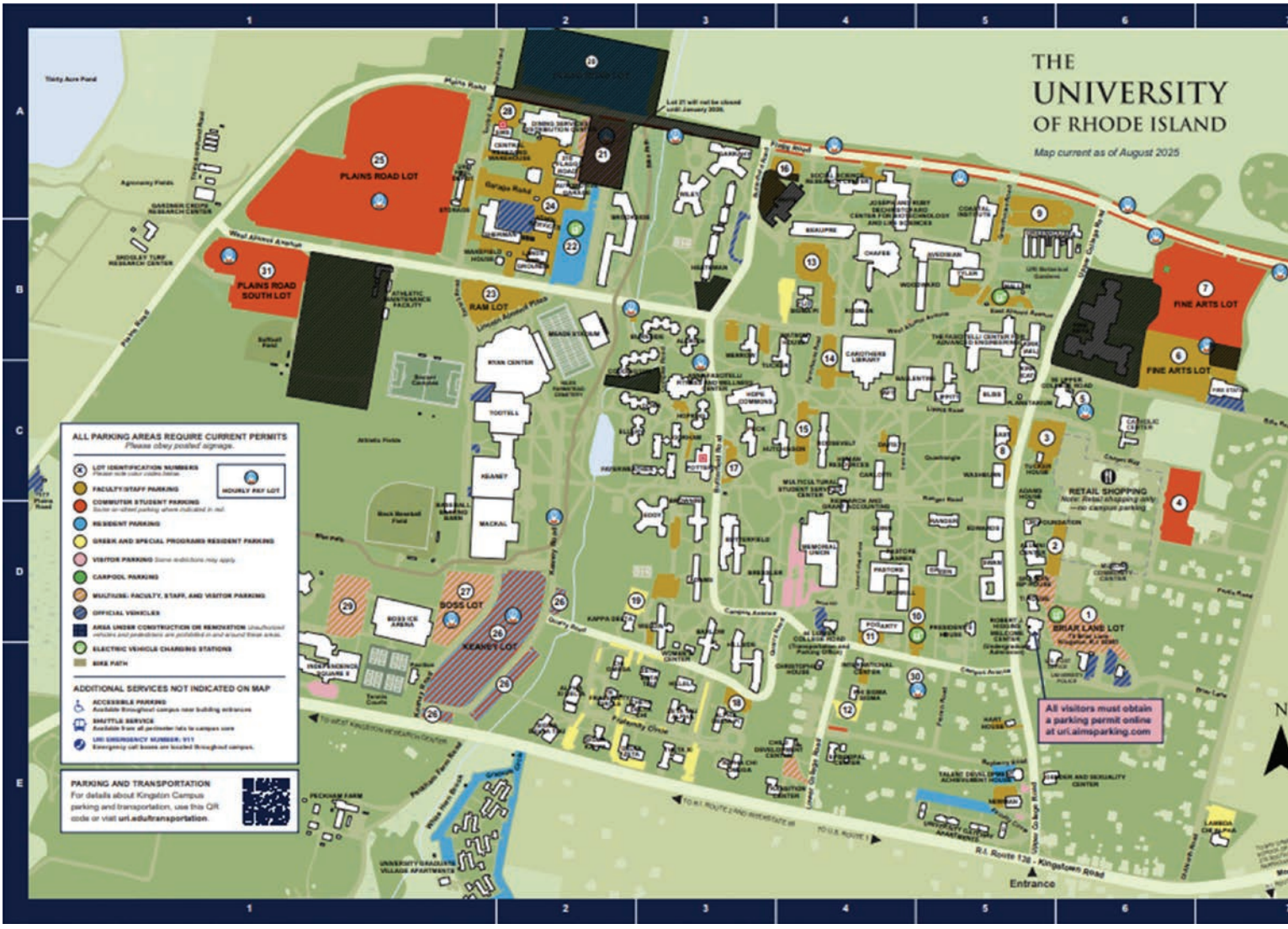
Spatially Visualizing University Data

One of URI's most exciting GIS developments is the data visualization capability that the ArcGIS Indoors model facilitates. Previously, URI staff visualized data one floor plan at a time using the former computer-aided facility management system. Combining the ArcGIS Indoors data model with the ArcGIS platform allows users to visualize data across the entire university and drill down to the campus, building, or space level.

However, the visualization doesn't end there. The spatial services team is also working on a pilot project for a digital twin. The team used base year data from a space survey for an indirect cost recovery rate negotiation to visualize how major research buildings on multiple campuses performed in terms of sponsored research activity. The team then used Indoors to see how the floors and individual research spaces performed during the space survey. This approach could be applied to many different types of data, including research expenditures, work order costs, and cleaning time.

The space survey data consisted of functions based on percentages for each room in the building. For example, a research laboratory might be functionalized as 50 percent sponsored research activities and 50 percent instructional activities. The team members took advantage of the unique unit ID to spatially relate the tabular space survey data with the rooms in Indoors. They then focused on the research spaces through a definition query for the research room types. Finally, the research spaces were symbolized based on the percentage of sponsored research activities.

By selecting the room, a user could also see all of the assigned functions in pie chart form and get a list of grant awards for the



principal investigator assigned to the research space. This project allows the university to analyze the performance of a building and its individual research spaces regarding indirect cost recovery. More importantly, it demonstrates the power of the ArcGIS suite to visualize various datasets at the university, campus, building, floor, or space level.

Looking Backward—and Forward

The biggest challenge has been managing expectations. As the number of departments and stakeholders relying on your enterprise GIS program grows, the more you will deal with people who don't fully understand GIS. They see maps, not data creation, collection, management, and visualization. They don't understand why it takes Indoors to render the more than 500,000 lines of code in the details feature class. They just want them to be rendered much faster. You need to educate your stakeholders so that their knowledge grows alongside the enterprise GIS. A GIS team or department needs to focus on building the geospatial tools. It's up to partner departments and stakeholders to manage their data using the tools that a GIS team builds, maintains, and supports.

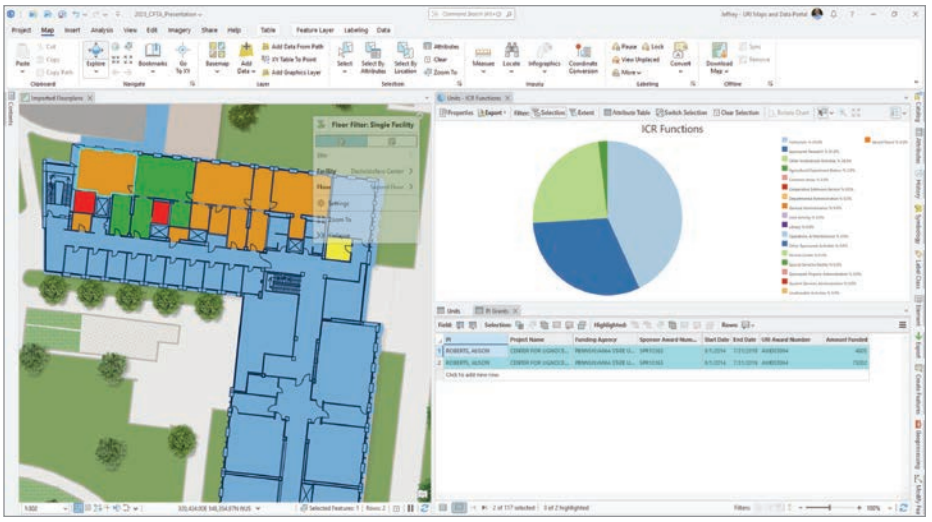
What has been clear throughout the process of integrating GIS technology across URI is the importance of a strong spatial foundation. The first step to an endeavor like this is a geospatial strategy. URI spatial services started with rounding out the GIS team, building a scalable ArcGIS Enterprise environment, and creating a university basemap. These pieces continue to help build success.

The spatial services team is still working to improve the basemap, but it's highly functional—even if it's not the most artistic. The same is true of the entire enterprise GIS program. The work will never be finished. An enterprise GIS program is always growing and adapting. The same is true of a geospatial strategy. That's why the spatial services team plans to revisit this strategy for a full refresh now that the ArcGIS Indoors implementation is complete. You always need a map to guide you on the next phase of the geospatial journey.

The transition to ArcGIS Indoors, combined with the comprehensive ArcGIS suite, has transformed how URI manages and shares

← A PDF parking map for URI.

→ The spatial services team is working on a pilot project for a sponsored research digital twin.



spatial data. Authoritative datasets continue to grow while collaboration flourishes. With this approach, the spatial services team continues to chip away at existing data silos.

Going forward, the team plans to publish a new interactive university web map. URI is implementing ArcGIS GeoEvent Server to facilitate real-time mapping of university shuttles; the fire alarm status in buildings; and, in the future, parking lot capacity. The shuttles use TransLoc fixed-route and on-demand transportation solutions and the fire alarms use the Digitize alarm monitoring platform. URI is also evaluating how the university can leverage additional ArcGIS tools, such as the ArcGIS Data Interoperability and ArcGIS Workflow Manager extensions, to automate processes and integrate data with other university systems. With all these innovations and plans, ArcGIS is no longer just a tool at URI; it's a strategic asset that drives innovation.

About the Author

Jeffrey Ulricksen is the assistant director of spatial services at the University of Rhode Island. He is responsible for space inventory and analysis and the integration of GIS into campus operations. Ulricksen also serves as president-elect for the Campus FM Technology Association, which focuses on the development, integration, and application of technology across multiple disciplines in the planning, maintenance, and management of campus facilities.

A GIS-Driven Approach to Property Management and Environmental Stewardship

By Jun Xiao

Established in 1925, Renewable Water Resources (ReWa) is a nonprofit, special-purpose district that provides wastewater collection and treatment services for upstate South Carolina. ReWa's mission is to enhance communities' quality of life by transforming wastewater into a renewable resource.

Over the past few decades, ReWa's service area has expanded substantially, and the organization has acquired new properties to support its growing operations, geographically dispersed throughout its service area. This area now spans Greenville County and portions of Anderson, Laurens, Pickens, and Spartanburg Counties.

Because of this growth, managing accurate and historically reliable property information across this region has presented significant challenges, particularly when it comes to maintaining historical records of properties that have changed ownership over many years. Much of the information existed only in institutional knowledge or was stored in boxes of paper documents. Without a unified and up-to-date property database, it was difficult to track and manage the properties.

To address these challenges, ReWa's GIS team collaborated with multiple departments across the organization to develop a comprehensive and authoritative property inventory, as well as a corresponding dashboard created with ArcGIS Experience Builder. This initiative aimed to create a centralized digital record of all ReWa-owned properties and establish a single, consolidated GIS data warehouse for property information. As the project progressed, this GIS-based property data became the foundation for property inspections, environmental and habitat assessments, and long-term planning for public recreation and trail development.

Building the Property Inventory

Before this project, ReWa had no centralized digital record of its property holdings, and parcel information varied across county jurisdictions. The GIS team began by researching parcel data from all five counties within ReWa's service area to identify every property owned by the utility. From county parcel datasets, information such as property boundaries, parcel identification numbers, purchase dates, and prior

← Aerial imagery of a ReWa water resource recovery facility shows the entire treatment plant layout and surrounding facilities.

↓ The Property Inspection App shows asset management inspection details and integrated asset links.

land-use records were extracted to enrich existing property data. The team also compiled related documents including deeds, easement agreements, and memorandums of understanding and organized them in a shared location. Each document was later linked to its corresponding property record in the GIS database, which could be accessed through a shared folder via URL.

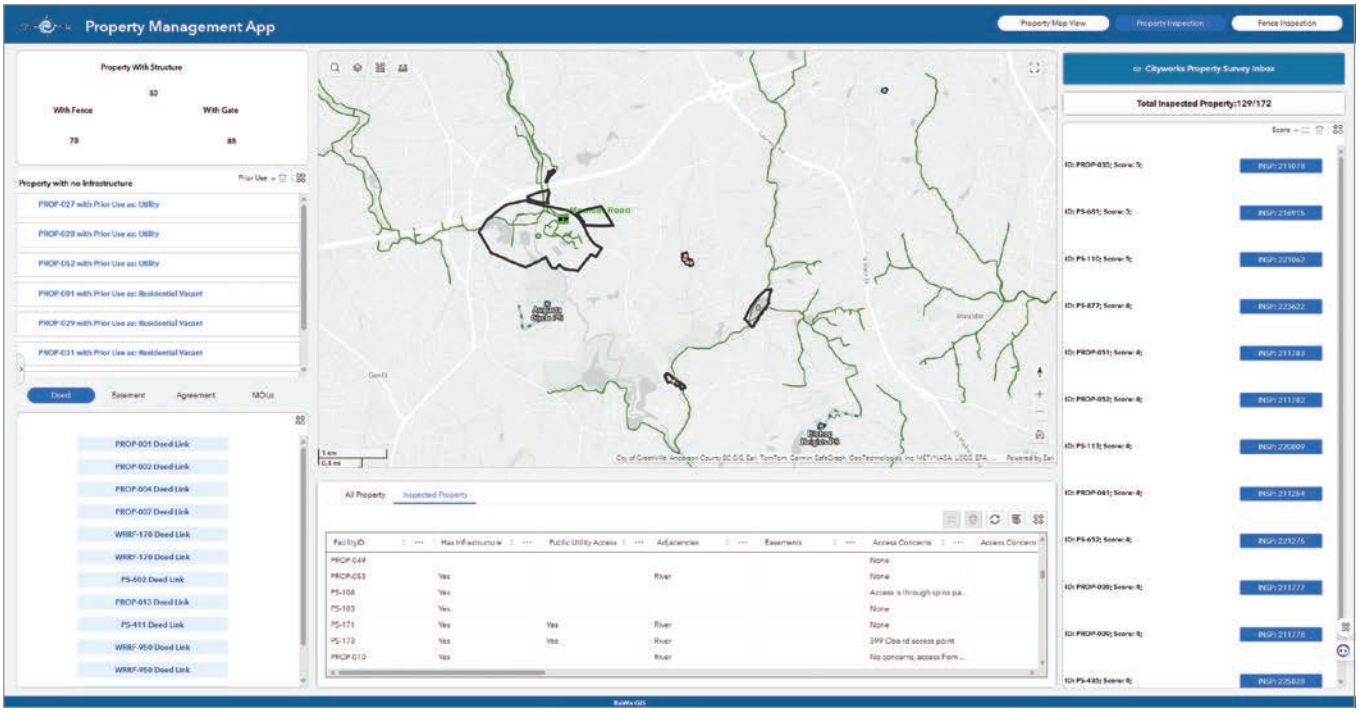
Collaborating with the facility management coordinator, the team added other data fields to support future property condition inspections as well as environmental assessments. These fields included attributes related to the physical condition of gates, fences, and structures, along with environmental indicators such as floodplain presence, aquatic ecosystem areas, and green space existence and acreage. By incorporating both operational and environmental attributes, the inventory evolved from a static ownership record into a dynamic dataset capable of supporting a wide range of management and planning needs.

During the research and development process, several key challenges emerged. One challenge was the standardization of property ownership records. Some properties were still listed under ReWa's previous name, which was changed in 2009. In other cases, treatment plant sites were still recorded as multiple small parcels that needed to be consolidated. The team also discovered that several pump stations transferred to ReWa were located on school or homeowners' association properties without distinct parcel identification numbers. To ensure data quality, the GIS team held standing review meetings with the engineering right-of-way coordinator and the facility management coordinator to verify property information and identify these and other issues that needed to be addressed.

Through this effort, ReWa established an authoritative property inventory that now includes 177 properties totaling approximately 1,883 acres. This inventory has provided the organization with its first comprehensive overview of all land assets and helped establish the foundation for subsequent stages of the organization's land management initiatives.

Integrating into the Asset Management System

With the property inventory established, the team's next step was to integrate the GIS data into the organization's asset management system to support routine property inspections.



↗ A damaged fence that was identified during a field inspection.

↘ Evidence of illegal dumping on-site that was identified during a field inspection.

In this stage, GIS played a pivotal role in connecting property GIS data with the Computerized Maintenance Management System. The asset management team worked closely with the facility management team to develop property inspection templates that aligned with the attributes defined in the GIS database. These templates ensured field staff consistently recorded property conditions and observations, including potential hazards, site signage, and any evidence of illegal dumping. To maintain data synchronization, the GIS team developed a daily scheduled SQL script that automatically overwrites inspection data back into the GIS database.

With the integration completed, the GIS team developed a property inspection dashboard using ArcGIS Experience Builder to make the data easily accessible and actionable across the organization.

The dashboard provides an interactive view of inspection progress, property observations, and conditions in real time. Users can filter inspections by property condition score and quickly prioritize areas requiring follow-up. Each property record includes direct links from the GIS environment to the corresponding inspections within the asset management system, enabling seamless navigation between inspection data and maintenance actions.

The dashboard has become a central tool for management and field coordination. Supervisors use it to monitor inspection progress and identify maintenance priorities, while field teams rely on it to verify property details and update inspection records.

Supporting Environmental Assessment and Land Revitalization

To better understand the environmental characteristics of ReWa's properties, the GIS team performed a series of spatial analyses using Federal Emergency Management Agency (FEMA) floodplain data, the National Land Cover Database, and wetland datasets. The analyses quantified the environmental composition of each property, identifying areas influenced by floodplain coverage, aquatic habitats, and green space.

Across ReWa's 177 properties, the results showed 124 aquatic ecosystem areas, 714 acres of floodplain, and 1,413 acres of green space. These findings now serve as the foundation for field-based environmental

↑ The Property Management app shows the editable map interface and active edit functions.

assessment efforts led by ReWa's watershed and natural resources team with support from the GIS team. It supports water quality improvement projects such as land protection, wetland and riparian restoration, stormwater and green infrastructure best management practices, and stream-bank stabilization by providing reliable property and environmental information.

Most recently, to support ReWa's land revitalization initiatives, the GIS team also developed a property map view application. This project combined many of the property inventory and asset management integration system components in a new collaborative effort. With the property map view app, managers and land management consultants can navigate geospatial data of property and land assets throughout ReWa's entire service area, conduct land-use assessment, and determine future land-use plans.

The application provides query, filter, and field edit functions that allow users to access property details, review environmental characteristics, and record assessment results directly within the GIS platform. By integrating environmental data, operational information, and planning tools into a single spatial environment, the application supports informed decision-making; promotes collaboration; and helps identify opportunities for restoration, repurposing, and community-focused development.

Through the land management initiative, ReWa has transformed how property information is collected, managed, and shared across the organization. What began as an effort to centralize property records evolved into a comprehensive GIS framework that supports asset management, environmental assessment, and land revitalization. By integrating data from multiple departments and systems, ReWa created a unified platform that improves efficiency, strengthens collaboration, and supports data-driven decision-making. This initiative not only enhances ReWa's ability to maintain its property asset portfolio but also advances its mission of environmental stewardship and community engagement.

As ReWa continues to build on this foundation, the organization plans to expand the use of GIS to further support sustainable land management, promote public access to natural spaces, and ensure that every property contributes to the health and vitality of the community.

About the Author

Jun Xiao is the enterprise GIS administrator at Renewable Water Resources. She leads the administration, maintenance, and optimization of ArcGIS Enterprise, focusing on system architecture, automation of geospatial workflows, and integration with asset management and operational systems. Since joining the utilities industry in 2018, Xiao has specialized in applying GIS technology to enhance wastewater utility operations, data governance, and disaster response. She holds a master's degree in geospatial systems engineering from Texas A&M University–Corpus Christi, where she developed a strong foundation in spatial data management and geospatial system design.

Through the land management initiative, ReWa has transformed how property information is collected, managed, and shared across the organization.

Halting the Spread of Desertification in Saudi Arabia

By Jim Baumann

Roughly 5,000 years ago, a river system called Wadi Al-Batin flowed through the Arabian Desert. Today, this area is devoid of any permanent rivers, though groundwater reaches the surface at some locations to form oases. Ninety-five percent of the Kingdom of Saudi Arabia lies within this desert region.

But according to Eyad Hammad, remote sensing specialist and project manager at Saudi Arabian Oil Company (Saudi Aramco), the country's fertile land is at risk of becoming as arid as the desert.

"Desertification is a variable phenomenon," said Hammad. "While much of Saudi Arabia is desert, some regions support an abundance of plant and animal life. In addition, farming is conducted near dry wadis by pumping water from underground aquifers to pivot irrigation systems."

The urgency of maintaining these resources and preventing the spread of desertification is one of the factors that led to the Kingdom of Saudi Arabia's National Water Strategy 2030. This plan is designed to provide a framework for the sustainable development of the country's water sector, and was developed by Saudi Arabia's Ministry of Environment, Water and Agriculture (MEWA) to help achieve Saudi Vision 2030, a strategy to diversify the country's economy.

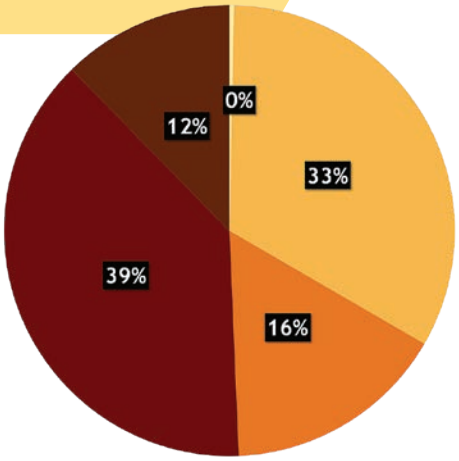
As part of this plan, Saudi Aramco, the world's largest oil exporting company, is using ArcGIS tools to model desertification risk throughout the country, gathering data and developing the means to hold onto Saudi Arabia's fertile ground.

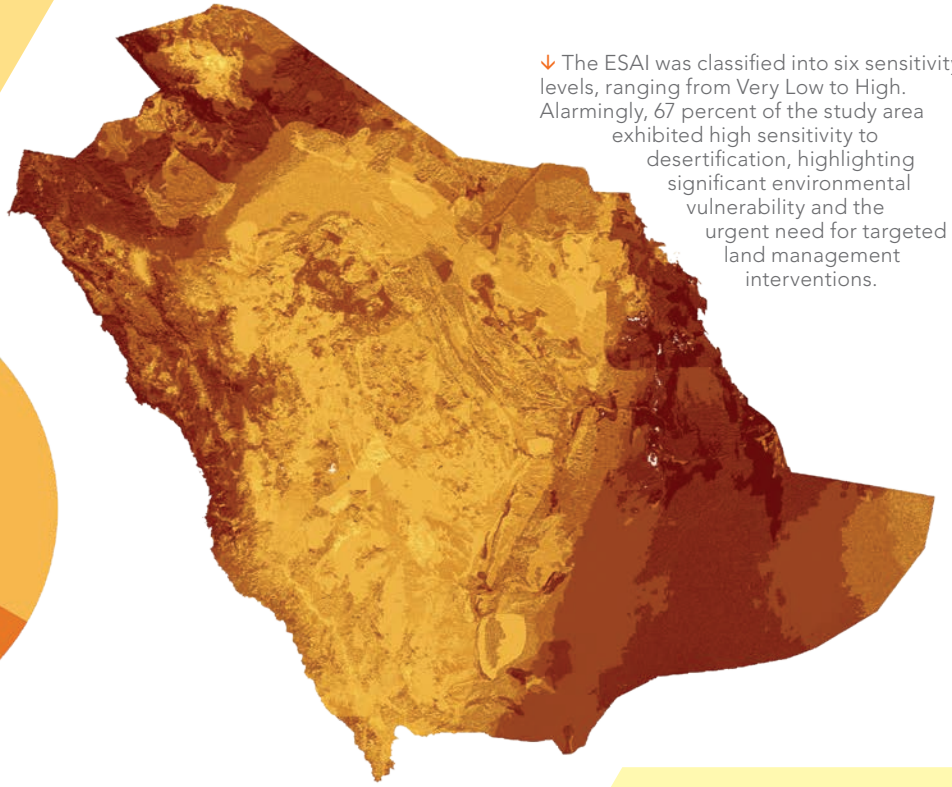
Developing the Model

Founded nearly 100 years ago, Saudi Aramco began implementing ArcGIS technology in 1982 for oil exploration and production. Since then, the system has grown into an enterprise-wide platform.

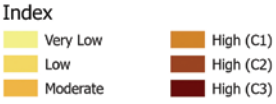
The company has relied on ArcGIS Pro to combat desertification with geospatial

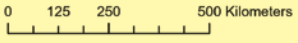
↓ A dedicated web application, interactive dashboard, and interactive map have been developed to enable authorized users to access, explore, and analyze the Environmentally Sensitive Areas Index (ESAI) results alongside subindexes and underlying input layers.





↓ The ESAI was classified into six sensitivity levels, ranging from Very Low to High. Alarmingly, 67 percent of the study area exhibited high sensitivity to desertification, highlighting significant environmental vulnerability and the urgent need for targeted land management interventions.





data processing, manipulations, and analysis. Portal for ArcGIS, a component of ArcGIS Enterprise, is used to share web GIS solutions, including dashboards and stories created with ArcGIS StoryMaps. ArcGIS Server hosts and publishes the project's online services. ModelBuilder was used to automate the processes.

"The goal of our project is to identify areas throughout the country that are at high risk for severe desertification," said Hammad. "We want to determine the reasons for this condition by analyzing the impact of various factors that can potentially contribute to desertification."

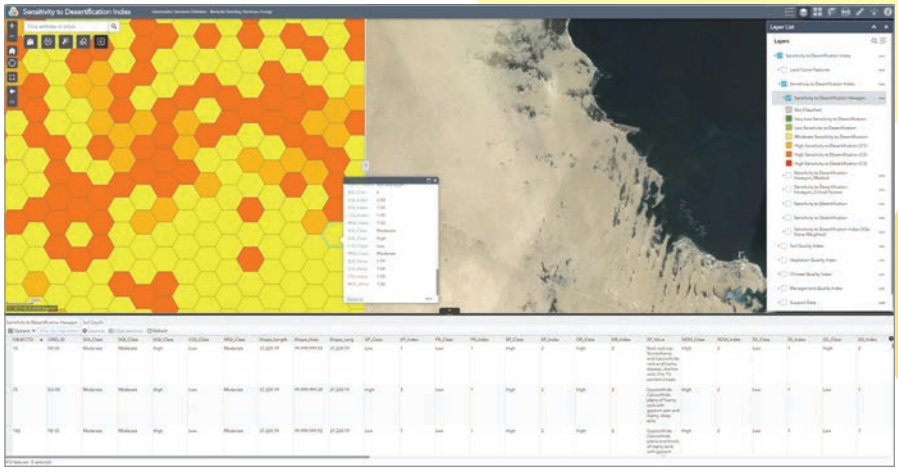
Imagery for the Saudi Arabian desertification risk model was acquired by Hammad's team from the European Space Agency's Copernicus Sentinel-2 satellite constellation.

Copernicus is the Earth observation component of the EU Space Programme. Sentinel-2 collects continual, high-resolution optical imagery of Earth with multispectral sensors, providing detailed views of vegetation, soil, and water cover under daylight and clear atmospheric conditions. The ArcGIS Image Analyst extension in ArcGIS Pro is then applied to the multispectral imagery to create false-color composites and perform analysis.

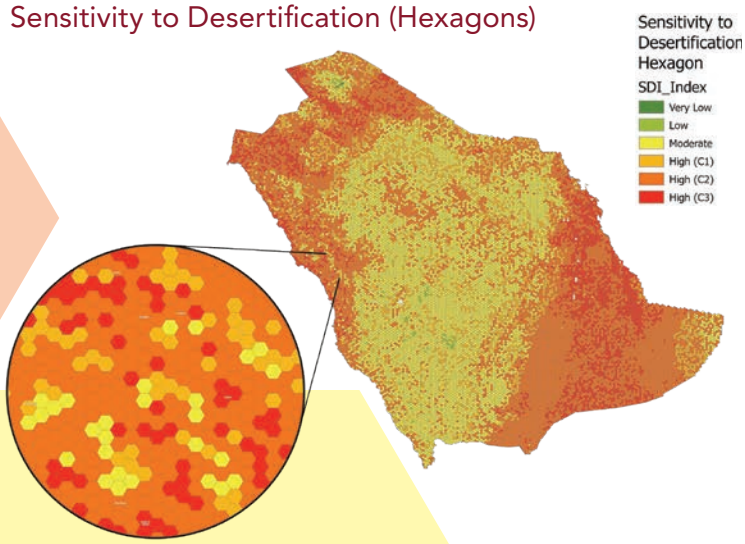
The team used historic satellite imagery with a very high resolution of 30 and 50 centimeters to analyze and classify changes in desertification throughout the country and validate the model.

Other data used in the model includes meteorological data from WorldClim, climate data from the Food and Agriculture Organization, demographics data from the

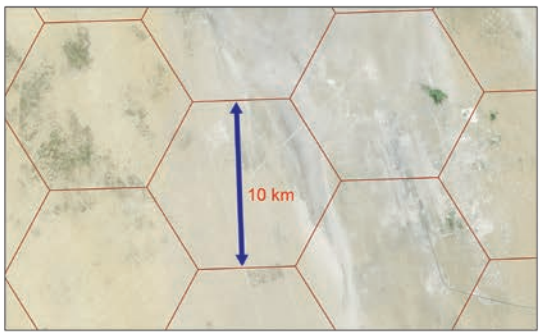
↓ The ESAI has been integrated into a comprehensive web-based platform using ArcGIS Server and Portal for ArcGIS.



Sensitivity to Desertification (Hexagons)



Hexagon Cell Size: 100km²



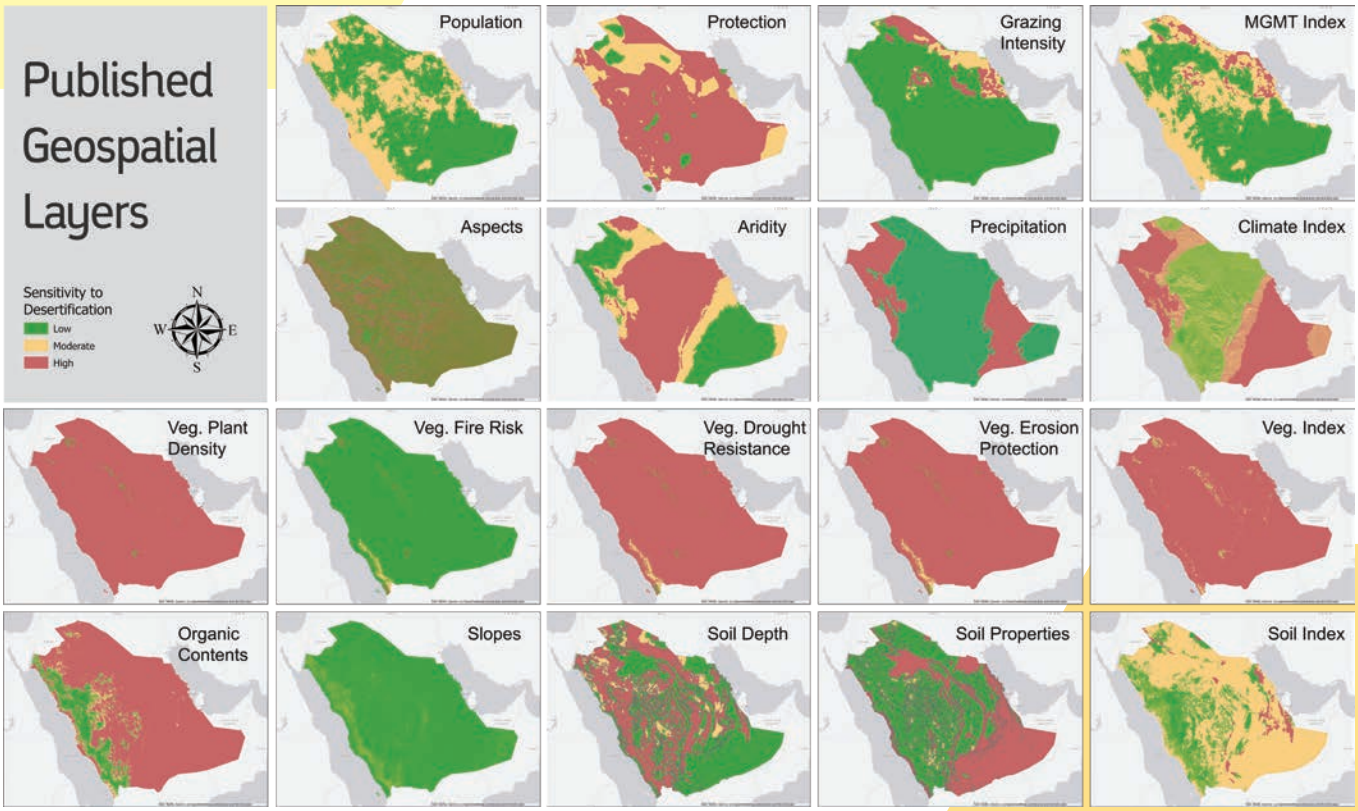
United Nations, and land-cover and soil data from the MEWA.

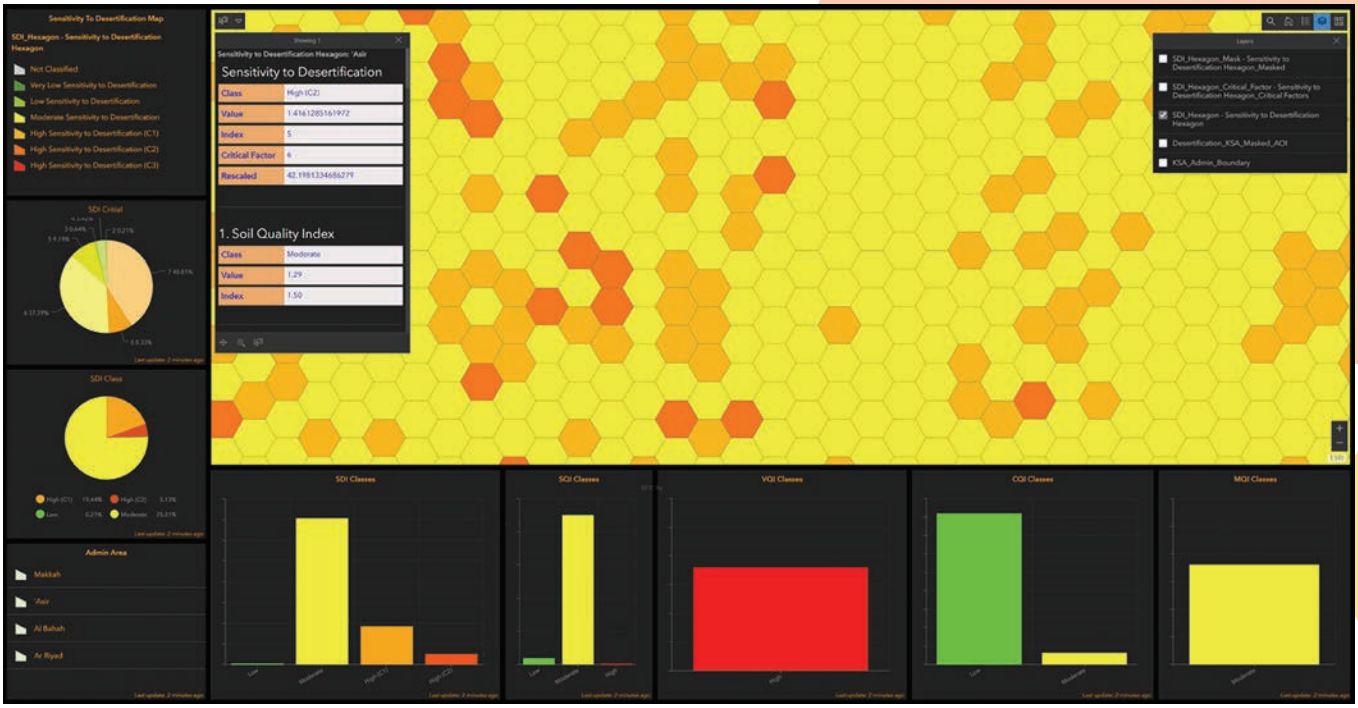
In the development of the dynamic Saudi Arabian desertification model, the project team also implemented modified versions of the Mediterranean Desertification and Land Use (MEDALUS) model and the Environmentally Sensitive Areas Index (ESAI). MEDALUS is a framework created by the European Union to identify areas vulnerable to desertification and land degradation.

"The team started the desertification model development by evaluating the original MEDALUS model, which contained three primary indices including soil, vegetation, and climate," said Hammad. "After the first assessment on a pilot area, we

↑ The ESAI has been visualized using a hexagonal grid map, with the 100-square-kilometer hexagon cell offering a more user-friendly and interactive way to explore the data.

↓ Together, these layers form a comprehensive assessment of desertification sensitivity, enabling a detailed understanding of environmental conditions across the study area.





↑ The solution supports dynamic interaction, measurement data, and spatial analysis, offering a powerful and user-friendly tool for informed decision-making and environmental management.

decided to implement an enhanced version of the model by adding a fourth index to represent the human factor related to land degradation or preservation."

The indexes required processing 14 different geospatial datasets that collectively represented various aspects of the desertification process. They were acquired from both public and private sources. To ensure consistency and comparability, all input data was normalized and converted to a unified unit scale. This involved assigning sensitivity scores of 1, 1.5, and 2 to each criterion, reflecting its relative impact on desertification and land degradation. The normalized datasets were then applied to the MEDALUS equations to calculate the ESAI index and include it in the desertification model.

First Steps

The completed model is the result of a one-year study and represents the first step in protecting those areas under threat of severe desertification by incorporating them into the Saudi Aramco Biodiversity Protection Program. Desertification risk maps, such as the *Sensitivity to Desertification Index* map, are crucial for highlighting areas at high risk of desertification using advanced interactivity, analysis, and geovisualization.

The results of the Saudi Aramco team's model were clear. Analysis revealed that climate factors play a major role in the ongoing desertification of Saudi Arabia. Perhaps unsurprisingly, rainfall is the most significant of these factors. The amount of annual precipitation has a direct impact on desertification sensitivity scores.

"Another crucial factor is human pressure, which encompasses human activities that interact with land, such as population pressure, grazing intensity, and conservation practices," said Hammad. "These factors have a noticeable impact on resource sustainability and land degradation."

Hammad noted that this project is only one building block in a larger plan to develop a climate change stress index in support of biodiversity protection. In addition to the original four indexes, desertification factors in future studies could include ecosystem diversity, elevation, storm surge flooding, sea level rise, dust storms, landslides, habitat impact, and desertification risks.

"Our analyses provide decision-makers with the necessary knowledge and insights to better understand the impact of desertification on biodiversity," said Hammad. "This allows them to prioritize areas for conservation and restoration efforts."

About the Author

Jim Baumann is a longtime employee at Esri. He has written articles on GIS technology and the computer graphics industry for more than 35 years.

Python Aids Rat Mitigation Efforts in New York City

By Erika Poulsen

↓ The death of Flaco the owl, a beloved Central Park Zoo resident, prompted the New York City Council to pass a law addressing rat mitigation efforts in the city. (Photo by Chris Huskey.)

Flaco, a popular Eurasian eagle-owl who famously escaped from New York City's Central Park Zoo, died in February 2024 after flying into a building. Necropsy results showed that Flaco had consumed rodenticides prior to his death.

While rat mitigation efforts are vital for public health, Flaco's death was a sign that city officials needed to consider alternatives to traditional rodenticides.

In response, New York City Council enacted Flaco's Law in September 2024 and legislated a 12-month rat contraceptive pilot program to evaluate products marketed as contraceptives for rodent control. Rodent contraceptives are considered to be less harmful to wildlife but have not yet been proven to be effective in controlling rodents at the neighborhood level.

Flaco's Law called for the New York City Department of Health and Mental Hygiene (NYC Health) to install contraceptive stations and collect detailed data to measure their effectiveness. Each station contains three different formulations of contraceptive products and one control product.

To support the data-intensive pilot program, NYC Health needed timely updates and clear visualization tools for analysis and decision-making. The department expanded its ArcGIS Online

inspection workflows for the rat contraceptive pilot program by automating key tasks with ArcGIS API for Python.

The solution integrated ArcGIS Online web maps and hosted feature layers with ArcGIS Field Maps, ArcGIS Dashboards, and automated Python scripts. This created a streamlined workflow that allows inspectors and supervisors to collect, track, and view inspection results in real time, reducing GIS staff workload while ensuring that inspection and office staff have access to accurate, up-to-date information.

Deploying Field Apps for Data Collection

The rat contraceptive pilot program began in May 2025 within the Harlem Rat Mitigation Zone in Manhattan. Rat Mitigation Zones are areas where the city has focused rat mitigation efforts, including proactive inspections, sanitation improvements, and intensive rat-management strategies.

NYC Health inspectors used handheld devices with the Contraceptive Station app, an ArcGIS Field Maps app to identify suitable locations for the contraceptive stations. The app displayed contextual layers including trees, parks, and open spaces for optimal placement. Once inspectors selected a location, they created a new station point in an ArcGIS Online hosted layer. Calculated expressions automatically populated attributes such as the nearest tax lot, street address, building description, installation date, and inspector name. Drop-down menus standardized data entry for attributes like bait type. This automation eliminated manual entry of addresses and property information, saving time and reducing data entry errors.

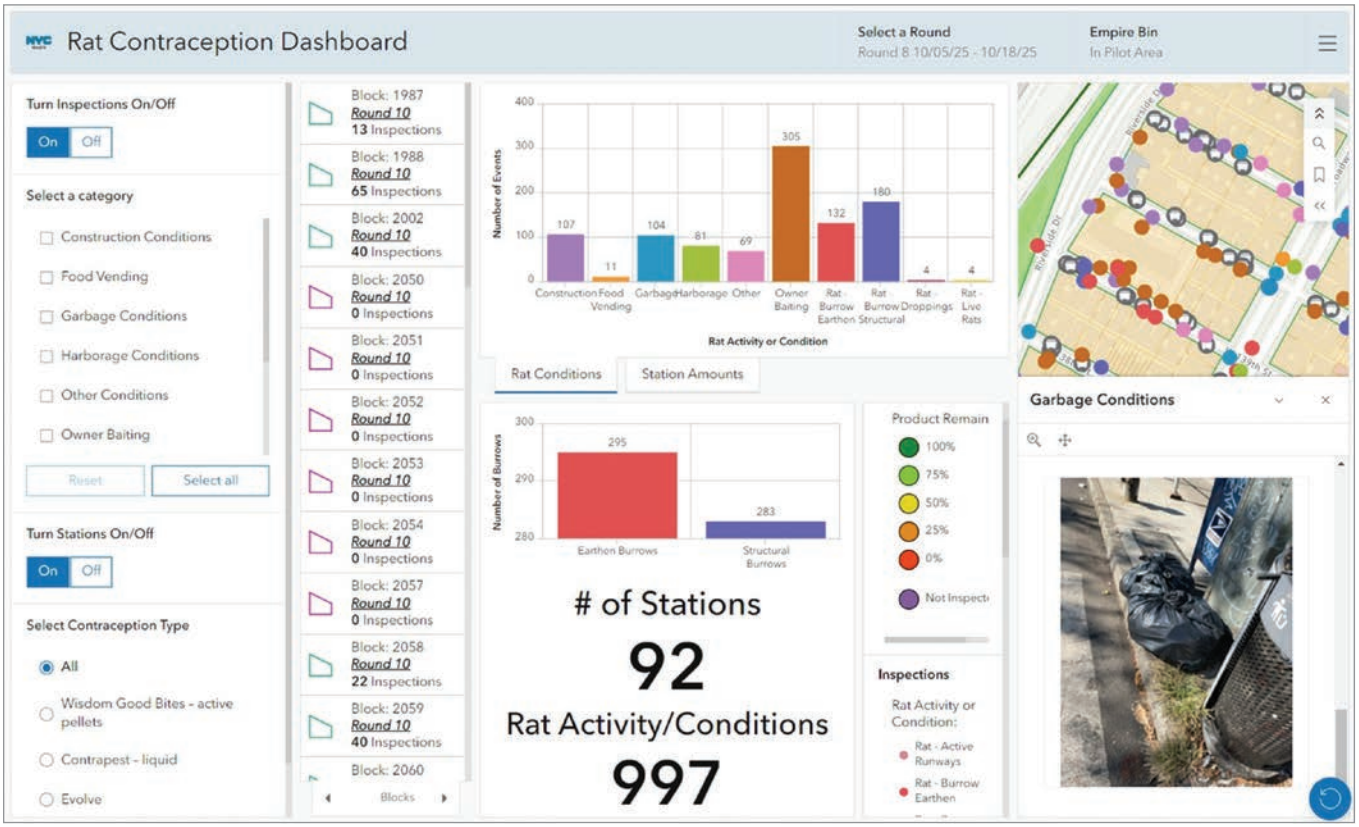
Once the contraceptive stations were established, inspectors began using a second ArcGIS Field Maps app, the Rat Inspection app, for ongoing monitoring. This app allows inspectors to create point features documenting rat activity and conditions throughout the pilot project area. Inspectors also add inspection records with attachments to related tables for existing contraceptive stations as well as the NYC Department of Sanitation's Empire Bins. Station inspections record product levels and station condition while Empire Bin inspections record rat-related conditions around the bins. These bins are large trash containers designed to securely hold garbage and prevent rats from accessing residential food waste.

Like the Contraceptive Station app, the Rat Inspection app uses calculated expressions to automatically populate attributes related to property information, inspection date, inspector name, and closest station or bin. Conditional visibility displays only relevant data collection fields based on the selected rat activity or condition.

Inspections follow a two-week schedule of monitoring rounds. During each round, inspectors check the entire pilot project area,

← A major part of rat mitigation involves preventing rats from accessing residential food waste.

↓ The Rat Contraception Dashboard allows supervisors to monitor rat activity and conditions for both the current and previous monitoring rounds.



covering every street segment, station, and bin. They look for signs of rat activity, such as fresh tracks, droppings, burrows, gnaw marks, and live rats, as well as conditions that may attract rats like garbage and harborage.

Monitoring with Dashboards

As part of the pilot program, NYC Health created the Contraceptive Station and Rat Inspection Dashboard to provide supervisors with real-time oversight. The dashboard allows supervisors to monitor rat activity and conditions for both the current and previous monitoring rounds. The dashboard's map displays the status of contraceptive stations, which blocks have been inspected, and the locations of rat activity and conditions.

Supervisors can click any station, Empire Bin, or rat activity point to view the latest inspection details and attached photos. Filters allow supervisors to view data by monitoring round or rat activity/condition type, and layers can be toggled on and off for customized views.

The dashboard includes two lists that rely on the automated Python workflows. The first list shows all blocks in the pilot project area, displaying the block ID, the number of rat activity and condition observations, and the current monitoring round. Pink block outlines indicate uninspected blocks, while aqua outlines show inspected blocks. Clicking a block zooms the map to that location, filters out other features, and updates charts and indicators throughout the dashboard. The second list displays all contraceptive stations, showing station ID, remaining product amount, and the date and time of the last inspection. Station points are symbolized by product level to provide a quick visual reference.

Charts provide additional insights. One chart shows the number and types of rat activity and condition observations across the project area for the current monitoring round, with options to filter by round or block. Another chart shows the distribution of stations by current product level based on the most recent inspection data. Dashboard indicators summarize rat activity and conditions according to the selected filters, providing supervisors with key metrics.

Extending ArcGIS Online with Python

While the Field Maps apps and dashboard provide inspectors and supervisors with the tools they need, building the underlying web maps presented several technical challenges. The standard capabilities of ArcGIS Online couldn't fully support the program's needs for dynamic filtering, symbolizing features based on related table data, or automatically updating block inspection counts and status by current monitoring round without some level of manual intervention. To address these limitations, GIS staff developed automated solutions using ArcGIS API for Python and scheduled cron jobs.

These Python scripts extend the capabilities of ArcGIS Online by updating a flag attribute used to filter data by monitoring round, copying inspection data from related tables into feature layers and calculating inspection counts and status by block. Hourly updates remove the need for manual intervention; keep supervisors informed with current inspection block status in the dashboard; and ensure inspectors have accurate, up-to-date data in ArcGIS Field Maps apps.

The web map used for the Rat Inspection app displays rat activity and condition data collected across multiple monitoring rounds.

↑ Contraceptive stations contain three different formulations of contraceptive products and one control product.

However, inspectors need to see only inspections from the current round to accurately track their progress covering the pilot project area. Previously, this map needed to be manually updated at the start of each new round to filter out previous inspections so that inspectors could focus on the inspections in the current round.

GIS staff created a Python script using ArcGIS API for Python to automate this filtering process. The script determines the current round by comparing the current date with each rat activity and condition data collection date. It then updates the [RoundFlag] column to "Yes" if the inspection falls within the current round or "No" if it does not. Since the [RoundFlag] column is used as a filter in the web map, this automated update eliminates the need for manual filtering. Running nightly, the script ensures that inspectors see only inspections relevant to the current round in the Rat Inspection app.

The dashboard map needed to display contraceptive stations symbolized by the amount of product remaining as of the most recent inspection. However, ArcGIS Online does not allow features to be symbolized or displayed in dashboard charts using attributes stored in a related table. This made it impossible to symbolize the station points and bar charts based on the latest recorded amount of contraceptive product remaining.

Another Python script was designed to update the rat contraceptive station feature layer with the most recent inspection data from

its related inspection table. GIS staff added a new column, [ProductRemaining], to the station layer. The script identifies the most recent inspection record for each station in the related table, extracts the remaining product amount, and writes that value into the [ProductRemaining] column. Running hourly, the script allows stations and charts to be symbolized by product levels.

The dashboard also needed to display inspection status and the number of inspections completed for each block during the current monitoring round to help supervisors track inspection progress across the pilot project area. One approach would be to use a join view linking the block layer with inspection data. However, a new join view would need to be created for each monitoring round, requiring manual updates by GIS staff.

↑ Because rats contribute to the spread of disease, food contamination, and structural damage, mitigation efforts are vital.

GIS staff developed a Python script to automate this process as well. The script identifies the current monitoring round based on date; counts all rat activity and condition inspections completed within that round for each block; and updates two columns in the block layer: [InspectionCount], which shows the number of inspections completed during the round, and [Status], which flags whether or not the block has been inspected. By automatically updating these columns, the script eliminates the need to manually create or manage join views. Running hourly, the dashboard always reflects current inspection activity.

These automated workflows demonstrate how Python scripts can extend ArcGIS Online capabilities to support real-time inspection operations. By combining ArcGIS Field Maps, ArcGIS Online, and ArcGIS API for Python, complex workflows involving multiple layers, inspection types, and time-sensitive data can be managed efficiently. The automation enables NYC Health to eliminate manual intervention, reduces human error, and ensures that both inspectors and supervisors have access to accurate, actionable information.

Closest Station | 241

Run

```
// create the 30ft buffer
var buff = Buffer($feature, 150, 'feet')

// get closest station
var xs_bbls = Intersects(buff, FeatureSetByName($map, 'Station'))
var closest_bbl = null
var min_distance = Infinity

// Loop through the stations
for (var bbl in xs_bbls) {
    // get distance
    var dist = Distance(bbl, $feature, 'feet')
    if (dist < min_distance) {
        min_distance = dist
        closest_bbl = bbl
    }
}

// check if a station was found
if (closest_bbl == null) {
    return "No Station found within 150 feet"
} else {
    // return formatted string with closest BBL info
    return `${closest_bbl['StationID']}`
}
```

About the Author

Erika Poulsen, PhD, GISP, serves as director of GIS at NYC Department of Health and Mental Hygiene in Environmental Health. She holds a PhD in geography from Rutgers University, specializing in spatial analysis of crime and an MS in geoinformation sciences from Salem State University. Poulsen has 27 years of experience applying GIS to criminology, emergency management, and environmental health. She has also authored peer-reviewed journal articles on spatial statistical methods.

← This calculated expression automatically identifies the closest contraceptive station to a rat activity or condition location.

The Benefits of Integrating GIS and Data Science

By Seth Marcus

In recent years, organizations have realized significant benefits from investing in geospatial technology and data science capabilities. GIS and data science naturally complement one another, each supporting the work of the other. Often, however, an organization's data science team resides within one department, and the GIS team lives elsewhere in the org chart.

At first glance, this division could appear advantageous. It may seem easier to manage separate teams responsible for their own business unit-focused analytics. However, if these two disciplines are disconnected in an organization without shared data or unified governance, it can result in higher costs; inaccuracies; reduced operational efficiency; and missed opportunities for deeper, more sophisticated insights.

The Price of Fragmentation

A GIS or data science team can often be created in response to a need within the organization. Say the CFO of a company wants a financial dashboard to track compliance with new regulations. The CFO's division forms a data science team that develops a data warehouse and dashboards to answer specific financial questions.

At the same time, the manager of the company's marketing department wants a map showing customer demographics in different sales regions. The manager hires a geospatial technology team that purchases GIS software, geocodes customer data into a geodatabase, and generates maps. The manager can now visualize market areas, gain new insights into customer purchase patterns, and improve targeted advertising.

In this scenario, the CFO doesn't need to care much about customer demographics and the marketing manager has little concern for the company's financial reports. Neither has a problem with siloed analytics capabilities across the company since their own parochial needs are being met. In fact, they may not even be aware of what the other's team is doing.

Now, say other executives at this organization recognize the value provided by the maps and dashboards and start building their own stovepiped analytics or GIS teams within their business unit silos. As analytics capabilities proliferate in an uncoordinated way across the company, efforts are duplicated; enterprise architecture becomes increasingly complex; and costs for data storage, infrastructure, and software licensing multiply.

Even worse, the lack of integration limits the company's ability to gain enterprise insights, making it difficult for the CEO to answer simple questions such as "How many customers do we have?"

Attempting to answer that question, the organization's financial data team might decide to define customers as clients who have submitted payments within the last 12 months. The team queries its financial dashboard and tells the CEO there are 1,251 customers.

Simultaneously, the marketing executive's GIS team defines customers differently. They tally all accounts with valid mailing addresses and tell the CEO there are 1,486 customers.

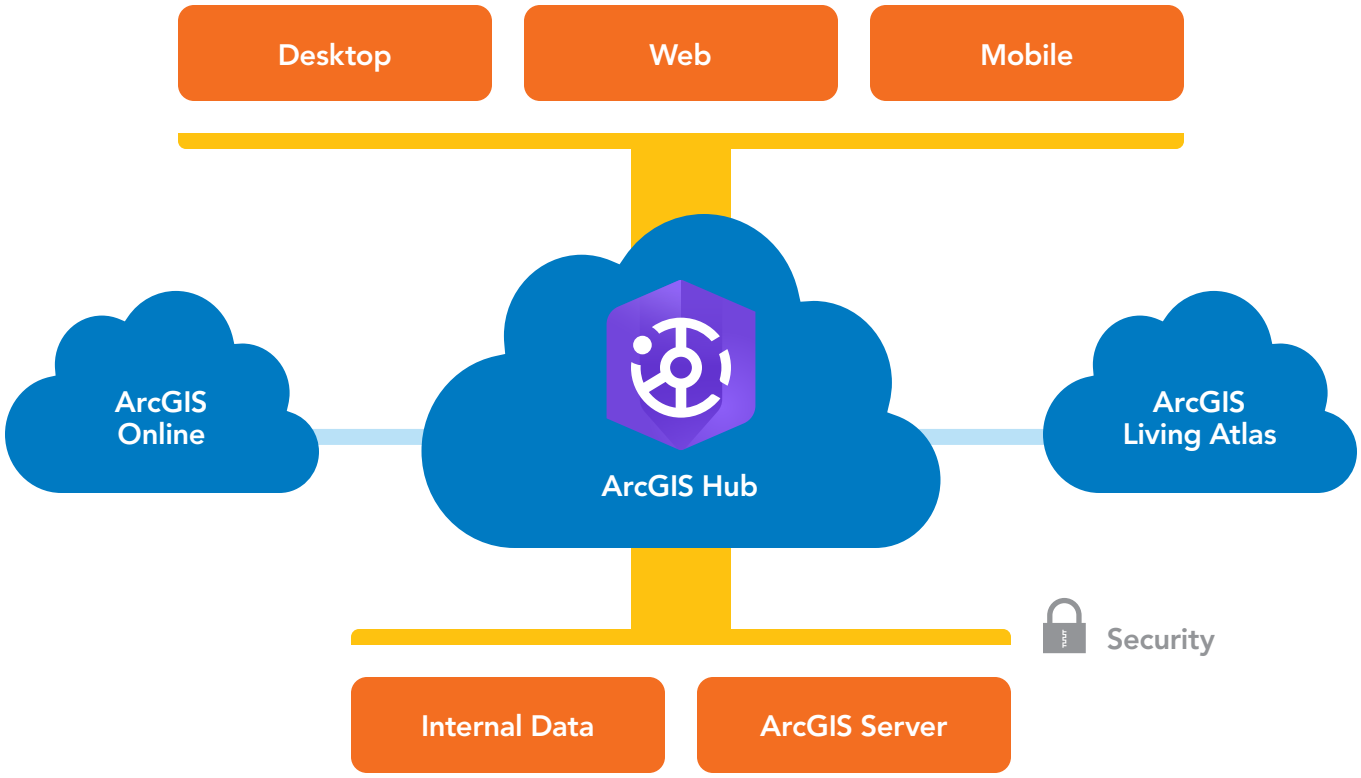
It's easy to see the problem here. Now consider a scenario in which what the CEO actually wants to know is how many customer interactions happened within the last two years, regardless of purchase history. The business rule that defines *customer* is not documented in a centralized metadata repository, and not communicated with either team. People become frustrated; time is wasted; and after so much investment in GIS and dashboard technology, nobody can answer a question that is, on its face, relatively simple.

If the organization had consolidated its GIS and data science teams into a one-stop data shop with an integrated data model and standardized data definitions, multiple problems would likely be solved. For one thing, those standardized data definitions and clear, structured lines of communication reduce the risk of miscommunication between the CEO and the rest of the organization. Additionally, the CEO would get their answer more quickly and with minimal cost and annoyance.

Maybe you've heard this one before: Imagine you ask four blindfolded people to each touch a different part of an elephant. One person, feeling the tusk, might think they have a pointy spear. Another person, touching the tail, would call it a rope. A third might grab a leg and say it's a tree. A fourth, feeling the trunk, might conclude they found a snake. Nobody gets the full picture and realizes it is an elephant. This is what happens when the GIS and data science teams are separate and uncoordinated.

The Benefits of Integration

When strategically and holistically evaluating an organization, it often makes sense to integrate GIS and data analytics teams. There are many benefits to using this approach. With it, you can:



- Gain efficiency through streamlined processes.
- Reduce costs by consolidating databases, infrastructure, and software licenses.
- Unlock more sophisticated and aligned visualizations of complex spatial information that drive deeper insights and empower more effective decision-making.
- Achieve more effective problem-solving through collaboration.
- Improve quality and consistency of data products.
- Enable AI, predictive analytics, and other advanced data capabilities.
- Create a one-stop shop by combining maps, dashboards, and data onto a single ArcGIS Hub landing page.
- Scale enterprise investments to reveal holistic insights and optimize business operations.

Ideally, companies should consolidate—or at least coordinate—data science and GIS teams so that they work together and stay in sync. This can involve defining and documenting the calculation rules and metadata for key metrics; establishing a centralized workflow for triaging and managing ad hoc data requests; and working to source all GIS map applications, dashboards, and ad hoc analyses from one authoritative data source. Doing so will create efficiency; save money; and—most importantly—ensure that everyone gets the same answer no matter what the question is, who asks it, or which tool is used.

There are many ways to achieve this kind of integration. Multiple ArcGIS tools, for example, already support this convergence. With ArcGIS Notebooks and integration with Python, organizations can unify spatial and nonspatial data science workflows in a single environment. ArcGIS Hub is a cloud platform that can become your company's landing page and centralized data catalog for easy sharing of data, geospatial apps, dashboards, and other data products. Advanced data-sharing capabilities that support open data standards such as REST are built into ArcGIS tools. You can also easily connect to internal company data, ArcGIS Living Atlas of the World, or other data sources and drag data directly onto your map.

As organizations increasingly adopt data science and AI to drive decision-making, the ability to spatially enable these models becomes a competitive advantage. Move beyond answering stovepiped data requests, toward a future that includes real-time operational intelligence across your enterprise GIS.

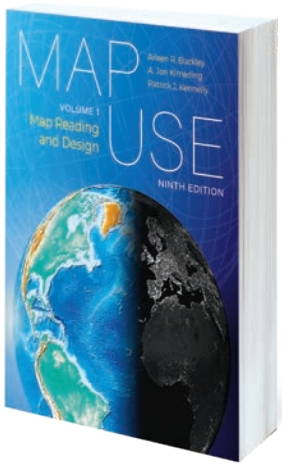
Taking advantage of these tools—and, crucially, the mindset behind them—positions you to be a leader in integrating geospatial and data science systems as analytics and operational intelligence become increasingly vital in a rapidly changing world.

About the Author

Seth Marcus is a senior consultant in Esri's DC Federal Delivery Center, primarily supporting ArcGIS Indoors digital twin projects. Prior to joining Esri, Marcus worked for 24 years as a data analytics, GIS, and IT program manager for several federal agencies, including HUD, HRSA, and Ginnie Mae. He holds a BA in geography from Binghamton University and an MA in geography from the University of South Carolina.

Bookshelf

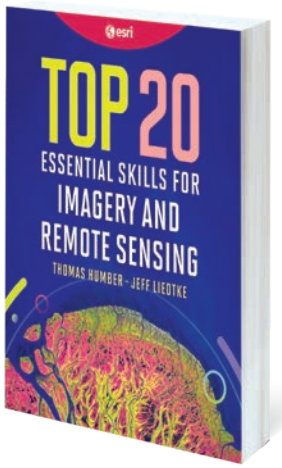
Map Use: Map Reading and Design, Volume 1, Ninth Edition



By Aileen R. Buckley, A. Jon Kimerling, and Patrick J. Kennelly

Maps convey as much about how people think and communicate as they do about the mapped environment. *Map Use: Map Reading and Design*, Volume 1, ninth edition, is a comprehensive primer on how to read and understand maps, design and make maps, and recognize their limitations and inaccuracies. Combining authoritative text with hundreds of stunning visuals, the book describes foundational cartographic concepts in the context of the industry's latest innovations. Changes for the ninth edition include reindexing; revised datums, maps, and images; an updated map projection guide; a new state plane coordinate system; and updated text. An online glossary is also available. March 2026, 334 pp. Ebook ISBN: 9781589487765, paperback ISBN: 9781589487758, and hardcover ISBN: 9781589488816.

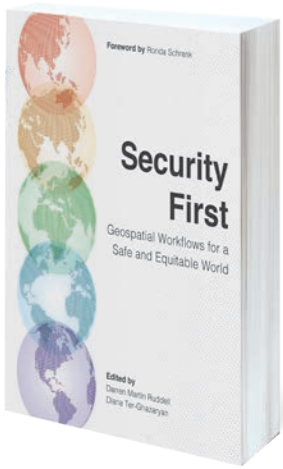
Top 20 Essential Skills for Imagery and Remote Sensing



By Thomas Humber and Jeff Liedtke

Top 20 Essential Skills for Imagery and Remote Sensing guides readers through key techniques needed to visualize, process, analyze, and manage imagery and raster products. The book contains concise chapters with easy-to-follow tutorials and practical examples. This is an approachable resource for users of all skill levels, from GIS professionals who want to deepen their understanding of imagery to students who are eager to learn about remote sensing. March 2026, 250 pp. Ebook ISBN: 9781589488229, paperback ISBN: 9781589488212, and hardcover ISBN: 9781589488731.

Security First: Geospatial Workflows for a Safe and Equitable World



By Darren Martin Ruddell and Diana Ter-Ghazaryan

Learning GIS has never been more critical for visualizing and interpreting data. *Security First: Geospatial Workflows for a Safe and Equitable World* guides readers through targeted exercises and examples to show how GIS can be used in the fields of human security and global intelligence. Each chapter outlines learning objectives, technical requirements, and prerequisite knowledge and includes a geospatial workflow, an analysis, and additional resources. All detailed exercises use ArcGIS software and downloadable data. After each exercise, readers interpret their results and write an intelligence brief, fostering critical thinking about how to incorporate GIS into analytical work. October 2025, 428 pp. Ebook ISBN: 9781589487840 and paperback ISBN: 9781589487857.

Scan the code to purchase these and other Esri Press books.

Future-Proofing Custom Widgets in ArcGIS Experience Builder

By Julie Powell

The world of web development is constantly evolving. Browsers are advancing both capabilities and standards, while developer tooling progresses. In this changing landscape, keeping your solutions future-proof requires adopting the latest standards and best practices.

ArcGIS Experience Builder allows you to create custom widgets for specific workflows—configurable and sharable functional units within Experience Builder. Creating your own widgets can be done with any integrated development environment that you're comfortable with.

However, if you are building solutions that integrate ArcGIS experiences into your apps, the new recommended approach is to use ArcGIS Maps SDK for JavaScript web components. That approach applies to solutions that are fully custom as well as those involving custom widgets in Experience Builder.

Web Components Are the Future

Esri is fully committed to building standards-based web components that extend the core API of JavaScript Maps SDK into reusable custom HTML elements (e.g., <arcgis-map>). All legacy JavaScript Maps SDK widget functionality is being deprecated and removed, making this transition essential for long-term stability.

While the 2026 road map for ArcGIS Experience Builder includes a transition for the underlying Jimu framework to use JavaScript Maps SDK components, the current implementation is based on the SDK's legacy widgets, MapView, and SceneView, rather than components.

Crucially, that doesn't prevent developers from building custom widgets using the SDK's components so that custom code embraces forward-looking techniques.

JavaScript Maps SDK widgets are legacy UI elements that enable maps, scenes, and other common web mapping workflows. These widgets are being deprecated and removed from the SDK. Equivalent functionality is available as web components.

Experience Builder widgets, however, are configurable UI elements that encapsulate functionality often built with the JavaScript Maps SDK. These widgets will transition to use JavaScript Maps SDK components rather than legacy widgets.

The Power of React

ArcGIS Experience Builder is now based on React 19. This version of React introduces major improvements for working with web components, essentially treating them as native HTML elements. Therefore, using SDK components within custom widgets has been greatly simplified.

React 19 fully supports the web components specification, allowing developers to use custom HTML elements within React without needing work-arounds or wrappers. Additionally, the most current version of React makes event handling for custom elements more consistent, behaving similarly to native HTML elements. It also allows for better management of properties, ensuring a consistent and reliable data flow between React applications and the custom elements.

Esri development teams are working to adapt to the changing technological landscape, enabling more powerful applications and optimum productivity for building web applications. As Esri product teams evolve the underlying architecture of Esri's web applications (like Experience Builder), there are pathways that developers can take today that will future-proof the hard work they put into custom solutions.

About the Author

Julie Powell is principal product manager for Esri's web development technologies. She works to ensure that developers can be successful in building state-of-the-art, purposeful solutions using ArcGIS software. Powell brings 20 years of experience working with global leaders such as Hewlett-Packard and Esri, delivering a variety of software solutions for both the enterprise and consumer markets.

Optimize Your Custom Widget Experience

By Kevin Gonzago and Kitty Hurley

When you first start building custom widgets in ArcGIS Experience Builder, the goal is to make it work. However, once you add more UI capabilities, maps, and interactivity, things can start to feel sluggish. Load times increase, interactions lag, and the app's responsiveness takes a hit. This is when optimization matters.

With the underlying framework in mind, let's look at how to keep your ArcGIS Experience Builder widgets fast and efficient using the three main component systems in your apps:

- **Jimu UI Components:** A React-based library built into ArcGIS Experience Builder
- **Calcite Components:** Esri's web component library for building apps with accessibility in mind
- **Map components:** Lightweight ArcGIS Maps SDK for JavaScript web components for maps, scenes, and tools

Each library plays a unique role in Experience Builder development. Knowing when and how to use each one helps you avoid unnecessary overhead.

Library	Purpose	Key Optimization
Jimu UI	React UI for Experience Builder	Importing specific components (or advanced ones from jimu-ui/advanced)
Calcite Components	Esri's design system composed of web components	Lazy loading large components; using kebab-case
Map Components	ArcGIS Maps SDK for JavaScript web components for maps, layers, and tools built with Calcite Components	Reusing the same view instance; configuring with item-id or basemap options

Jimu UI provides React components built for Experience Builder, such as Buttons, Switches, Sliders, and Layout helpers. Because these are the same components used by the core application, they integrate naturally with Experience Builder themes and layouts. If you need more advanced widgets, such as FeatureLayerPicker, FieldSelector, or Filter, you can import them from jimu-ui/advanced.

Calcite Components are web components built on Esri's design system. Calcite is best served when you're creating a UI or looking for a consistent Esri web app look and feel. Since Calcite Components are shipped as stand-alone web components, you should import components individually to avoid inflating your bundle.

Map components bring JavaScript Maps SDK functionality directly into your widgets without manually creating MapView or SceneView objects. You can add an <arcgis-map> element in your React render method and get instant map functionality with minimal setup, as shown in the Map components documentation.

Code snippet 1 shows the imports statements for each library.

Keep Imports Lean

Large imports are among the most common causes of slow widget load times. If you import entire libraries, your production bundle grows unnecessarily. Import only the components needed to improve performance and your bundle, as in snippet 2.

You can also avoid importing everything from libraries, as in snippet 3.

The Jimu UI storybook documentation lists every available component, making it easy to find what you need and import selectively.

For Calcite Components, ArcGIS Experience Builder includes those components as part of its architecture. Starting with version 1.8, you can import Calcite Components directly from the calcite-components entry bundled with Experience Builder. You should avoid wildcard imports, and import only the components you need, as in snippet 4.

A guide, titled Calcite Components in a custom widget, details not only how components can be imported individually but also asset path management for efficient loading.

Keeping your imports modular reduces a widget's initial load time substantially, in particular when your app contains multiple widgets.

```
// Jimu UI
import { Button, Switch } from 'jimu-ui'

// Calcite
import '@esri/calcite-components/dist/components/calcite-button'

// Map
import '@arcgis/map-components/dist/components/arcgis-map'
```

↑ Snippet 1

```
// Import only the components needed
import { Button, Slider } from 'jimu-ui'
```

↑ Snippet 2

```
// Avoid importing all of Jimu UI
import * as JimuUI from 'jimu-ui'
```

↑ Snippet 3

```
// Import only the components you need
import {
  CalciteButton,
  CalciteIcon,
  CalciteLabel
} from "calcite-components";
```

↑ Snippet 4

```
// Less efficient
<CalciteButton onClick={() => setCount(count + 1)}>{count}</CalciteButton>)
```

↑ Snippet 5

```
// Optimize rendering in your solutions
const handleClick = useCallback(() => setCount(c => c + 1), [])
<CalciteButton onClick={handleClick}>{count}</CalciteButton>
```

↑ Snippet 6

```
import { useRef, useState } from "react";

function MapComponent() {
  const [view, setView] = useState(null);
  const handleViewReady = (event) => {
    const mapView = event.target.view;
    // Initialize the Map
    setView(mapView);
    // Add a zoom widget when view is ready
    mapView.ui.add("zoom", "top-left");
  };
  return (
    <arcgis-map
      item-id="e691172598f04ea8881cd2a4adaa45ba"
      onarcgisViewReadyChange={handleViewReady}>
    </arcgis-map>
  );
}
```

↑ Snippet 7

```
function AddLayerButton({ view }) {
  const addLayer = async () => {
    const [FeatureLayer] = await $arcgis.import(["FeatureLayer"]);
    const layer = new FeatureLayer({
      url: "https://services.arcgis.com/.../FeatureServer/0"
    });
    view.map.add(layer);
  };
  return <calcite-button onClick={addLayer}>Add Layer</calcite-button>;
}
```

↑ Snippet 8

Manage State to Avoid Rerenders

React's state system is powerful, but it can result in redundant renders if not managed carefully. Every time a parent component updates its state, its children may rerender, even if their output hasn't changed.

For example, see snippet 5, which is less efficient with rerendering.

The inline function in snippet 6, however, is re-created on each render, where optimization improves efficiency.

These improvements to avoid rerendering help keep large widgets responsive, in particular when combining React with web components that don't follow React's virtual DOM.

Work Smarter with Map Components

Map components are incredibly convenient, but they can also be complex when not managed properly. One of the most important principles is to initialize your map once and reuse it across your app. This prevents unnecessary rerendering, reduces memory usage, and improves performance.

For instance, see snippet 7 for an example of how to efficiently handle map interaction.

Next, as in snippet 8, reference the MapView for reusability.

Reusing a single map instance is important for building efficient web apps. Multiple initializations can slow down performance and increase unnecessary API calls, while a single map ensures that layers, widgets, and state remain consistent across your app.

You can configure <arcgis-map> using an item-id (for a web map or web scene) or define properties directly, such as basemap, center, and zoom, depending on your workflow. Avoid re-creating the map unnecessarily, and load tools like an <arcgis-legend> or <arcgis-layer-list> only when needed. These strategies can dramatically reduce your widget's initialization time.

Use Jimu, Calcite, and Map Component Libraries Together

To show how these component systems can work together, snippet 9 contains an example using Jimu UI, Calcite, and Map components in one widget.

This custom widget demonstrates how you can use Jimu UI for interaction, Calcite for layout, and the Map component APIs for display—all with minimal overhead.

Keep Styling Consistent

ArcGIS Experience Builder already has a robust theming system. Instead of adding your own CSS, use Jimu UI's emotion-based styling system so that your widget matches the app theme automatically, as in snippet 10.

When using Calcite Components, rely on CSS custom properties rather than global overrides, as in snippet 11.

These CSS custom properties also apply to Map components, allowing you to override styles globally or on individual components. The Calcite Components design token reference provides

examples for aligning your widget's look and feel with Esri's color, typography, and spacing standards.

When referencing Calcite web components in JSX or HTML, use the kebab-case naming convention, where words are separated by hyphens (-) and characters are lowercase—for instance: <calcite-button>, rather than CalciteButton.

Deployment Tips

ArcGIS Experience Builder ships with specific versions of Jimu UI, Calcite, and Map components. If you import newer or mismatched versions, you may see console warnings or missing icons. Before upgrading, check the supported versions in the latest Experience Builder release notes.

Before deploying, it's recommended that you profile your widget. For example, you can open Chrome DevTools, record a performance trace, and look for long scripting or paint times when interacting with your widget. Most performance issues include nonrelevant imports, redundant map initialization, and overuse of third-party dependencies.

It's also recommended that you test in both preview and production modes. Production builds use minified assets and optimized React behavior, which can change performance characteristics.
For TypeScript-based widgets, the default in Experience Builder, the same principles apply in your .tsx files in the ArcGIS Experience Builder widgets directory.

Custom widgets are among the best parts of ArcGIS Experience Builder because they let you go beyond templates and build exactly what your app needs. The trick is to balance flexibility with performance. Good widget performance isn't just about speed, it's about writing clean, optimized code that scales as your ArcGIS Experience Builder apps grow. By keeping imports modular, managing React state carefully, reusing map views, and styling through the Experience Builder theme system, you can create widgets that look great and perform smoothly.

```tsx
// A legend toggle panel using Jimu UI, Calcite and Map components
import { React, useState, type AllWidgetProps } from 'jimu-core'
import { JimuMapViewComponent, type JimuMapView } from 'jimu-arcgis'
import { Switch } from 'jimu-ui'
import { CalcitePanel } from 'calcite-components'
import 'arcgis-map-components'

const Widget = (props: AllWidgetProps<object>) => {
  const [visible, setVisible] = useState(true);
  const legendRef = React.useRef(null)
  const onActiveViewChange = (activeView: JimuMapView) => {
    if (!activeView || !legendRef.current) {
      return
    }
    legendRef.current.view = activeView.view
  }
  return (
    {/* Calcite Panel for the Jimu UI and Map components */}
    <calcite-panel heading="Map View">
      {/* Jimu UI Switch for toggling legend visibility */}
      <Switch checked={visible} onChange={() => setVisible(v => !v)} />
      {/* Initialize Legend component on active view change event */}
      <JimuMapViewComponent onActiveViewChange={onActiveViewChange}
                            useMapWidgetId={props.useMapWidgetIds[0]}>
      </JimuMapViewComponent>
      {/* Legend component displayed when visible */}
      {visible && <arcgis-legend ref={legendRef}></arcgis-legend>}
    </calcite-panel>
  );
}
export default Widget
```

↑ Snippet 9

```tsx
/* @jsx jsx */
import { jsx, css } from 'jimu-core'
const panelStyle = css`
  padding: 1rem;
  color: var(--dark);
`;
// Apply with the `css` prop:
<div css={panelStyle}>Your content here</div>
```

↑ Snippet 10

```tsx
calcite-button {
  --calcite-color-brand: var(--primary-color);
}
```

↑ Snippet 11

About the Authors

Kevin Gonzago is a product engineer at Esri on the developer experience team, where he helps developers succeed with Esri's products, APIs, and SDKs through tools, guidance, and best practices. Outside of work, Gonzago loves lacing up his running shoes to explore new neighborhoods—chasing scenic routes and local eateries.

Kitty Hurley is a principal product engineer at Esri with Calcite Design System, passionate about expanding access to the web and maps for broader audiences. She is dedicated to creating inclusive, user-friendly web experiences that connect people and places through innovative design and technology. Outside of work, Hurley enjoys exploring the wilderness of Minnesota and has a goal to visit every Major League Baseball stadium across America.

A MODEL FOR URBAN RESILIENCE

By Brian Cooke

Australia's most populous city faces a worrying outlook: Heat-related deaths in Sydney could rise by up to 444 percent under current warming trajectories, according to Australia's first-ever national climate risk assessment, released in September 2025. This projection comes as heat waves already cause more deaths in Australia than all other extreme weather events combined, with about 341 heat-related excess deaths recorded in Sydney between 2007 and 2017 alone. Even under the best-case warming scenario, Sydney's heat-related mortality is expected to double.

The crisis is already manifesting in concerning ways: Between 2000 and 2020, the greater Sydney region experienced more days with temperatures exceeding 35°C (about 95°F) than during the preceding 120 years combined, according to research by Professor Sebastian Pfautsch and his colleagues at Western Sydney University.

In response to this escalating threat, the City of Sydney partnered with Western Sydney University to conduct the most detailed analysis of urban microclimates ever undertaken in the city. With more than 100 sensors deployed across diverse urban landscapes in 2023 and 2024, the project leveraged tools like ArcGIS Velocity and ArcGIS Pro to transform temperature and humidity measurements into actionable intelligence for protecting vulnerable communities.

A City Under a Microscope

The project grew out of earlier work the City of Sydney had undertaken. According to Zoe Morrison, a senior sustainability strategist who oversees the city's environmental and resilience strategies, a 2022 climate equity study had identified communities that were most at risk from heat. But Sydney needed more detailed information.

"We decided that we wanted to find out more about how heat's going to impact the city on more of a granular level," Morrison said.

Led by Western Sydney University's Urban Transformations Research Centre, the urban heat mapping project took place from December 2023 to March 2024 and involved deploying 127 sensors across a range of urban landscapes. Developed at the university, the sensors each consisted of a single-use

↑ Zoe Morrison, senior sustainability strategist for the City of Sydney, installs one of more than 120 sensors to measure urban temperatures.

temperature logger protected by a passively ventilated radiation shield. Placed three to four meters from the ground, the devices recorded near-surface ambient air temperatures—and, in some locations, relative humidity—every 10 minutes for 110 days.

From public parks and residential streets to the city's bustling waterfront and industrial hubs, the sensors collected more than 1.5 million measurements, painting a granular picture of how heat is distributed across the city.

Processed in R—a powerful programming language designed for statistical computing and data visualization—this huge dataset required a robust platform for analysis and visualization. ArcGIS Pro provided the core of the data analysis and cartography workflow.

To manage real-time data streaming from the sensors, the team also used ArcGIS Velocity, an ArcGIS Online add-on that enables real-time and big data processing. This allowed the team to collect a continuous flow of temperature and humidity readings and process them on the fly. Researchers fed the data into ArcGIS Online, providing a centralized, cloud-based platform for the project's data and maps.

Now, the public can access time-enabled maps that show temperature changes across the city on various hot days, providing a visual narrative of how the urban environment heats and cools.

In recent years, the need to understand and combat the impact of extreme heat on Australia's urban environments has become increasingly urgent.

Pulling Back the Curtain on Sydney's Thermal Landscape

The analysis revealed stark thermal inequalities across the city. On hot days of 35°C (95°F) or higher and extreme heat days of 40°C (104°F) or higher, a clear north-south thermal gradient emerged. Specifically, while the cooling influence of Sydney Harbour and the Pacific Ocean provided more benign temperatures in northern areas such as the Royal Botanic Garden, southern suburbs such as Alexandria and Rosebery endured temperatures more than 10 degrees higher. These findings challenged common perceptions about the city's climate.

"A lot of people assume that since Sydney is a coastal community, it's going to be fine during a heat wave," Morrison explained. "But having this study helped show that it actually gets really hot and humid here, and we don't cool down much [at night] either."

The data also pinpointed specific hot spots. On December 9, 2023, the hottest day of the summer that year in Sydney, temperatures in the city's boundary with the St Peters neighborhood were as high

as 45.3°C (almost 114°F). The project also identified areas with the highest summer nighttime temperatures, a key factor in heat-related health risks.

Animations created in ArcGIS software provided a world-first visualization of Sydney's harbor breeze, when cool air over the ocean moves inland. Time-enabled maps show the intensity and spatial extent of this cooling breeze as it moves across the city, and provide insights into natural cooling resources that can be enhanced via strategic planning.

From Data to Actionable Intelligence

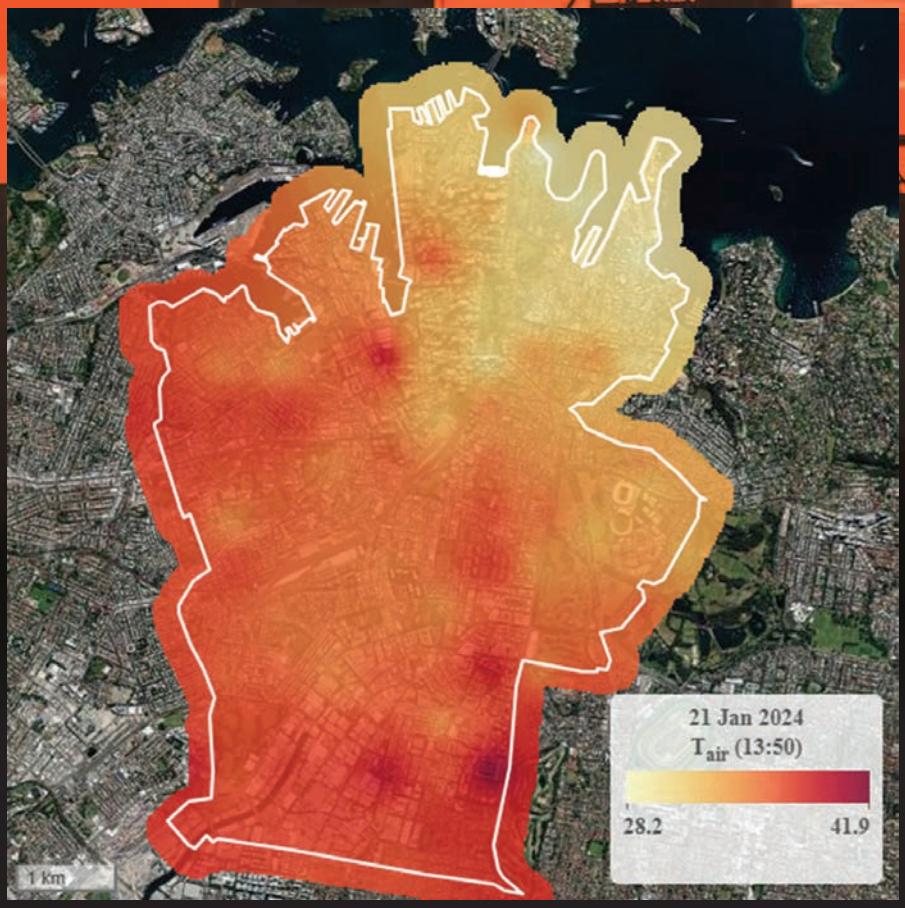
The project's findings provided the City of Sydney with a clear road map for heat mitigation. Detailed maps and analysis allowed the city to move beyond a one-size-fits-all approach and develop targeted, place-based cooling strategies such as planting trees or installing water-based cooling infrastructure.

For Morrison, the ability to layer multiple datasets in ArcGIS was a key advantage. She combined the new microclimate data with existing layers for canopy cover and demographic information to create a comprehensive risk profile.

"The data has helped us map the resulting GIS microclimate maps and overlay them with canopy cover layers, our climate priority community layers, and flooding layers to profile our most at-risk suburbs and where to target action," she said.

Recommendations stemming from the report call for focusing cooling efforts on the city's central and southern suburbs, increasing tree canopy cover along the hottest streets, and promoting cool zones such as public parks during heat events. The data also highlights the need to cool specific hot spots, such as the playground at Juanita Nielsen Community Centre in the inner-city suburb of Woolloomooloo.

Pfautsch, who works at the Urban Transformations Research Centre, emphasized the importance of this evidence-based approach.



↑ Sensor data enabled researchers to map the Sydney's ambient temperatures throughout the summer of 2024.

"The key outcome of this project is to provide the City of Sydney with the evidence to make targeted decisions on where to implement greening strategies to cool the city," he said. "So instead of just planting trees anywhere, we can now tell them, 'These are the streets that are hottest, and these are the communities that are most vulnerable, and this is where you should invest first.'"

Collaboration between the City of Sydney and Western Sydney University

↑ Sebastian Pfaustch from the Urban Transformations Research Centre at Western Sydney University holds up two of the sensors created to help the City of Sydney identify its hottest neighborhoods.

serves as a powerful example of how cities can leverage GIS to build resilience to rising temperatures. By combining scientific research with analytical and visualization capabilities of the ArcGIS platform, the project has transformed a complex environmental challenge into clear solutions. The resultant publicly available maps, data, and clear recommendations help ensure that the project's insights can inform decision-making at all levels, from city planners to individual residents.

"Some of the actions, like increasing tree cover and being more equitable with planting, are already being monitored through thermal flyovers and greening reporting," Morrison said, adding that this data is also processed into a GIS.

The city is exploring how to create a permanent monitoring network, such as by looking at whether the city has permanent sensors plugged into its smart light poles.

As cities around the world grapple with rising temperatures, Sydney's urban heat mapping project offers a model for evidence-based climate adaptation. It demonstrates that by understanding the intricate details of their thermal landscapes, cities can develop smarter, more effective strategies to protect their communities and create more livable, resilient urban environments for the future.

About the Author

Brian Cooke is a writer and contributing editor for the Esri publications team. He helps readers stay informed about ArcGIS technology and tells compelling stories about how Esri partners and users apply Esri technology. Cooke has worked as a marketplace researcher, an enterprise technology analyst, a technical writer and editor, and an environmental science writer for clients such as the US National Park Service and the US Forest Service. In addition to a bachelor's degree in science writing from Lehigh University, he has a master's degree in natural resource stewardship and a certificate in conservation communications—both from Colorado State University.

Create a Mobile Style for Native Apps

By Mara Dolan

Across the ArcGIS ecosystem, a style can mean anything from applying characteristics, such as shape, to completely changing a layer's symbology. It can even mean using attributes (data fields) to drive the appearance of a multilayered symbol.

In any case, adding a style to a map, app, or dashboard is a great way to make it stand out, match organizational guidelines, add emphasis to your data, or make symbols themselves informational.

Here are a few of the different ways styles can manifest in ArcGIS:

- **ArcGIS Pro styles** let you apply the same symbol styles, colors, color schemes, layout items, or label placements across maps using a .stylx file. They can be created and shared among any ArcGIS Pro users. Several different style types can be used in ArcGIS Pro.
- **Dictionary symbol styles** in ArcGIS Maps SDKs for Native Apps are typically used for complex symbols such as military symbols, which are multilayered and attribute driven. This style includes an ArcGIS Arcade script that assembles each symbol from multiple parts based on the logic you write in the script and/or multiple fields, so often the symbols are data specific.
- **Basemap styles** are basemaps hosted by Esri that you can use in your native apps. They're unrelated to the above styles and are typically used to provide context for your other map layers.

In addition to these, mobile and web styles are styles you can use in native apps with some limitations. These styles are the ones to use for apps you build using Native Maps SDKs.

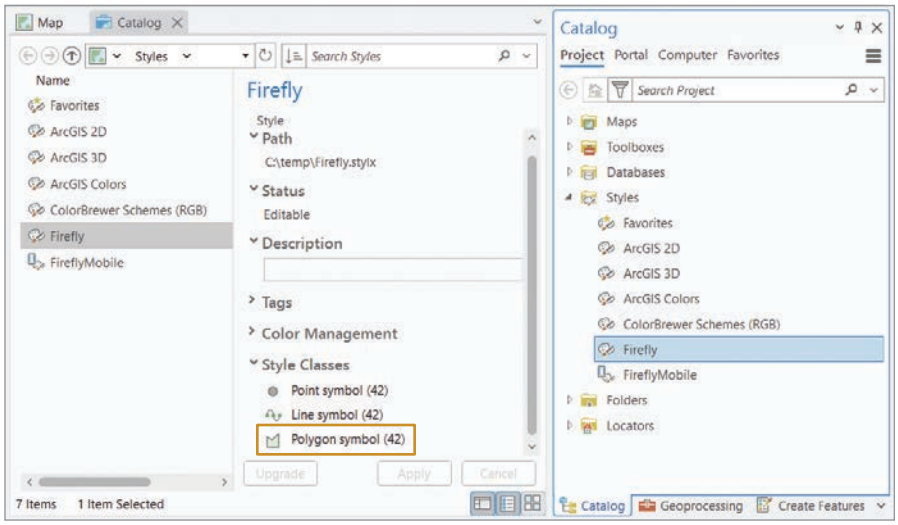
The example used in this article takes the Malibu data in Native Maps SDKs tutorials and changes the symbols for its feature layers of points (trailheads), lines (trails), and polygons (parks) into glowing symbols using the Firefly style created by Esri cartographer John Nelson.

After using ArcGIS Pro to create a mobile style file, you can add styles to it from the Firefly style, then grab other styles and

← Polygons with a style from the firefly.stylx file applied.

↗ In the Style Classes area, you can select the style class that stores the styles you want to bring over.

↘ You can also select style items from other styles, such as ArcGIS Colors.



add them to the same file. This mobile style file can be used to style the Malibu layers. Users who go offline can bundle the style file with the app so that it's local to the device and its styles can be used even when users aren't connected.

While the Firefly style provides eye-catching emphasis, you may be more interested in one of the many other styles available in ArcGIS Pro, including styles specific to your industry.

Choose Your Style

First, go to the gallery at links.esri.com/styles to see available styles. Use the search box to filter the results or browse all style files. For example, you can type "firefly style for arcgis pro" to quickly get to the style used in this article.

You can download the Firefly style by going to Nelson's style files and clicking the Download button for Firefly style for ArcGIS Pro. Download the style to your project folder (the folder with your .csproj file).

The Firefly style is useful because it can make your map elements appear to glow and sparkle. But a different style may suit your purposes better. A multitude of styles are available to choose from in ArcGIS Online.

Copy Symbols into the Mobile Style File

In ArcGIS Pro, on the Catalog pane's Project tab, create a mobile style by right-clicking Styles and then clicking New > New Mobile Style. Navigate to your ArcGIS Pro project folder, then type "FireflyMobile" (or whatever name you choose) as the name of your new mobile style file. Click Save.

Add the Firefly style to the project. On the ArcGIS Pro ribbon, click Insert; then, in the Styles area, click Add Style. Navigate to the location you downloaded Firefly.stylx to (the folder with your .csproj file) and double-click Firefly.stylx. If you don't see the file where you expect, remember to click the Refresh button near the top of the Add a Style File dialog box.

In the Style Classes area that displays, select the first style class that stores the styles you want to bring over. Here, start with Polygons.

Another pane will display that shows the polygon styles available. From there, select the style items to bring over. Select FireflyPoly_8 to style your polygons. Copy and paste it into FireflyMobile.stylx. Repeat this step for FireflyLine_5 in Lines and FireflyShimmer_2 in Points.

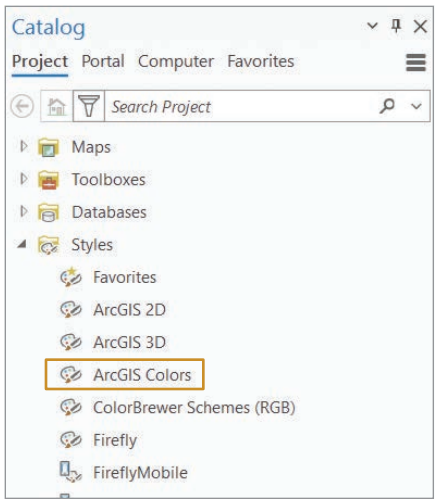
FireflyMobile.stylx is now ready to use in your native map app.

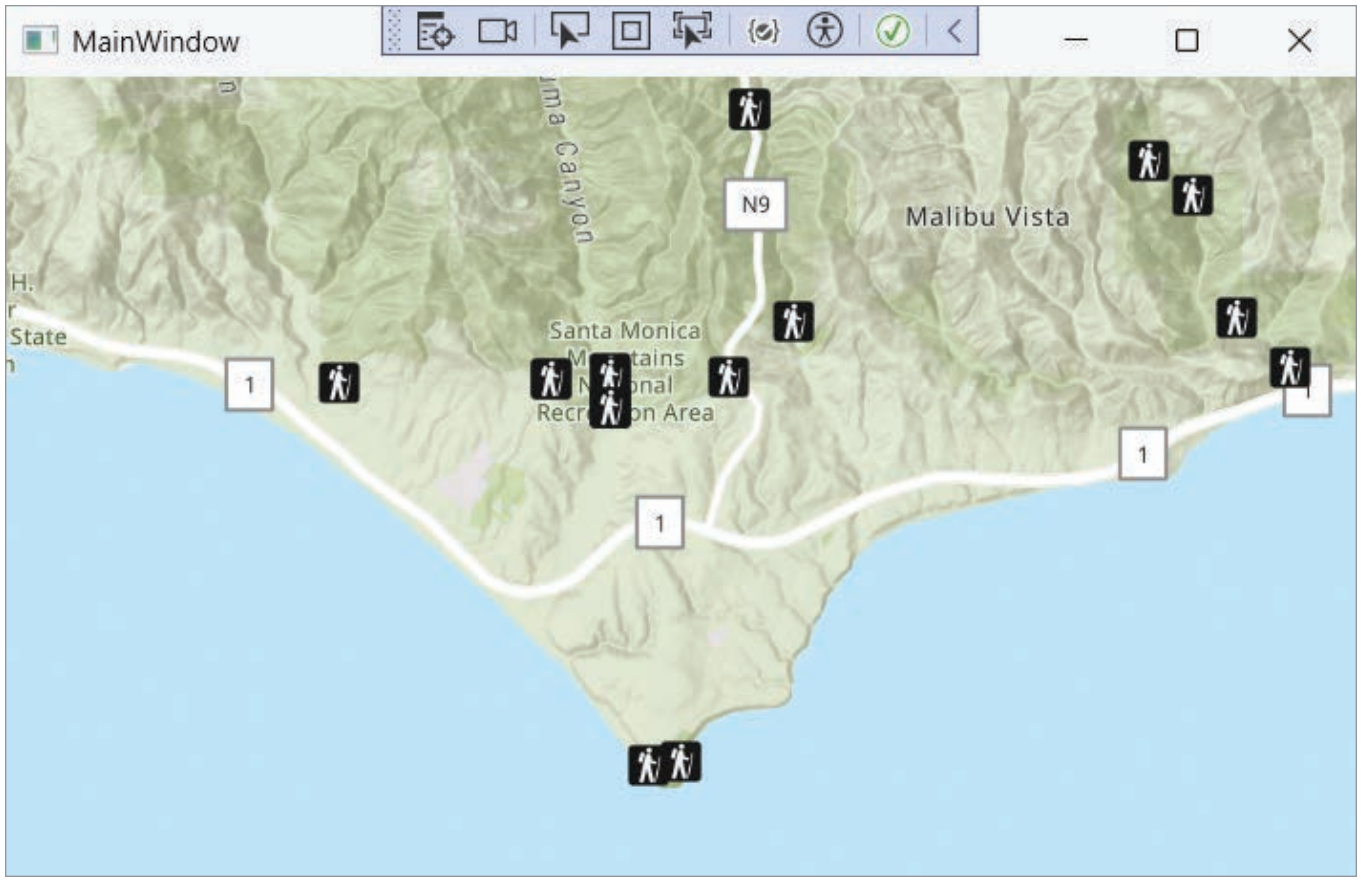
You could also select style items from other styles, such as ArcGIS Colors, and bring those over into the same FireflyMobile.stylx style file, the same way you brought over the Firefly styles.

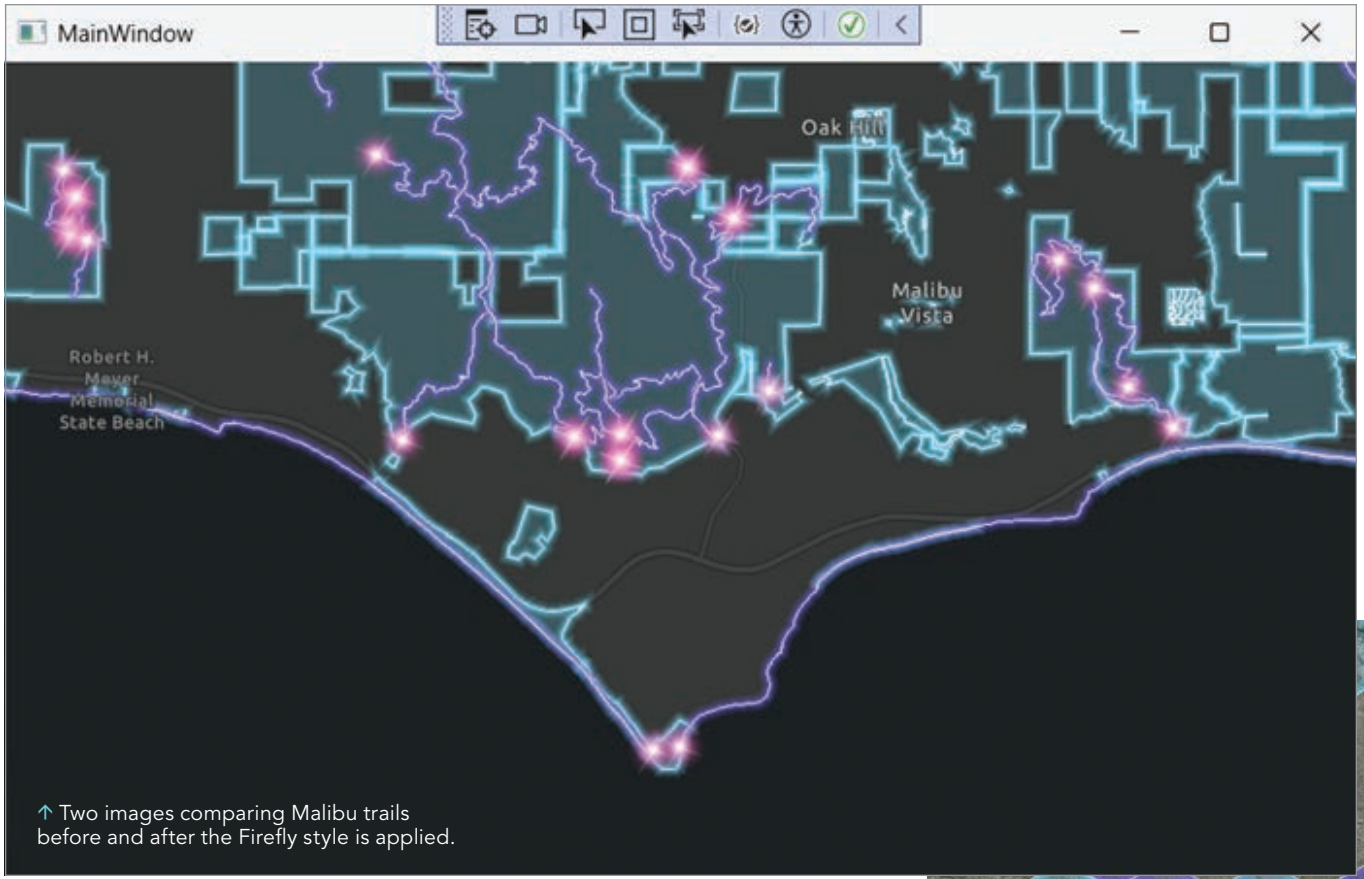
Apply the Mobile Style File to Layers in Your App

This C# code sample is for use with ArcGIS Maps SDK for .NET, but the general approach is the same for ArcGIS Maps SDK for Kotlin, ArcGIS Maps SDK for Swift, and ArcGIS Maps SDK for Qt.

Snippet 1 on page 57 creates the map with a dark basemap style.







↑ Two images comparing Malibu trails before and after the Firefly style is applied.

With snippet 2, open the mobile style you want to use, then add the layers, specifying the style you want for each layer. The method GetLayerWithSymbol will be created in a subsequent code block.

In snippet 3, the GetLayerWithSymbol method uses the GetSymbolAsync API method to get the specific symbol to be applied to the layer and creates a simple renderer with that symbol. You can then apply the renderer to the layer and return the new FeatureLayer. The GetSymbolAsync method is the cornerstone of this article's sample code.

Bundle the Style File with Your App

When adding the mobile style file to your Visual Studio project, if you change the Build Action setting to None and set the Copy to Output Directory value to, say, Copy if Newer, the style file will be copied to your app's output folder alongside the .exe file and then you can use the same syntax to specify the .stylx file location, as in this example:

```
SymbolStyle mobileStyle = await
SymbolStyle.OpenAsync(@"Firefly.stylx");
```

You can take advantage of the styles created by others by applying them to the layers in maps in your native apps. Be sure to check out the styles on ArcGIS Online, especially the more common ones, like industry-specific ArcGIS Pro styles. Make sure to test your layers after you apply new styles to them.

About the Author

Mara Dolan is a senior product engineer at Esri who specializes in technical communication. She has supported Esri's documentation and outreach efforts for 23 years.

```
private async Task SetupMap()
    {
        try
        {
            // Create a new map with an `ArcGIS dark gray' basemap.
            // Set the initial viewpoint around the Santa Monica Mountains in California.
            Map map = new(BasemapStyle.ArcGISDarkGray)
            {
                InitialViewpoint = new Viewpoint(34.027, -118.805, 100000)
            };

            // Set the map property with the map.
            MyMapView.Map = map;
```

↑ Snippet 1

```
// Open the mobile style file at the provided path.
SymbolStyle mobileStyle = await SymbolStyle.OpenAsync(@"Firefly.stylx ");

// Add layers to the map using the specified symbols from the mobile style file.
map.OperationalLayers.Add(await
GetLayerWithSymbol("https://services3.arcgis.com/GVgbJbqm8hXASVYi/ArcGIS/rest/services/Parks_and_Open_Space/FeatureServer/0", mobileStyle, "FireflyPoly_8"));
map.OperationalLayers.Add(await
GetLayerWithSymbol("https://services3.arcgis.com/GVgbJbqm8hXASVYi/ArcGIS/rest/services/Trails/FeatureServer/0", mobileStyle, "FireflyLine_5"));
map.OperationalLayers.Add(await
GetLayerWithSymbol("https://services3.arcgis.com/GVgbJbqm8hXASVYi/arcgis/rest/services/Trailheads/FeatureServer/0", mobileStyle, "FireflyShimmer_2"));
}
catch (Exception)
{
throw;
}
}
```

↑ Snippet 2

```
async Task<FeatureLayer> GetLayerWithSymbol(string path, SymbolStyle symbolStyle, string symbolName)
{
try
{
FeatureLayer featureLayer = new FeatureLayer(new Uri(path));

// Get the Firefly symbol to be applied
Symbol? symbol = await symbolStyle.GetSymbolAsync(new List<string>() { symbolName });
if (symbol != null)
{
// Set the renderer of the feature layer to use the Firefly symbol
featureLayer.Renderer = new SimpleRenderer(symbol);
}
return featureLayer;
}
catch (Exception)
{
throw;
}
}
```

↑ Snippet 3

From Survey to Surface with ArcGIS for AutoCAD

By Geoff Cook and Michael Davidson

Designing infrastructure—whether highways, railways, or airport runways—demands precision; speed; and tight collaboration between surveyors, civil engineers, and GIS professionals. With multiple teams collecting and editing project information, maintaining data integrity and tracking changes is critical to prevent costly errors.

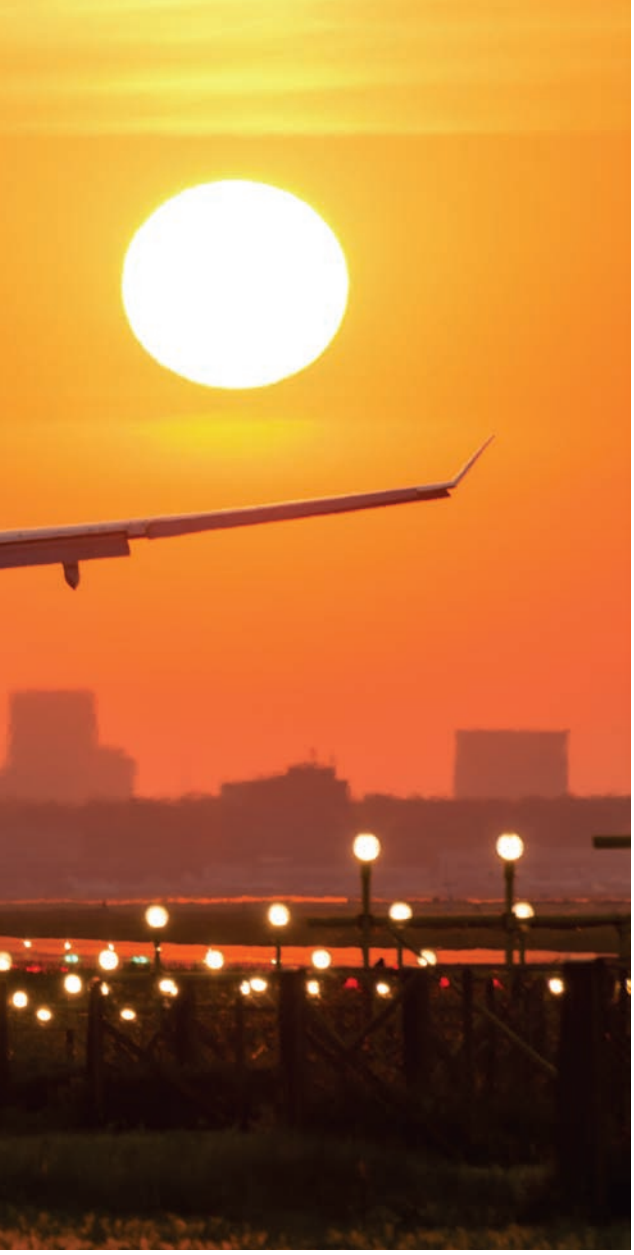
ArcGIS for AutoCAD, combined with multiuser editing capabilities in ArcGIS Enterprise, empowers civil engineering teams to work concurrently on designs in Autodesk Civil 3D without the risk of overwriting each other's work or losing track of design decisions.

Within this workflow, civil engineers and GIS professionals can improve collaboration between Civil 3D and ArcGIS using branch versioning. Authoritative GIS data and branch versioning help eliminate errors and guesswork when designing infrastructure, including the creation of surface models from survey points.

Laying the Groundwork

As an example, consider a project scenario for a proposed airport runway extension. This project, like many infrastructure projects, involves multiple teams working in parallel—surveyors capturing existing ground conditions, civil engineers developing design options, and GIS team members ensuring data governance and quality.

The teams on this project will start by gathering existing conditions. Historical topographic survey points previously collected by a surveying team allow civil engineers to generate a triangulated irregular network (TIN) surface of the



existing ground in Civil 3D. However, with data arriving from multiple surveyors in the field, the risk of civil designers working from potentially incomplete or outdated information grows.

Without a way to accurately track and version changes as they happen, merging updates to authoritative project information can be risky, leading to costly rework and delays.

GIS Aids Collaboration on Project Designs

Say the project team for the runway extension is using ArcGIS as the system of record for project information. The team is also using ArcGIS for AutoCAD to keep CAD and GIS data between Civil 3D and ArcGIS in sync.

With survey points stored in ArcGIS Enterprise, a civil engineer can use ArcGIS for AutoCAD to add previously collected survey points as coordinate geometry (COGO) points into a Civil 3D design. Initially, the z-coordinates for the points appear as zero. After identifying an elevation field among the GIS attributes, the engineer corrects the vertical positioning.

Using the support for branch-versioned layers in ArcGIS for AutoCAD, a named version is created for the engineer to propose changes to the survey point elevations. The engineer then submits these changes for review by teammates and the GIS team, ensuring that they can be incorporated into the authoritative dataset.

Before synchronizing the proposed changes to ArcGIS, the engineer uses standard Civil 3D commands to form an initial surface—an essential first step in characterizing the existing ground for the runway extension. The synchronization process ensures that these updates are available for review and, ultimately, for potential use by other project contributors who rely on accurate data for their work downstream.

Multiuser Editing Across Teams and Platforms

With branch versioning, civil designers and surveyors with a Professional user type license can create and manage their own branch versions directly within Civil 3D using ArcGIS for AutoCAD.

This means that each designer can add GIS web feature layers to their CAD drawings without the risk of overwriting authoritative data. With the default version locked, only changes that the GIS team has reviewed and approved can be added to the main project data.

Using branch versioning in Autodesk Civil 3D and AutoCAD, multiple project team members can work with the same project data at the same time.

As the project progresses, new survey points fill gaps identified in the initial surface in the northeast corner of the site. One of the surveyors creates a named branch and uploads the latest field data.

Meanwhile, a civil designer working on a proposed taxiway alignment creates a separate branch to test design options without interfering with the main dataset. Team members synchronize their edits to ArcGIS Enterprise, and the GIS manager can see who made each change and when.

Updating Design Data

The project team incorporates new data and refines design options. Supplementary topographic survey data can be incorporated into a named version using ArcGIS for AutoCAD.

> “Merging updates to authoritative project information can be risky.”

> "The entire project team benefits from working from a single source of truth."

The engineer adds these new points, rebuilds the surface, and synchronizes the changes from Civil 3D. The result is a richer, more accurate TIN surface that better characterizes the existing ground where the runway extension is proposed.

Synchronizing these changes makes them available for review by the lead civil engineer and the GIS team so that the updated information can be brought into the authoritative dataset when ready. This ensures that all team members—from designers to project managers—are working from the latest, most reliable information.

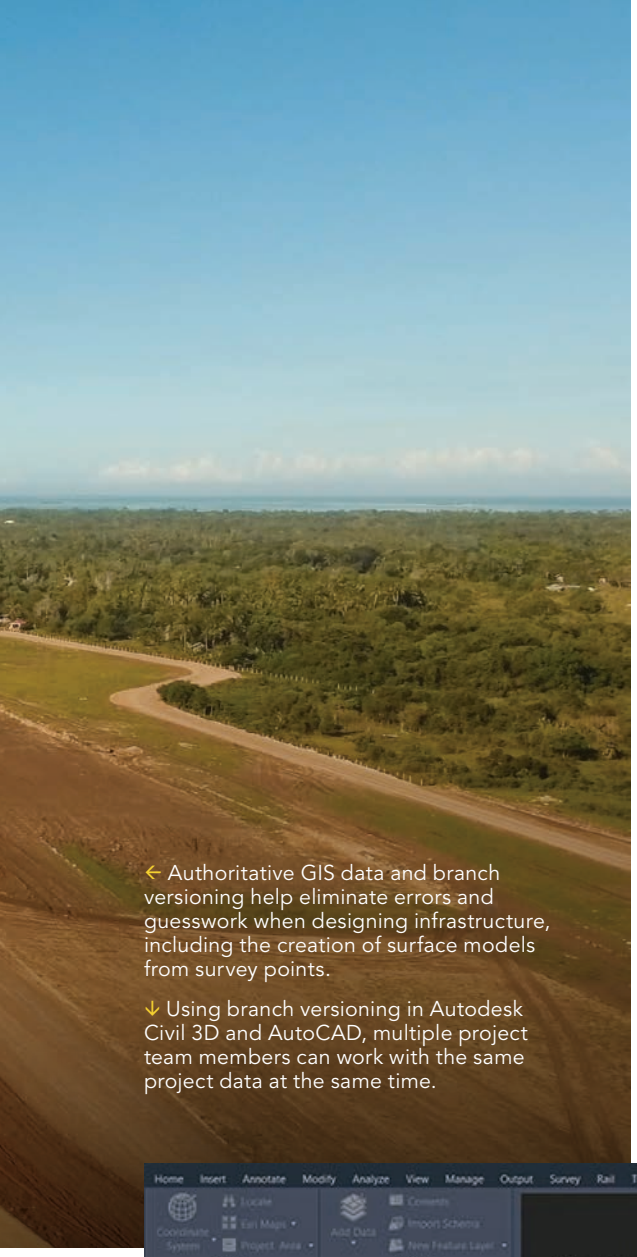
Once the design option is chosen, the GIS manager reconciles the preferred branch with the default version from ArcGIS Pro. After a final round of QA/QC, the updated surface can be published for stakeholders.

Outdated layers on named branches will be archived or deleted as needed, keeping the project data clean and organized. This process not only reduces risk but also ensures that every contributor's work is traceable.

The Value for Project Teams

Throughout this workflow, the value of using ArcGIS for AutoCAD with branch versioning is clear. Civil engineers gather data on existing conditions and participate in GIS workflows directly from Civil 3D. They make edits from their familiar CAD environment while leveraging authoritative GIS data. Additionally, GIS managers maintain control and data integrity. They work with a full chronology of who edited what and when, for collaboration between multiple project contributors without bottlenecks.

The entire project team benefits from working from a single source of truth—with every change auditable and the authoritative dataset



← Authoritative GIS data and branch versioning help eliminate errors and guesswork when designing infrastructure, including the creation of surface models from survey points.

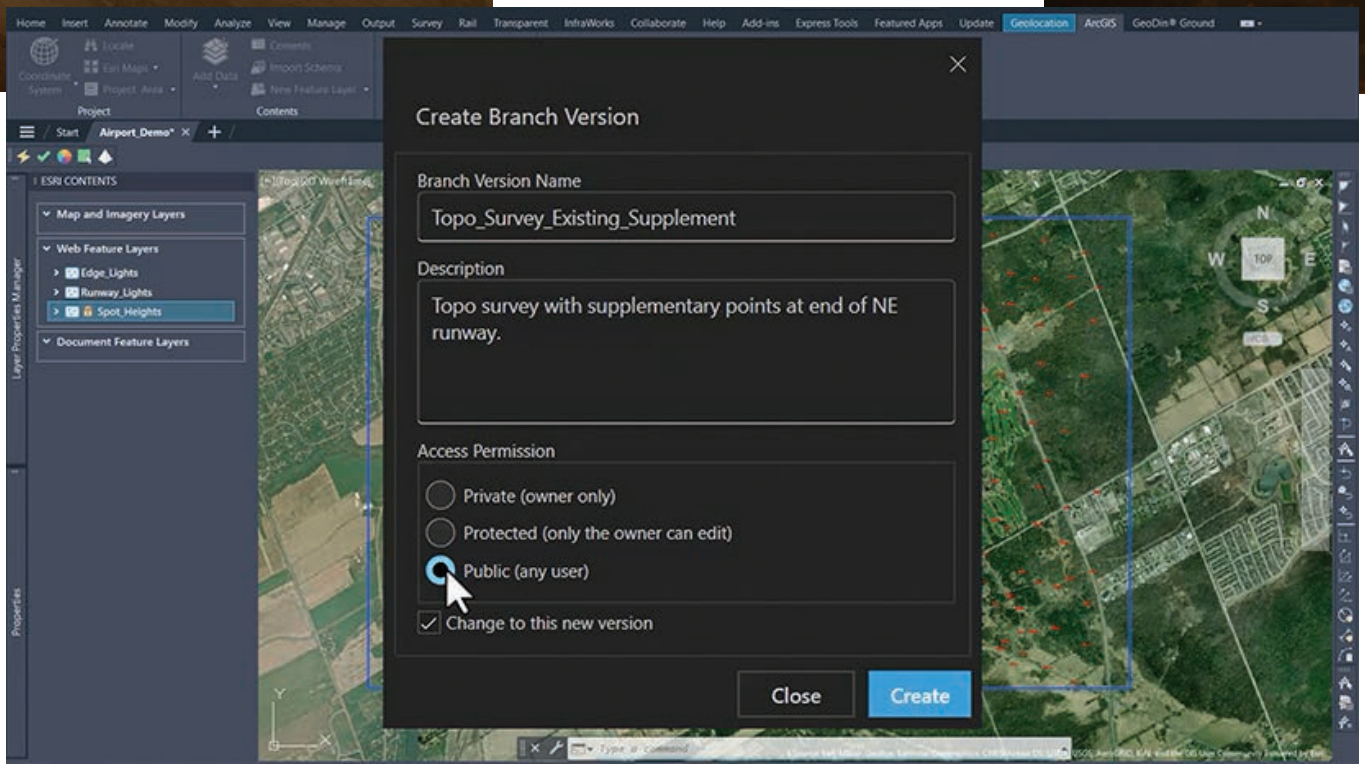
↓ Using branch versioning in Autodesk Civil 3D and AutoCAD, multiple project team members can work with the same project data at the same time.

protected. For infrastructure projects with multiple contributors who need to work concurrently, using branch versioning in GIS and CAD collaboration adds confidence that every design decision is made using current, authoritative project data.

About the Authors

Geoff Cook is senior product marketing manager for ArcGIS GeoBIM, ArcGIS for AutoCAD, and GIS/BIM integration at Esri. With more than a decade working in the technology and sustainability sectors, he has supported the go-to-market and growth efforts of several enterprise cloud solutions. First encountering GIS during his environmental management studies, Cook has always had a passion for design, innovation, and sustainable practices.

As a product manager at Esri, **Michael Davidson** pushes the boundaries of interoperability across GIS, CAD, and BIM as well as ArcGIS for AutoCAD. Davidson possesses more than 10 years of experience in civil engineering software development, including past focuses on BIM for bridges and geostatistics. He has a PhD in civil engineering and is a licensed PE.



← Offline maps are vital for responding to emergency events such as Hurricane Helene, which severely damaged infrastructure across multiple states, including this road in Virginia.

PREPARE OFFLINE MAPS AHEAD OF TIME

By Jared Motuz

THE ABILITY to take maps offline is essential for organizations that need to work with their service data when internet access is limited or unavailable, such as in remote locations or in the event of a natural disaster. Whether you're part of a utility company that needs to assess damage and restore services, or an emergency response team working to save lives, accessing information is imperative to tackle these challenges safely and quickly.

Taking maps offline is not a new workflow in the world of GIS. It has long been supported by ArcGIS Field Maps, ArcGIS Survey123, and apps built with ArcGIS Maps SDKs for Native Apps. Additionally, ArcGIS Pro includes on-demand offline capabilities that require each user to determine a map area and perform individual queries and downloads of the data from the server.

With ArcGIS Pro 3.5 and 3.6, you can download offline map areas prepared ahead of time. This allows the use of prepackaged, predetermined map areas that can be downloaded, edited, and synced by multiple users in a faster, more system-friendly process.

There are several benefits of using offline map areas prepared ahead of time:

- Map areas are downloaded and stored locally so that users can still access and rely on maps and data in areas without internet connectivity.
- Prepackaged data allows quicker downloads and minimizes repetitive data extracts, reducing server load and improving scalability.
- Each user sees a uniform geographical area along with consistent map content, ensuring accurate data representation.
- Web map owners can set a regular update schedule for these packages, guaranteeing users access to current offline maps.

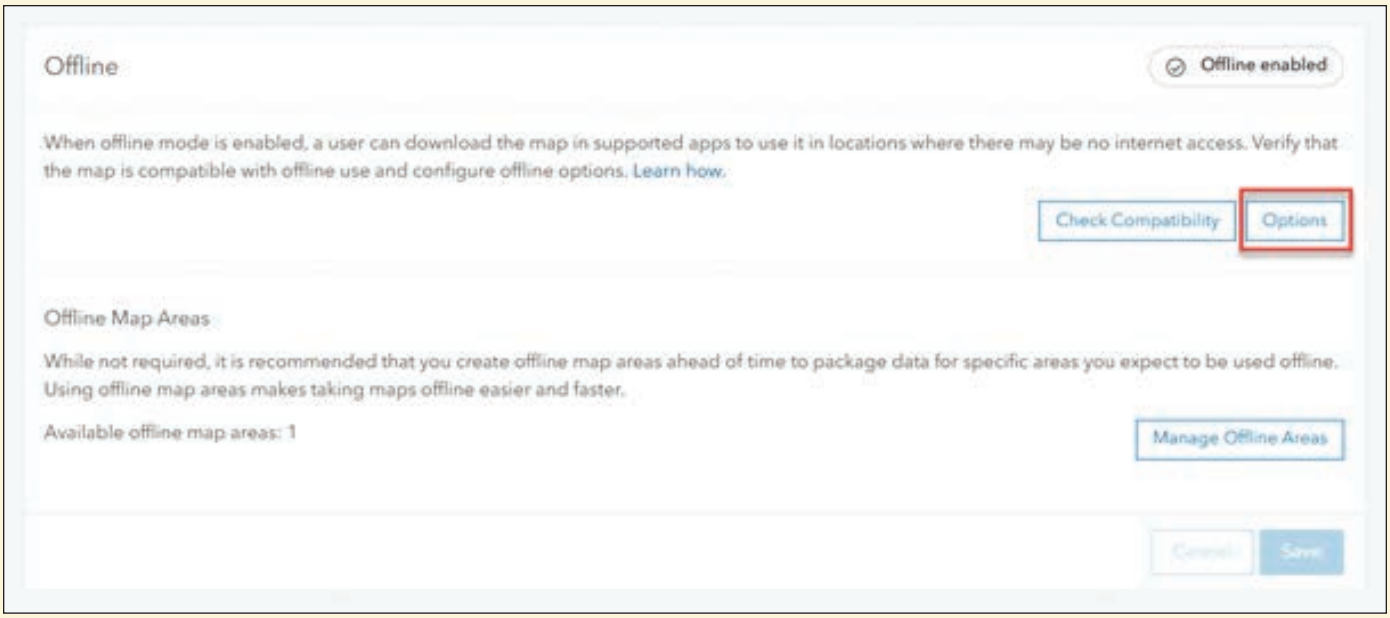
Taking advantage of the ability to prepare offline map areas ahead of time can streamline your field operations, especially in remote environments or when connectivity is limited.

Create the Web Map for Offline Use

To create a web map for offline use, you can either use ArcGIS Pro to share a web map or use Map Viewer to create and save a web map on a portal.

First, make sure that all layers, including the basemap and reference layers, are enabled for offline use. In general, Esri raster basemaps and Esri vector basemaps are automatically enabled for offline use. If using ArcGIS Enterprise, the default Esri basemaps included in your portal aren't enabled for offline use. You can take similar basemaps offline by adding an Esri basemap from ArcGIS Online to your web map or by authoring your own basemap and enabling offline use.

Once you set up a web map for offline use, go to the web map's item page and click the Settings tab. In the Offline section,



↑ In the Offline section, click Options to access the additional settings for features and attachments.

↘ The offline options for features and attachments determine feature and attachment behavior during sync.

click Options to access additional settings for features and attachments, as well as the basemap and tile package. This is where you can control what data is delivered, both on the initial download and when synchronizing or downloading. Select the appropriate choices based on offline usage requirements, taking into account device storage constraints, cellular data usage, and the speed of downloads and synchronization.

In the Features and attachments section, you can set how attachments and features are delivered. They will be used when the offline map area is downloaded for the first time as well as each time data updates are synchronized from the map in the organization.

The Features and attachments option will prepackage all the data and attachments within the extent of the map area. Features only will exclude attachments from being packaged. Choose this option to provide only feature updates if offline users don't need access to attachments. To download a blank geodatabase with all the necessary fields for data collection, select Neither features nor attachments.

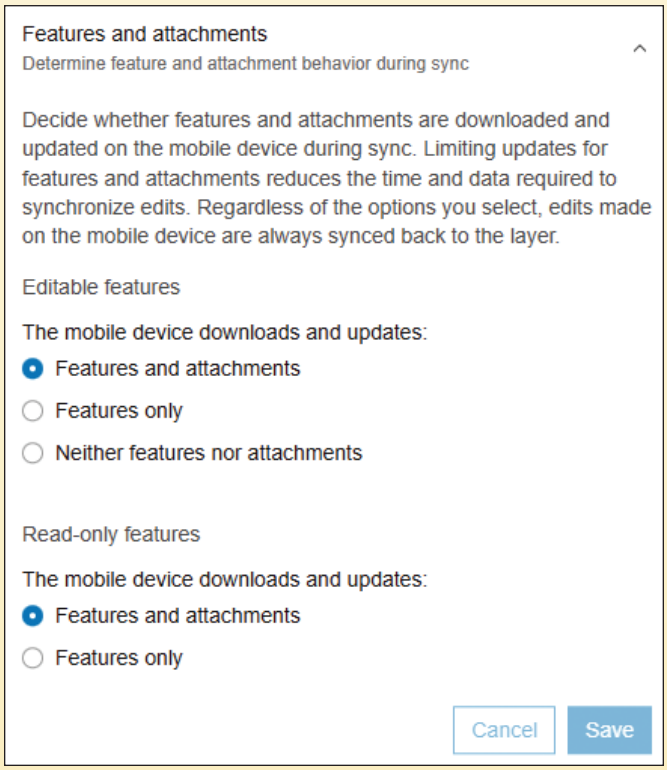
When your data is editable, all local edits are synced back to the layer, regardless of the options you select. However, for data that is only query and sync enabled, local edits are never synced back to the layer.

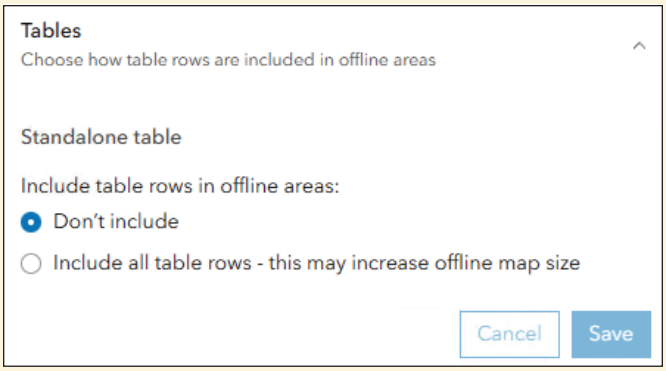
In the Tables section, you can determine how records within a stand-alone table are delivered. The Don't include option excludes all current records and displays a blank table with necessary fields for data collection. The Include all table rows option will prepackage all records within the stand-alone table. Keep in mind that this option may increase the offline map size.

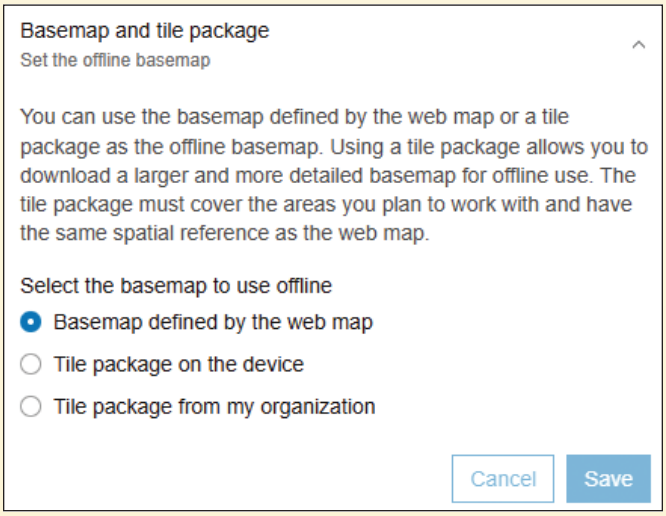
In the Basemap and tile package section, you can choose to use either the basemap defined by the web map or a tile package.

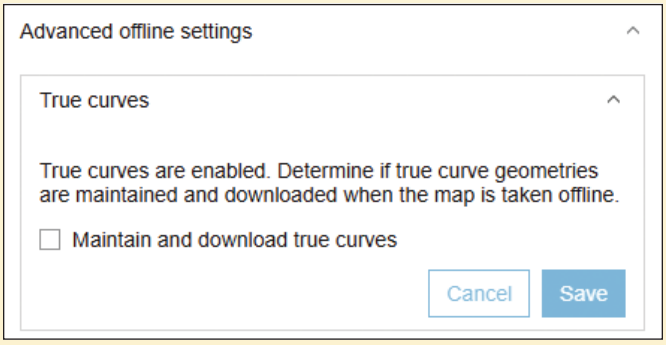
If using a tile package, there are two options to choose from. The Tile package on the device option allows the use of a tile package that has already been downloaded to the device. You'll need to provide a file name when selecting this option. Later, when the offline map area is downloaded, select the tile package previously downloaded to the device.

The Tile package from my organization option allows the use of a previously published tile package. After choosing this option, select a previously published tile package. When taking offline a map area prepared ahead of time, the tile package appears alongside the downloaded mobile geodatabase in the project's home folder by default.









In the Advanced offline settings section, check the box to maintain and download true curves. By default, this option isn't enabled, and when using offline map areas prepared ahead of time, true curve features are densified. These features can still be edited, but behavior during sync varies depending on the configuration of the web feature layer feature access properties.

Creation, Configuration, and Management

After creating and configuring a web map, you can create the offline map areas ahead of time for the extents where work needs to be completed. You can also set options for each map area, which affects size and data delivery.

Begin creating map areas prepared ahead of time:

1. Go to the web map's item page and click the Settings tab.
2. In the Offline section, click Manage Offline Areas and click Create offline area to begin creating the new map areas.
3. Navigate to a location for the new map area.
4. Use the Sketch rectangular map area button or the Sketch polygon map area button to create the boundary around the map area.
5. Provide a name for the new map area. The total number of offline map areas associated with the web map is limited to 16.

Once the new map area's boundary is set, configure offline map areas using the following options:

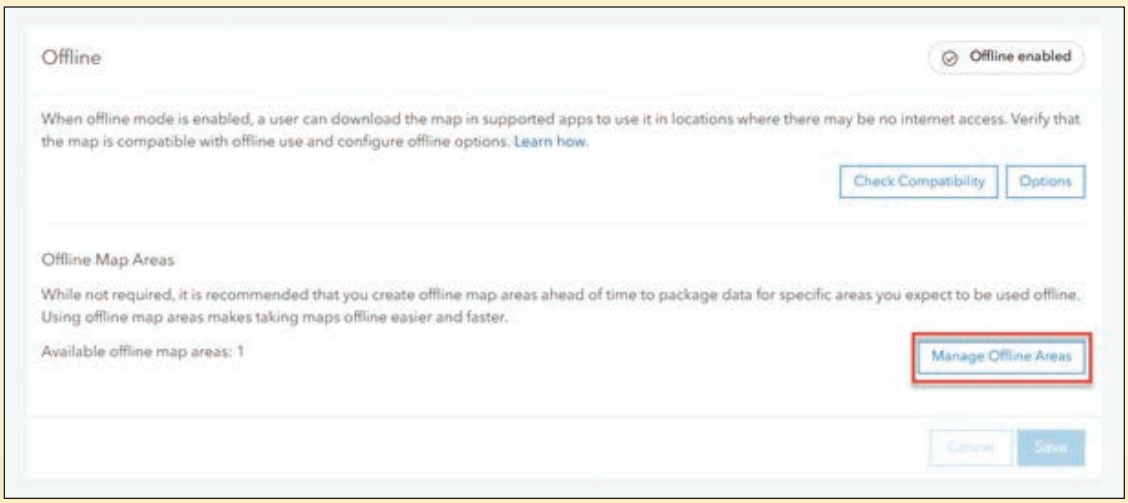
- **Level of detail:** The Level of detail slider lets you control the quality and resolution of the downloaded tile layers. Select the highest and lowest levels of detail to generate tiles for. Each increase in detail increases the size of the tile package as well as the time to create it.
- **Packaging schedule:** After a map area is created, it's packaged and stored on the server. The packaging schedule allows web

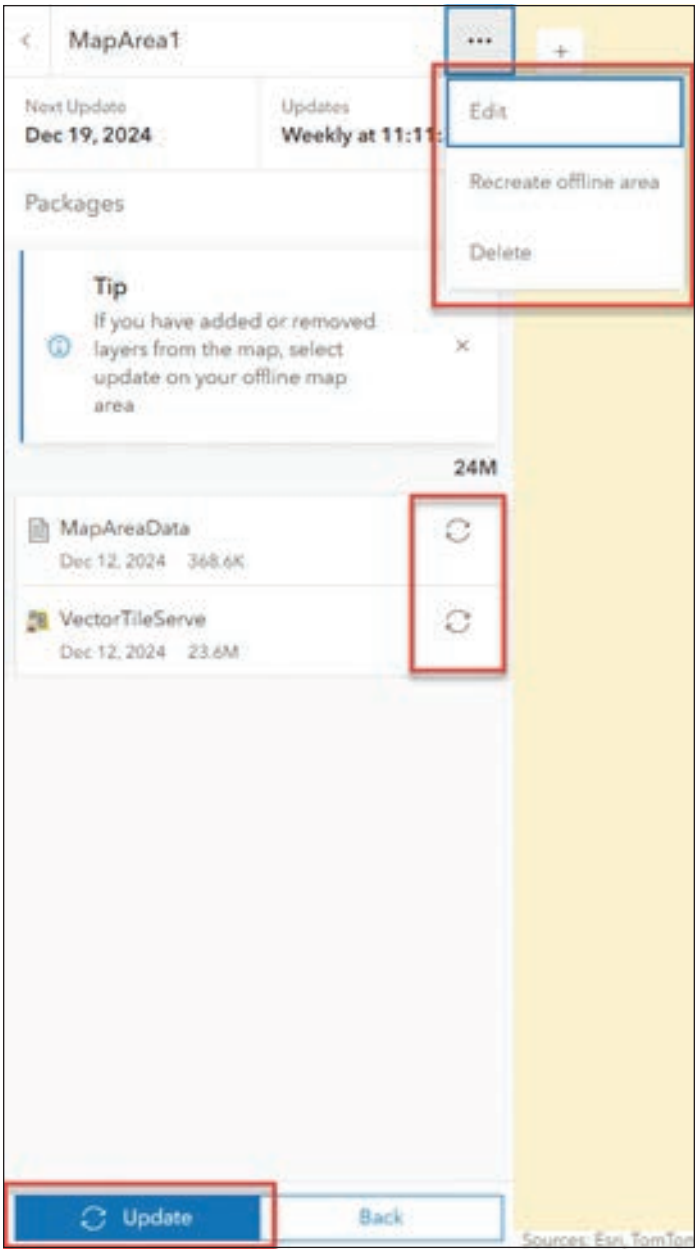
↑↑↑ You can choose how table rows are included in offline areas.

↑↑ The offline options for basemaps and tile packages.

↑ You can determine whether true curves are enabled when a map is taken offline.

→ Click Manage Offline Areas and then click Create offline area to begin creating the new map areas.





↑ If layers have been added or removed, data has been updated, or advanced offline settings have been changed, you can repackage these changes so that they are available to download before the next scheduled package update.

map owners to set the interval in which the offline map area package is to be refreshed with updates to the feature layer data. For offline mobile device and ArcGIS Pro users, this schedule won't affect the accuracy of the initially downloaded data, as map areas are set to perform an initial sync to retrieve the most up-to-date data. If the data in your maps isn't updated often, you don't need to repackage frequently.

- **Optimization:** For large deployments of offline map areas prepared ahead of time, it's important that they scale well when multiple users pull updates to mobile devices at the same time. To alleviate additional work on the server, a read-only optimization is used when the Enabled packaged updates option is turned on. This option uses the packaging schedule to generate files that are stored on the server and can be downloaded for updates. When you click Sync, these update files are downloaded and applied to the local geodatabase.

After making the map area boundary and configurations, saving the map area begins the process of packaging the data using the OfflinePackaging service. The amount of time to complete this depends on the size of the data being packaged.

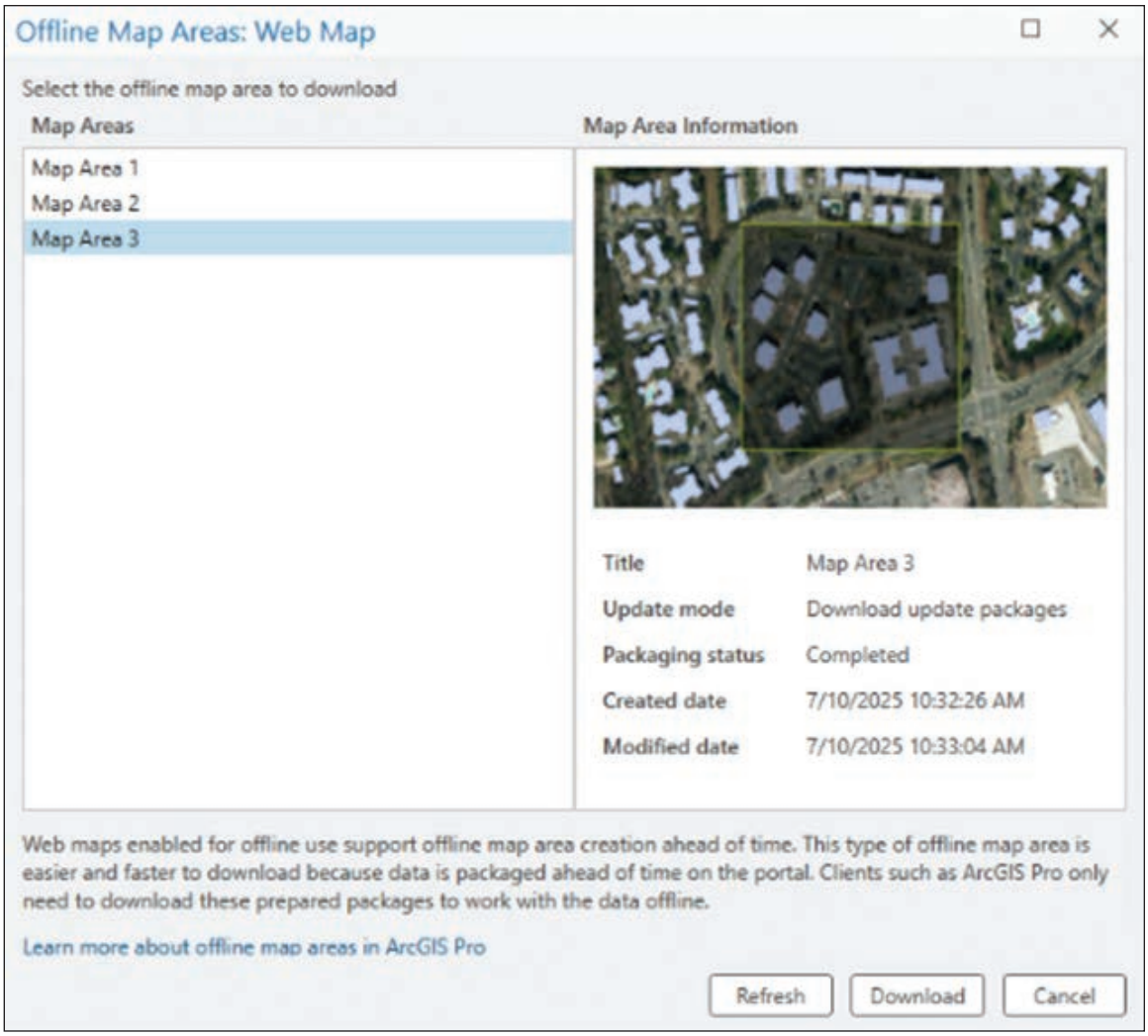
Once complete, clicking the offline map area provides update details and the downloadable packages created. Feature layers are bundled into mobile geodatabase files (.geodatabase), tile layers into tile packages (.tpk or .tpkx), and vector tile layers into vector tile packages (.vtpk). If there are multiple services within the web map, additional geodatabase files will be generated.

By default, if the total size of packages exceeds 4 gigabytes, the web layer packaging fails, and a warning displays in the map area manager. If this occurs, here are a few options to get the size down:

- Attempt to reduce the size of the sketched area by using the Sketch polygon map area button.
- Exclude attachments from the offline package if they are within the features but are not necessary for the offline user.
- If using tile layers, adjust the level of detail included in the offline package by updating the level of detail that was first set when creating the map area.

After you create the map areas, you can modify or update them:

- Click the Edit option to change any of the previous items set during initial creation. You can rename the map area or change its boundary or configuration (level of detail, packaging schedule, and optimizations). After you edit and save a web map, the map packages for this area are repackaged.
- Re-create the existing preplanned map areas with the Recreate offline area option. This option is used after adding or removing fields, creating or updating domains, or making any modifications in the underlying schema. Any existing edits should first be synced with the service before the re-creation of offline areas occurs. Users must redownload the offline map areas to pick up the new packages.
- If a preplanned map area is no longer needed, the Delete option removes the offline map area and any associated packages.
- Refresh specific packages in a map area if the data has changed but you want the updates to be available for download before the next scheduled package update.
- If layers have been added or removed, data has been updated, or the advanced offline settings have been changed, use Update to repackage these changes so that they're available to download before the next scheduled package update.



→ The Offline Map Areas dialog box.

Download, Access, and Update Changes

Taking map areas prepared ahead of time offline doesn't perform a query on the back end of the database, as is typical when taking other maps offline. Instead, it downloads prepackaged data. This download allows for greater scalability and efficiency of map areas.

Once downloaded, the map and data can be accessed without internet connectivity. Editing capabilities for this data depend on the configuration of the individual layers as well as whether the preplanned map area has been enabled with the packaged updates optimization.

Along with the file download, a replica is generated during this time that allows the use of synchronization to retrieve updates or upload edits.

When downloading a map area prepared ahead of time, some updates may not be within the map area if a packaging schedule has been set. ArcGIS Pro takes this into account and performs a sync after the initial download to check for additional data changes.

To take map areas prepared ahead of time offline, complete the following steps:

1. In the Catalog pane, click the Portal tab.
2. Browse to a web map or web scene in My Content or another portal collection.
3. Right-click the web map and click View Offline Map Areas.
4. In the Offline Map Areas window, select a map area.
5. Click Download. When the process is complete, a mobile geodatabase containing the offline data appears in the project's home folder and a new map opens with feature layers that reference feature classes in the mobile geodatabase.
6. Save the project.

Once the project is downloaded and saved, you can access the data in ArcGIS Pro. No internet or network connectivity is required at this point to read or edit the data.

If the offline map area hasn't been configured with the Enabled packaged updates optimization and the underlying data has editing capabilities, users can add, update, or delete data. If the offline map area has been configured with the Enabled packaged updates optimization, editing will be disabled.

After edits are complete, or if there are updates to retrieve, you can use the Sync button when a network connection is available.

If packaged updates haven't been enabled, the Sync button will push and pull data changes from the data on the server or the local geodatabase. Keep in mind that the Features and attachments offline option still determines what data is pulled from the server to the local geodatabase.

If packaged updates are enabled, the Sync function first checks if there are any packaged updates generated based on the set packaging schedule. These packaged updates contain changes to the data that have occurred since the last packaged update. If there are packaged updates available, they are downloaded and the data updates are applied to the local geodatabase.

For each time that the packaging is run, an individual update package file is generated with changes that have occurred since the last scheduled run of the packaging. As these files are generated, the local geodatabase can become out of date if the packaged updates are not downloaded and applied after the scheduled packaging.

Sometimes, ArcGIS Pro redownloads the whole preplanned offline map area rather than the individual packaged updates. This can occur if there have been multiple scheduled packaged updates since the last time a sync has been performed and the local geodatabase has become too out of date with the data updates on the server. This can also occur if the size of the packaged updates exceeds either 100 MB or the total size of the packaged offline map.

If the local copy of the offline map area is no longer needed, click the Remove button. This will first perform a sync if there are any edits that need to uploaded. Then the locally created mobile geodatabase will be removed from the project and deleted from the project's home folder. The map that was generated within ArcGIS Pro when the offline map was downloaded will also be removed.

With these offline map capabilities tailored to your needs, you can improve scalability and reliability, especially when working in environments with little or no internet connectivity.

About the Author

Jared Motuz is a product engineer on the feature service client team at Esri. He focuses on building and supporting feature service capabilities that help customers successfully create, manage, and share GIS data. Motuz holds a BS in geography from East Carolina University.

Designing LEGO Maps, BRICK BY BRICK

By Christie Roland

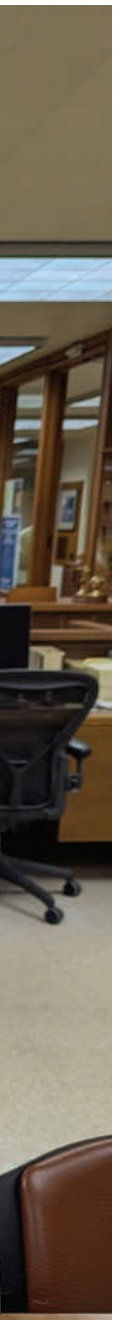
Atlas Guo, a PhD student at the University of Wisconsin-Madison, is combining the digital and physical worlds in a way that is not only unique and beautiful but also practical for geographic education. While his research focuses on applied geospatial AI and geospatial data mining for natural disaster management, Guo's love for maps led him to this surprising way to explore cartography: designing maps in a LEGO brick style.

In this interview, Guo explores how he uses ArcGIS Pro to make LEGO maps that are accurate on the ground and can be used to build physical or virtual models, as well as how he hopes these maps can inspire educators and future mapmakers.

Q: I'd love to learn more about how you got into cartography and mapping. I know you're academically pursuing it, but it would be great to better understand the road here and where you want to go next.

A: I got my bachelor's degree in GIS from Sun-Yat-sen University in Guangzhou, China. Then, I moved to the United States and got my master's degree in geography (GIS) from the University of Georgia. Now I'm working on my PhD at the University of Wisconsin-Madison, so I've been using Esri software for over 10 years. Basically, all my research has been on the GIS side—doing things like spatial computing, data mining, [geospatial] AI, mostly writing code and making maps—but not really from the cartographic perspective.

An important experience in my geography PhD program at UW-Madison is working as a teaching assistant and instructor for cartography courses. It was during this time that I learned a lot about cartography, especially having the chance to systematically appreciate the cartographic design of many great maps. Then when the pandemic occurred, everything paused, giving me time to explore cartography more. One practical example is building up a local COVID dashboard using ArcGIS Dashboards. That was an important moment for me, to realize how I could make maps to benefit the local communities, my family and friends, and even myself. In one sentence: My research is in GIS, but my passion and future are in cartography.



Q: It's inspirational how you pivoted and found power in making maps that can serve as a great communication tool. It looks like you also discovered mapmaking can be fun. This LEGO brick project started off as a happy accident. How did that come about?

A: My experiment with LEGO mapping started by coincidence. I wasn't a LEGO fan before 2024, but I just love trying new ways to make maps, especially through crafts. So, my journey began with a LEGO topographic map of Wisconsin. I thought LEGO could be a good way to combine crafts and maps. Instead of just randomly making a map-shaped LEGO [model], I decided to make it more accurate. That's why I started using ArcGIS Pro to design it. After that, I could either make a physical LEGO model or a virtual one using LEGO's Studio software.

Q: With any map, there are a lot of design choices you make and a lot of tinkering to get things right to represent like the terrain, the water, creating the landforms and the contours. Could you talk more about this process of using ArcGIS Pro for LEGO maps?

A: There are so many things to share, but maybe starting with a common topic in cartography would be helpful. The planning part is hard because I need to choose a projection and extent that make the LEGO map easy to recognize while still allowing for measurement. So I needed to compromise between keeping the shape accurate and recognizable while making each LEGO unit represent a rounded value. For example, in my first LEGO map (Wisconsin), I chose a scale where one LEGO unit—in this case, a round plate—represents a 10-mile-by-10-mile area. Another factor to consider is that if I make a physical LEGO map, it usually needs to fit a single LEGO baseplate, which may be a 32-by-32 or 48-by-48 unit. This part is very challenging but also really fun to play with, as it ties in with other aspects of cartographic design.

After figuring out the projection and scale, my data solution was to create a fishnet of rectangular cells in ArcGIS Pro and use it as sampling points. I extract the value of each cell in the fishnet from the elevation and sometimes bathymetry layers. The source for these is always a layer from ArcGIS Living Atlas of the World. That saved me a lot of time. I don't need to worry about the digital elevation model (DEM) at all because [ArcGIS] Living Atlas has everything.

Then I move on to the design and styling part. This is a process with a lot of joy and freedom to explore and experiment. For every LEGO map I've made, I've tried to make something different. However, I prefer to keep my LEGO-style symbols relatively simple, in more minimalist rather than realistic style.

For the color choice of topography, I have my own habits. The basic version uses five colors: dark green, light green, beige, light brown, and dark brown, representing low to high elevations. I try to keep the color scheme the same across my work, which works better for geographic education. This way, people who don't know much about topographic maps can still recognize the patterns. This makes the LEGO maps a learning tool to help others better understand real maps.

Q: As you've gone through this process, what are some things you've learned that you're going to take into the future with LEGO map building? Are you planning to do more?

A: Of course, I will do more, and I have lots of plans, though I don't have enough time to turn these creations into LEGO models. One thing I'm exploring is creating a complete workflow, from buying new LEGO elements to building a real, physical LEGO map. LEGO is a global company, and its bricks are highly standardized. If people have step-by-step instructions, they can get the materials anywhere and build their own LEGO models.

I hope my work can inspire educators and mapmakers to create more LEGO maps of the areas they're interested in. I think this will really help children learn about geography in a joyful way because LEGO is a language they understand much better. This work can help them study what the terrain patterns are, what map colors represent, and what elevation means—things like that.

A great thing about LEGO mapping is that it can be customized in many ways. For example, you can use a topographic map as a basemap. At a *Star Wars*-themed LEGO showcase event this year, I used my North America map as a basemap with the filming locations added on top. Now it's not only a topographic map; it serves as a thematic map. That's actually the next thing I want to explore: building more thematic maps with LEGO models that can inspire creativity and serve as a meaningful tool for education and more.

Check out more of Guo's LEGO maps and others at **links.esri.com/guo**.

About the Author

Christie Roland is the product marketing manager for ArcGIS Pro. Before coming to Esri, she studied heritage preservation and GIS in graduate school. In her spare time, Roland enjoys exploring the outdoors, hanging out with family, and trying new recipes.

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Jesse Hamlin's path to becoming a renowned GIS professional with The HALO Trust, a humanitarian organization dedicated to clearing landmines and other explosives, was fueled by a passion, a purpose, and commitment to meaningful work.

Hamlin '14 chose to study at what he said is the "best GIS school in the world," — University of Redlands. He was drawn by U of R's prestigious program and its close relationship with Esri®, the global leader in GIS technology. While earning his MSGIS degree, Hamlin said he enjoyed the unique access to Esri's resources and staff which gave him an invaluable mix of theoretical and hands-on learning, preparing him for the challenges of his future career.

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— Jesse Hamlin '14 MSGIS

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