Geographic Information Systems Outlook 2020

Richland County | SC

GEOGRAPHIC TECHNOLOGIES GROUP

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GIS Outlook 2020

Introduction to GIS

An enterprise Geographic Information System (GIS) is an organization-wide asset and collaboration platform that supports the collection, sharing, and exchange of geographic information. It allows an organization to visualize, search, analyze, and interpret data to identify relationships, patterns, and trends contained within location-based information to create efficiencies in services and programs, and support decision making. An established enterprise GIS will contain many spatial data layers that represent the collective assets, responsibilities, and considerations of departments throughout an organization.

GIS technology can support many diverse functions including, but not limited to, asset and capital project plan management, planning, public safety, assessments, managing infrastructure, and a host of other department-specific duties. GIS is a key enabler of digital and hardcopy cartographic map production and other location-based information products that can be leveraged by staff, contractors, stakeholders, and the general public for interpretation and decision-making. These mapping products are all derived from information stored and managed in enterprise geodatabases that support the enterprise GIS and other related information systems.

GIS technology facilitates data-driven decision making, playing a key role in strategic service management and tactical service delivery. GIS is an integral part of Computerized Maintenance Management Systems (CMMS), Work Order Management systems (WOM), Enterprise Asset Management (EAM), and an array of other Information Technology (IT) systems used throughout local government.

GIS also allows users to analyze the world geographically (spatially). Spatial analysis is how we understand our world – mapping where things are, how they relate, what it all means, and what actions to take. From the computational analysis of geographic patterns to finding optimal driving routes, identifying areas for economic development, and advanced predictive modeling, spatial analysis is at the very heart of GIS technology.

GIS takes massive amounts of data and puts them into a context that is readily accessible and actionable. GIS enables residents to understand a multitude of civic information including property data, infrastructure work in their neighborhoods, how to prepare and recover from natural disasters, visualize all of the government services in an area.

GIS should be considered a unifying enterprise technology that promotes organizational sustainability and empowers employees to view pertinent data through a common platform. Coordinating efforts can help organizations better utilize the capabilities of GIS technology and results in less staff time spent searching for, compiling, and integrating geospatial and related data of common interest. This, in turn, reduces operational inefficiencies associated with silos of information that are not readily accessible and/or exchanged with others where needed.

Project Overview

Over the past two decades, GIS has become an essential information management tool for Richland County, SC. The County's investment in GIS has been substantial and, as such, the GIS should be viewed as a critical county-wide asset. More than 15 mapping solutions for collecting, viewing, and analyzing spatial data have been developed and over 100 accurate and comprehensive GIS data layers created representing location-based information of the organization.

It was observed in the 1980s that "80-90% of all data maintained by a local government is related to geography." *(Huxhold, 1991)* That number is certainly higher today and this data lends itself to being mapped and analyzed. Thus, as most functions of government are related to the 'where' of a service or population, the limited use of geospatial technology across a County organization can truly be a handicap. This underscores the importance that the Richland County GIS program needs to be well governed, planned, and funded. To that end, Richland County has commissioned Geographic Technologies Group, Inc.® (GTG) to prepare this Outlook 2020 plan to guide the expansion of GIS technology within the County and to ensure that the continued investment in GIS service delivery is most effectively managed.

A GIS Strategic Plan for Richland County was originally developed 20 years ago by GTG. Two updates to this plan have been completed since the original document was drafted. The purpose of this Outlook 2020 plan is to document the past successes and present status of the County's GIS program as well as to define the future direction of the GIS.

Strategic Planning Methodology

Multiple data-gathering techniques and assessment methodologies were used to identify recent achievements and future needs at Richland County. Key methodologies include:

- Six Pillars of Sustainability – used to evaluate Richland County's GIS regarding gaps and organize action items. The Pillars of GIS Sustainability are as follows:
    - GIS Governance – how is GIS managed and maintained
    - Data and Databases – key data elements that feed the GIS
    - Procedures, Workflows, and Integration – how is the GIS being integrated with other systems and within the workflows of the organization
    - GIS Software – the appropriate software for various types of users and needs
    - Computing Infrastructure – the appropriate hardware, network, and field tools
    - Training, Education, and Knowledge Transfer – ensuring that GIS is understood and that the organization has pervasive knowledge of the power of GIS and how to use it
- GIS Benchmarking – analysis of the RCGEO program as compared to analogous organizations nation-wide.
- Key Performance Indicators (KPI) – enabling Richland County with a set of KPIs to track success now and in the future based on the Six Pillars of Sustainability.
- GIS Division Input – to determine existing conditions and potential future uses of GIS.
- Success Stories – documentation of some of the most impactful projects throughout the history of GIS at the County. This includes why the project was undertaken, what was used to accomplish the project, how the project was completed, and the impact on the organization.

This GIS Outlook 2020 is comprised of the following sections which outline Richland County's current status and plan for growth:

- **Introduction to GIS and Project Overview**: An introduction about GIS and its purpose – this will serve to orient the reader about GIS technology and its use within the county government.
- **History of GIS at Richland County**: an overview of how/why the County's GIS was started and how it has matured and transitioned throughout the years.
- **Richland County Success Stories**: documentation of some of the most impactful projects throughout the history of GIS at the County. This will include why the project

was undertaken, what was used to accomplish the project, how the project was completed, and the impact on the organization.

- **GIS Governance**: discussion and recommendations for protocols, management, and organization of the GIS administrative structure.
- **GIS Budget and Funding Strategy**: budget and funding options and alternatives to support GIS initiatives.
- **Future Direction of the GIS Program**: documentation of future projects and needs of the organization in regards to GIS.
- **Key Performance Indicators for the GIS Program**: a review and analysis of current Richland County GIS performance measures, data collection methods, and systems; and a comprehensive performance measurement framework and set of Key Performance Indicators (KPIs) at both the County GIS division and service delivery levels.
- **Mission, Goals, and Objectives for the GIS program**: documentation of the formal vision and goals of the GIS program and specific objectives to meet these goals.
- **Conclusion**: All concluding remarks and recommendations

History of GIS at Richland County

This section is an overview of how the County's GIS was started and how it has matured and transitioned throughout the years.

The initial effort to establish a Geographic Information System (GIS) program in Richland County dates to a proposed coordinated effort between several regional entities in late 1998, called the 'Richland County Area GIS Initiative.' From the meetings of that effort, a GIS Implementation Plan was written in an attempt to coordinate GIS development activities as an enterprise effort among several community members including Richland County, City of Columbia, University of South Carolina, Fort Jackson, and others. However, only Richland County acted on the initiative with defined goals and a budget to create a County system.

Once the project was approved by County Administration and County Council, GIS moved forward by collecting foundation layers, creating procedures, disseminating applications to several departments, and executing all the activities required to establish a functional enterprise GIS program. In 2000, the County Council enacted Ordinance No. 072–00HR to create the Geographic Information System Division within the Information Technology Department. Also, in 2000, the newly-formed Richland County Geographic Information System Division, known as RCGEO, retained GTG to perform a GIS Needs Assessment, Feasibility Study, and Three-Year Implementation Plan. That study identified Richland County as the sole stakeholder in the area GIS Initiative and found that the Richland County Information Technology Department was spearheading the implementation of GIS throughout the County, led by the County's GIS Coordinator. The findings indicated that there was "a groundswell of enthusiasm for utilizing GIS and global positioning system (GPS) technology." Early data projects included aerial imagery for base layer development, exploiting new and cost-saving technologies for elevation data collection, mylar parcel map conversion to GIS, and street centerline addressing, among others. The program also began to provide software and training to departments for data maintenance and analysis. These efforts were most successful in the Assessor's office, Public Works, and Planning.

The next phase of enterprise implementation was to integrate GIS technologies in departmental systems such as pavement management, mass appraisal, 911 dispatching, etc. The most visible and successful system integration was within the 911 call center. With this system in place, geospatial technologies were being realized as essential. In 2002, the

Richland Maps website (www.RichlandMaps.com) was activated and the 'Internet Mapping Service' and several other web applications were developed.

By 2004, significant progress had been made in developing the foundation of the Richland County GIS, with a few departments relying on the County GIS to do their work and other departments seeking similar solutions. Critical data layers were in progress or completed and many other datasets had been created. Also, business practices and procedures had been modified to leverage the evolution of spatial technologies, and additional data layers and applications were planned. The program updated its strategy in June 2004 GIS Implementation Plan Update, also composed by GTG. That update marked the evolution from 'start-up' to 'application.'

The latest strategic planning effort was undertaken in 2007, with the GIS Implementation Plan Update. The focus of this volume was on the corporate governance of the enterprise GIS. With a formal governance model in place, the County could take full advantage of the robust GIS already developed. By this time, RCGEO had achieved several major accomplishments. Over 100 spatial data layers had been created and maintained, several major projects were completed, and four mapping applications were deployed.

The program has had many successes since the end of the implementation plan period (2010), several of which are detailed in the Success Stories section. The foundational datasets of tax parcels, street centerline addressing, address points, aerial photography/LiDAR, building footprints, and hydrography have been completed/acquired.

However, as GIS began to have a positive impact on a growing number of departments, organizational changes occurred that prevented the technology from being implemented across the enterprise. Unlike enterprise GIS operations in many local governments across North America, geospatial technology is not considered an essential component in departmental IT system functions or software within Richland County. This is a significant departure from the original intent of the GIS program in Richland County.

Fortunately, recent approvals for IT infrastructure signal the County Council's understanding of the importance of IT in all County operations, especially since the COVID-19 pandemic. It is the vision of the interim IT Department Director that the three IT divisions work better together and collaborate on projects.

Major projects completed by the RC GEO team include:

- Survey Network Monumentation
- Land Cover Classification and Change Detection
- 3-D Urban Model
- Vector Control
- Tower Permitting System
- Real-time Kinematic GPS Correction Station
- Street Centerline Impedances
- 911 CAD System
- Open Source Technology Adoption
- Cloud Technology Adoption
- Drone Program
- LiDAR Technology Adoption
- GIS Emergency Operations Center
- Automated Vehicle Location for Fleet
- Digital Submissions
- Airport Audio Feed
- Field Data Collection
- Utilities Data Collection

Public/Citizen and *internal* applications developed over the years by the RC GEO team include:

- Internet Mapping Service
- Online Property Assessment Inquiry
- Online GIS Data Ordering System
- Census Data Application
- 2015 Flood Response
- COVID-19 Response
- Dataviewer
- CompSales
- GeoInfo
- Delinquent Property Tax Sale
- *Dynamap Interface*
- *Historic Parcel Viewer*
- *Permit Lookup*
- *Permit Activity Dashboard*
- *Polling Manager*
- *Annexation*
- *Crash Data Portal*
- *Daily Usage Stats App*

The current state of the County's GIS system reaches a broad spectrum of users across several departments and external customers.

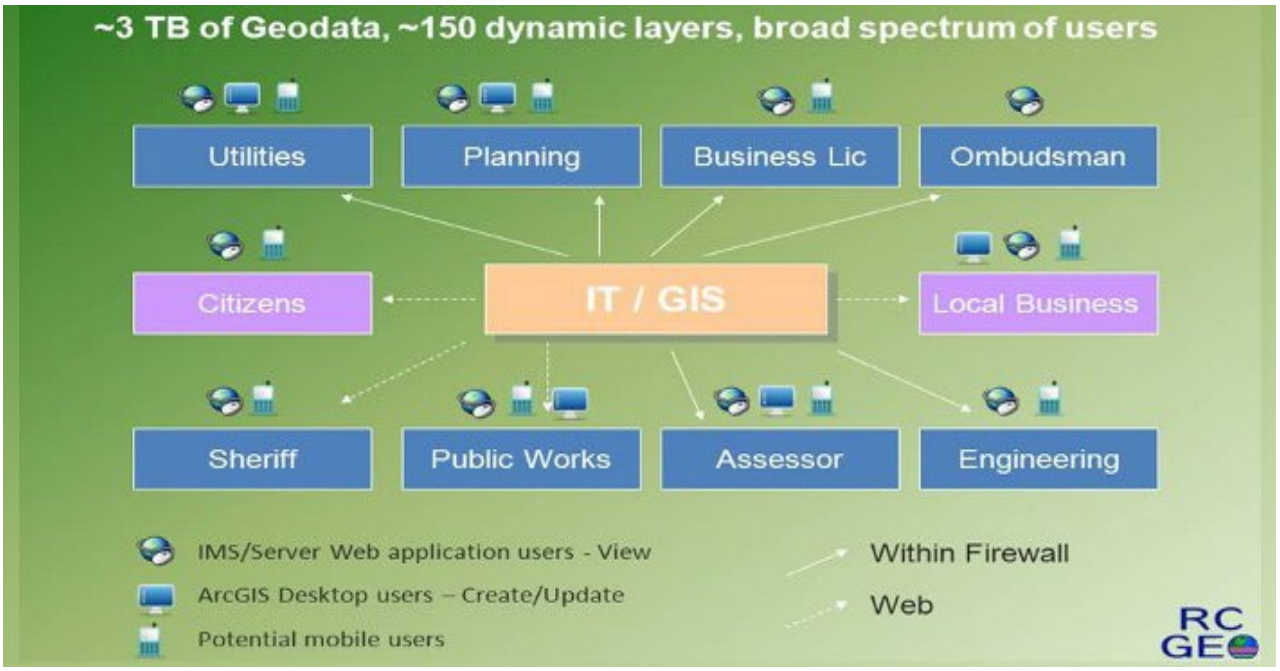


Figure 1: The current GIS system status of Richland County GIS

Richland County Success Stories

What constitutes a successful Geographic Information System (GIS)? This question has been a topic of debate for decades. Some people argue that success is a robust database of GIS layers. Others contend success is the implementation of software and hardware that enables users to use GIS. However, the ultimate success of a county-wide GIS program is how the GIS is being effectively used to impact the organization and the lives of residents. Articulating Return on Investment (ROI) is very important for an organization. A GIS program might have highly successful projects, but without visibility to these successes, the GIS might be under-appreciated. Therefore, one of the key responsibilities of the GIS leaders in an organization is documenting accomplishments and giving visibility to these organization-wide. This visibility will ensure that staff thinks in terms of success and that support remains strong throughout the organization because successes are understood.

Several of the most impactful GIS projects at Richland County are outlined below. These success stories include why the project was undertaken, what the project accomplished, how the project was completed, and the impact on the organization.

Drone Program

Why:

The adoption of drone technology is increasing rapidly, providing cost-effective solutions compared to traditional methods of acquiring aerial photography. Drones can quickly, easily, and frequently collect imagery and other remotely sensed data that can be imported into the County's GIS and converted into 2D and 3D products. An aerial photo for an area of interest can be quickly created by stitching multiple drone images together using specialized software applications. This technology enables the County to obtain near real-time imagery quickly and easily for an area of interest. The incorporation of drone-collected imagery into County workflows has improved the quantity and quality of information used to make decisions, thus leading to improved decision making by staff. Projects suited for drone capture include site selection, volume calculations, construction progress, inspections, and public outreach.

What:

Richland County GIS (RCGEO) was one of the first governmental agencies in South Carolina to incorporate Unmanned Aerial Systems (UAS), or drones, into their daily operations. The

drone program has supported various departments at the County for acquiring aerial imagery and terrain surface imaging. Departments that have benefited from this technology include Emergency Services, Stormwater Management, Planning and Community Development, Utilities, Solid Waste, Public Information Office, Transportation, and Economic Development.

RCGEO currently maintains a fleet of four drone platforms for most operations - DJI Inspire, Mavic Pro, Mavic Enterprise, and Matrice 210 drones. All have undergone system testing and operational deployment. Each drone platform has a specific set of capabilities that dictate its use. The UAS can be used for orthophotos, elevation, 3D modeling, thermal infrared, and more.

Four GIS staff members have completed the requisite FAA training and obtained their FAA CFR Title 14 Part 107 Remote Pilot Airman Certification with a small UAS rating. Each drone pilot is responsible for a single airframe, with the group maintaining the remaining aircraft along with data processing software.

Since its inception in 2014, the drone program has been used for at least eight high-profile, highly beneficial projects, which have saved the County time and money by removing the need for contractors to complete the work using more traditional methods. Several of these projects are described below.

Richland County Emergency Services

The Richland County GIS team used a drone to investigate suspected tornadic activity on a 50-acre tract of land following a major storm in April 2020. The images were shared with the National Weather Service (NWS) to use as part of their analysis to determine if the damage in the area was caused by a tornado.

The project delivered the following Returns on Investment:

- **Saved Money** – Post-disaster relief funding relies on this type of data.
- **Improved Efficiency** – Data package is known and ready to go for these events.

- **Collaborated with Federal Agencies** – Drone use made it easy to deliver information to the NWS, allowing the agency to consider all pertinent data, which resulted in an informed evaluation.

Richland County Solid Waste

The drone program is used to transition surveys of the Richland County Construction & Demolition (C&D) Landfill from traditional land surveying techniques to a drone-based analysis. The Richland County C&D Landfill receives construction and demolition debris, which typically consists of roadwork material, excavated material, demolition waste, construction/renovation waste, and site clearance waste. Volume calculations and capacity permitting data are captured, along with data and calculations for surveying and engineering such as ground control points, contours, volume, and subsidence calculations.

The project delivers the following Returns on Investment:

- **Saves Time and Money** – UAS-based analysis saves two survey crews from visiting the site two to three times a year.
- **Improved Data Accuracy** – Precise drone data enables staff to generate accurate calculations.
- **Regulatory Compliance** – Drone collected imagery is delivered to surveyors to comply with regulations.

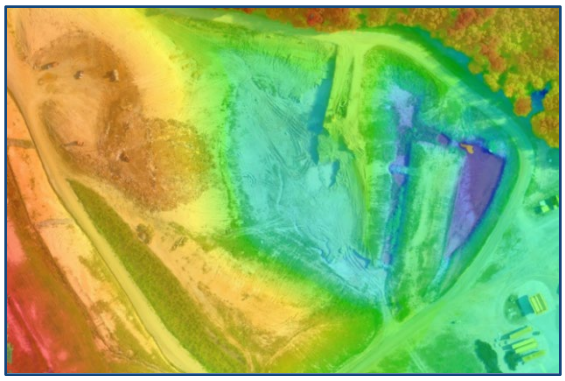


Figure 2 Resulting map of volume calculations from drone data

Economic Development Project Updates

Drone imagery provides updates of ongoing Economic Development projects and helps review potential project sites. Using their current methodology, the GIS team can complete a UAS photo or video mission in a day. For example, the technology has been used to capture imagery of building construction and to provide courtesy updates to foreign investors to demonstrate progress.

The drone program delivers the following Returns on Investment:

- **Improved Communication, Coordination, and Collaboration** – Drone imagery and video convey timely information in an accessible format.
- **Quicker Response Times** – With drone data available in a matter of days, staff members can easily respond to requests from businesses with aerial images of potential sites.

Figure 3 Site Selection and Construction Progress

Other Drone Operations

- Dam Inspections – Assists with **providing data to regulators** for the Emergency Services Division.
- Multimedia products for the Public Information Officer (PIO) – **Improved communication and coordination** by allowing Transportation and Greenways to document before and after photos of their projects and add to their presentations. This removes the need for the Transportation Department to hire a helicopter and/or videographer.
- Utilities Water Tower Inspection – Removes the need for an inspector to climb the water tower to take photographs and send them to the South Carolina Department of Health and Environmental Control (SC DHEC). This **limits liability** and the need for a contractor.
- Stormwater Program – Enable and support for the Stormwater Department to start a drone program using the **workflow procedures** that have been established by the GIS team.
- Building Inspections – Unobstructed views of buildings to conduct unsafe housing inspections **increased the productivity** of the inspectors.

How:

An Unmanned Aerial System (UAS) includes a drone aircraft, sensor, navigational controls, and software. Drones can be outfitted with many different types of sensors to capture a

plethora of data for an area. The process of data collection is highly automated but still requires detailed mission planning and post-processing expertise.

The following key steps were undertaken for the drone program to be successful:

1. Developed a drone strategy.
2. Evaluated various aircraft platforms.
3. Acquired the UAS equipment, mobile devices, and software for processing imagery with ground control points.
4. Obtained FAA (Federal Aviation Administration) Remote Pilot Airman Part 107 certifications.

Figure 4 DJI Inspire aircraft in action.

5. Developed procedures/checklists for drone pre-flight checks and data capture, conversion, and integration.
6. Developed and tested drone data gathering procedures to accommodate thematic department needs.
7. Educated the organization on the use of drones for remote image capture and the benefits of resultant data.

Figure 5 Drone image of a project site.

An RCGEO dedicated utility vehicle is used as a robust support base for drone operations to conduct field mapping, measuring, observation, and drone operations.

2015 Flood Response

Why:

The Richland County GIS (RCGEO) team worked with numerous partners to provide recovery and assessment support following the flood event, a federally-declared natural disaster, that began on October 5, 2015. As part of that effort, several geospatial tools were developed for use by local authorities for coordination efforts and by the public for information. The combination of process, coordination, and control resulted in situational awareness for the County to respond to and recover from this crisis.

What:

The RCGEO team assembled an online assessment tool, called RCGeo Flood 2015, to assist County departments in their efforts to record and analyze flood impacts. The publicly available website gave real-time updates to citizens and officials as road and bridge closures were reported, in addition to mapping shelter locations, state-monitored dam integrity status, and property impact. This tool has been instrumental in the recovery and assessment process.

An aerial service firm, Woolpert Inc., voluntarily flew 1-foot aerial imagery the afternoon of Tuesday, October 6, 2015, to assist in delineating the geographic extent of the flooding. The imagery was collected over much of the City of Columbia and Forest Acres. Woolpert then created the Flood Inundation Tool, which incorporated pre-event and post-event imagery to aid in assessing damages.

The RCGEO team also established a process to update rapidly changing road and bridge conditions based on field reports collected from County Inspectors and Public Safety

personnel, social media, Waze, and Google Traffic. The information was then verified by the Richland Fire Department and RCGEO team before publishing the map. Also, State-regulated dams were monitored using real-time resources provided by the South Carolina Department of Health and Environmental Control (SC DHEC) showing risk levels and breached status.

Due to space constraints at the Emergency Operations Center (EOC), the RCGEO staff was able to augment the EOC by extending all GIS-related operations to the GIS offices, creating a “GeoEOC” to provide the most efficient support for the flood response effort. At this location, RCGEO handled ad-hoc requests from EOC, Inspectors, Appraisers, Public Works,

Solid Waste, Public Safety, the National Guard, Public Information Officer, and others, preparing digital maps for use on mobile devices or electronic dissemination.

The public-facing applications can be viewed using the links below:

RCGEO Flood Viewer: http://www.richlandmaps.com/apps/flood15

Flood Inundation Tool: http://maps.woolpert.com/sites/sc-flood/

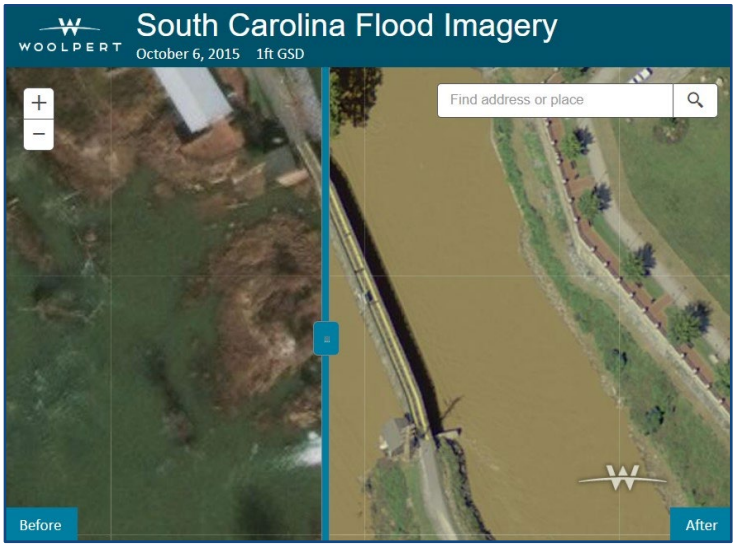


Figure 7 Woolpert's Flood Inundation Tool shows impacted area before and after the flood.

Figure 6 RCGEO Flood 2015 app shows flood waters nearing the 100-year flood line.

How:

As an immediate response to the flood on October 5, 2015, the RCGeo Flood 2015 app was developed by the end of the first day of the disaster, as a single-source web map that aggregated the most relevant data available, including real-time data for road closures (RCGEO), dam status (SC DHEC), flood imagery (Woolpert), and evacuation shelters (EOC).

The RCGeo Flood 2015 viewer was built using open-source technologies and includes the flood imagery collected by Woolpert as well as Google-sourced imagery available through

the County's Google contract. The cloud-based and open-source approach used resulted in an elastic, platform-agnostic, and mobile-ready application that was immediately available to various personnel and decision-makers.

ROI:

Saved Time – Having information when it is needed saves time, staff resources, and ultimately money. In this emergency response, the use of GIS helped avoid response time impacts due to flooded or impassable roads.

Saved Lives – In an emergency, every second counts, and GIS can help rescuers identify the quickest path to the scene. The RCGEO staff and the apps they created helped to reroute emergency vehicles around closed roads and bridges to get them where they were needed most.

Protected the Community – GIS helps public safety officials develop emergency plans and respond to disasters more effectively than ever before. RCGEO offered the tools to monitor conditions, recognize threats, predict consequences, and respond effectively and efficiently to this natural disaster. GIS also helped officials deliver information to citizens during the emergency through the PIO and public-facing web apps.

Recognition

In 2016, the Richland County GIS division received two awards related to their contributions to disaster response and recovery throughout the 2015 flooding event.

- Richland County Emergency Services Director's Award – This award was given*, "In recognition of dedication and outstanding contributions to*

Richland County emergency management during the millennium flood event October 2015."

- J. Mitchell Graham Award – 2016 Honorable Mention – Each year the South Carolina Association of Counties (SCAC) grants the J. Mitchell Graham Award to counties that demonstrate innovation in projects that are designed and implemented to meet community needs. Richland County IT/GIS was recognized for the development and publication of geospatial resources to assist with the 2015 flood disaster response/recovery.

> ***"This is the height of your career. You'll never be needed as much as you are right now."***
>
> ***Dr. Patrick Bresnahan, Richland County GIO***

911 CAD

Why:

Public Safety is a primary use of GIS in local government. 911 Computer Aided Dispatch (CAD) relies heavily on accurate geolocation for dispatching a call. When the joint City of Columbia - Richland County 911 center chose new dispatch software vendor TriTech, the solution included GIS software modules for dispatch and mobile units. The County's existing address and street data were not compatible with TriTech's GIS-based CAD system. Modification of these datasets entailed understanding the GIS requirements of TriTech and ensuring that Richland County data was compliant.

What:

The implementation required significant effort on the part of the Richland County GIS (RCGEO) team. The team needed to augment and/or alter the address points and street centerline datasets to make the data work with the TriTech requirements. Optimally, the system requires that the County have a complete set of address points geo-located on top of the actual building/unit that they represent. Additionally, the street centerline GIS layer needed to be fully routable so that the 911 system could identify the closest units for response and route vehicles.

How:

RCGEO conducted a full assessment of county address points to find areas that needed augmentation and/or field verification. Street centerlines were examined to identify necessary database modifications. This included 'routability' features such as one-way streets, overpasses, underpasses, and other travel impedances. Final modifications included:

data, procedures, integration, and mobile access for the new TriTech system. Once the system went live, a GIS employee was stationed at Public Safety to maintain the data.

ROI:

Saves Time – The time saved in locating a citizen can be the difference between life and death. The new GIS-based CAD system has improved response times.

Saves Lives – In an emergency, GIS can lead rescuers quickly and accurately to the scene. In an emergency, when each second counts, integrating GIS with the TriTech CAD system allows the CAD software to quickly find the location of an incident.

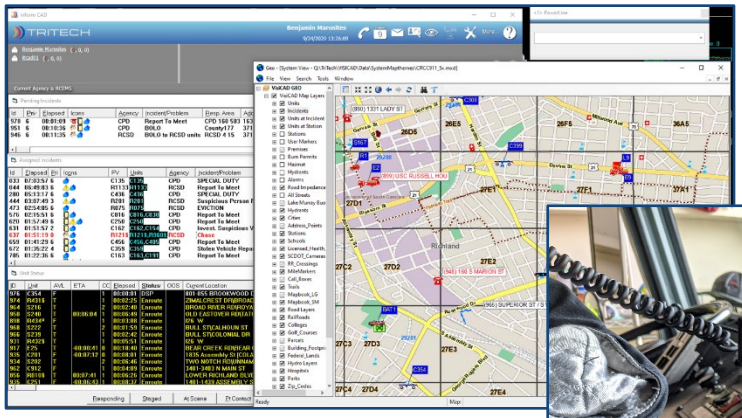


Figure 8: CAD 911 screen sample

Figure 9: Fire Truck screen sample

Open Source Technology Adoption

Why:

Enterprise-grade software licensing has represented a heavy cost of doing business for decades. Furthermore, in the multi-core computing era, licensing compliance has only increased in complexity. Because software licensing contracts often represent five- or even six-figure budgetary outlays, they need to move through the organization's procurement process, which has at times required County Council approval as well as sign-offs from County administrators. Due to the recent technical maturity of free and open technologies – particularly solutions serving the GIS space – the Richland County GIS team (RCGEO) recognized an opportunity to simultaneously save money as well as alleviate some institutional burdens associated with software licensing.

What:

Free and open-source software (FOSS) is software that is available for anyone to acquire at no cost, use, and in some cases, modify. It is packaged with a permissive license that explicitly allows for reuse and customization, without the hardware limitations often imposed by proprietary solutions (i.e. licensed for 4 processor cores vs. no processor core restrictions). Most significant FOSS projects are professionally managed and widely collaborated on by expert developers around the world, resulting in viable alternatives to many cost-prohibitive proprietary options.

Over the last nine years, RCGEO has adopted and endorsed multiple FOSS technologies to benefit the organization and the community. Most notably, the department's public-facing

internet presence is built using free and open software at every level of the platform. To date, the full scope of the team's use of open technology includes the following:

- Operating systems;
- Web server technologies;
- Spatially-enabled databases;
- Internally-developed automation scripts;
- Desktop GIS software and utilities;
- Adoption of open-source software development tools; and

- Customized GIS developments using open libraries. (See the GIS Applications Success Story for examples.)

How:

RCGEO's interest in open-source GIS solutions swelled in 2011 after team members attended the Free and Open Source Software for Geospatial (FOSS4G) conference, an international conference held that year in Denver, Colorado. This conference increased the team's confidence in the larger open-source community and accelerated their trust in the capability of open solutions to help fulfill various objectives of their implementation plan. This trust was later validated during the flood event of 2015, as the system remained responsive and seemingly unaffected during a prolonged high-traffic event.

Shortly after attending the conference, with the goals of reducing their cost of doing business and streamlining the process of software acquisition, the RCGEO team began researching and experimenting with open technologies for use in their public-facing solutions. To date, the team has successfully moved the entirety of its web presence to an open architecture spanning two cloud servers. Additionally, several custom applications with external and/or internal scope have been developed, and most recently, one in-house server running an open-source operating system and database has been configured.

ROI:

Saves Money – Adoption of open technologies has resulted in considerable savings in software licensing expenses. For comparison, RCGEO recently replaced its in-house database server, which hosts the entire GIS database. This required $31,000 in up-front fees for database software licensing. The internal application server was also replaced and incurs an additional $5,000 in annual licensing fees.

Saves Time – Eliminating the need to traverse procurement and budgetary hurdles result in quicker turnaround for system deployments and upgrades, and reduces the impact on personnel across the organization, including administrators and County Council.

Cloud Technology Adoption

Why:

Acquiring and updating equipment for on-premises Information Technology (IT) infrastructure can represent a significant portion of an organization's budget. Additionally, every node in the system demands ongoing time and attention from hardware and

networking professionals managing it. On average, most network servers are replaced after three to five years, usually because the hardware is 'out of warranty', even though the system continues to satisfy needs. In a separate respect, web-facing servers attract additional risk, particularly automated hacking, which makes them ideal gateways into private networks where a successful security intrusion can be at best costly and at worst, disastrous. Using cloud-based servers and infrastructure allows the County to optionally offload the liability of hardware management and sequester high-risk systems.

What:

Since 2011, RCGEO has gradually advanced from a single cloud server with an experimental mission to an established production platform built upon two cloud servers and an Amazon AWS S3 archive. In the process, the division's public-facing GIS data viewer was moved outside of the County's private network and into the cloud, both reducing risk to mission-critical systems and automatically reducing the load on the County's internet bandwidth, as existing infrastructure is no longer needed to accommodate internet traffic to the GIS servers.

How:

The team's initial, 2011 proof-of-concept verified the viability of hosting GIS applications and data in the cloud. Next, in 2015, the architecture was proven to be stable and dependable during a surge in server demand when the Flood Viewer was deployed. That first solution remained performant while meeting the goals of having low maintenance overhead, being reasonably priced, and invoiced annually – an important criterion considering the cyclic budgeting demands of a government office. As of 2020, the team has adopted cloud resources for their entire web presence, and they continue to experiment with and consider cloud-based technologies as potential solutions for other scenarios as needs arise.

ROI:

Saves Money – The GIS division helps control spending through cost reduction and cost avoidance. Their entire cloud-based operation, which includes nightly backups, costs the County less than $210 a month. For comparison, a recently upgraded on-premise server required a $20,000 up-front expenditure for hardware alone; a purchase that ultimately went to County Council for approval. As a bonus, moving the web-facing GIS platform off-site reduced load on the County's existing network.

Reduces Risk – Because the GIS cloud servers run in isolation, any potentially compromising event (hacking, malware, ransomware, etc.) is automatically quarantined and easily mitigated. This arrangement prevents high-visibility systems like web servers from becoming the point-of-entry to more sensitive systems on the same network.

Saves Time – Because cloud computing vendors maintain equipment currency and strive to prevent downtime, the County benefits from seamless, invisible equipment updates that happen behind the scenes, freeing the County's networking professionals to monitor and manage higher priority platforms.

LiDAR Technology Adoption

Why:

Richland County GIS (RCGEO) strives to be early in the adoption curve of proven innovative technologies. LiDAR (Light Detection and Ranging) technology uses lasers mounted in aircraft to collect precise elevation data. Realizing the potential cost savings and wealth of information provided by LiDAR, the team decided to assess the use of this then-cutting-edge technology for County operations.

What:

In the year 2000, Richland was one of the first counties in the US to move from traditional photogrammetry to LiDAR for documenting elevation, slope, and tree canopy characteristics. As part of a countywide large-scale mapping effort for the County, an assessment of the accuracy of a LiDAR-derived dataset was conducted.

How:

RCGEO conducted an error assessment to quantify the accuracy of LiDAR data, incorporating various platform parameters, environmental conditions, and geography. The results were published in a peer-reviewed paper comparing LiDAR acquisition with conventional photogrammetric surveying, titled "Accuracy of Airborne Lidar-Derived Elevation: Empirical Assessment and Error Budget" by Michael E. Hodgson and Patrick Bresnahan. (*Photogrammetric Engineering & Remote Sensing, March 2004*) RCGEO worked with professional organizations to make this a standard practice for remote sensing, with the article being referenced by others in the industry.

The County also contributed to the South Carolina Statewide LiDAR project in 2010, and the Savannah - Pee Dee LiDAR project in 2020.

ROI:

Significant cost savings – The traditional method of recording contours (elevation) on mylar sheets using photogrammetric methods would have cost the County $1.75 million. Using LiDAR, Richland County received elevation data in digital format immediately consumable in a contemporary GIS for $900,000. That cost also included the collection of base framework GIS layers such as water features, road edges, and building footprints.

GIS Applications

Why:

In addition to meeting Richland County's public-facing expectations, the GIS division has regularly engaged with other departments to help visualize their data using specialized interfaces built for the use case. Ideally, custom applications provide quick answers to common as with the GeoInfo application, support other IT solutions using the Dynamap interface, or help explain a situation with a map as can be done with the CompSales application. A look at Richland County GIS (RCGEO) application successes shows the ability to add value to other County departments, either at the departments' immediate request or by the GIS team's initiative where they have identified a potential business benefit.

What:

Public/Citizen Applications:

Dataviewer

RCGEO's flagship application and the initial implementation of the division's reusable, customizable mapping framework, the Dataviewer publishes most of the County's GIS base data. It includes a property search interface that implements search-suggest style query results. In addition to providing a dynamic, mobile-ready user experience paired with a sharable URL, the application also provides a convenient, property-centric gateway into the CompSales and GeoInfo applications. As the team's highest-ranking application by usage volume, the Dataviewer represents over 80% of served demand.

CompSales

The CompSales application provides a dashboard for researching real property sales data and comparable attributes for the purpose of estimating a parcel's market value as compared to nearby properties. In addition to real estate professionals and developers, this application also benefits the County Assessor's internal appraisers, which represent about 10% of that application's total usage.

GeoInfo

The GeoInfo application provides jurisdictional information about a property in an easy-to-use interface that identifies trash collection days, council district and municipal boundaries, congressional representation, etc. The GeoInfo application's primary in-house user is the Ombudsman's Office, which represents almost 20% of the application's overall usage. The feedback it provides helps to answer citizens' questions and route calls to the proper organizations when callers are unsure about correct jurisdiction.

Delinquent Property Viewer

The Delinquent Properties application aids the Treasurer's annual tax sale by providing a quick-loading internet map of the Auditor's delinquent real property data. The application visualizes delinquent parcels, color-coded by the severity of delinquency (number of years overdue), and includes interactive callouts detailing the balance of taxes owed. The application benefits investors by helping them locate and research prospective opportunities in advance of the County's annual tax sale.

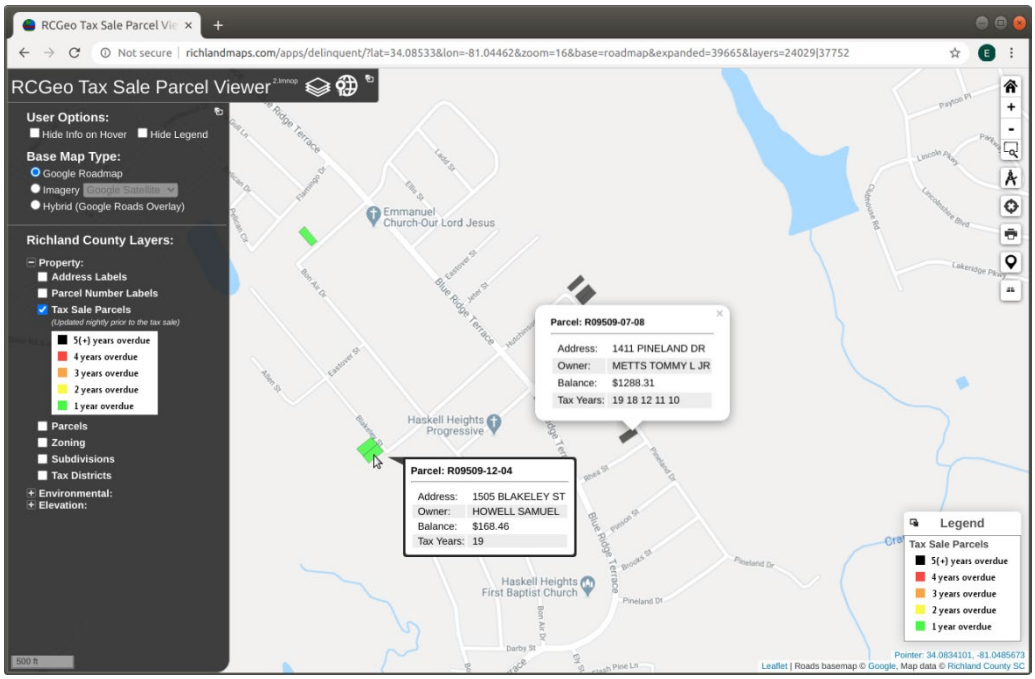


Figure 10 Delinquent Property Viewer shows parcel details

COVID-19 Response

RCGEO created two COVID-19 related applications to be used by citizens and internal decision-makers. The first is a dashboard that displays information including world-wide statistics, social distancing metrics, and other trend-related information. The second application was developed in-house and provides daily case numbers and their geographic distribution for South Carolina at the county level and the ZIP Code level.

- Dashboard Link: https://richlandsc-coronavirus-rcgeosc.hub.arcgis.com/
- RCGEO COVID-19 Link: http://www.richlandmaps.com/apps/covid19

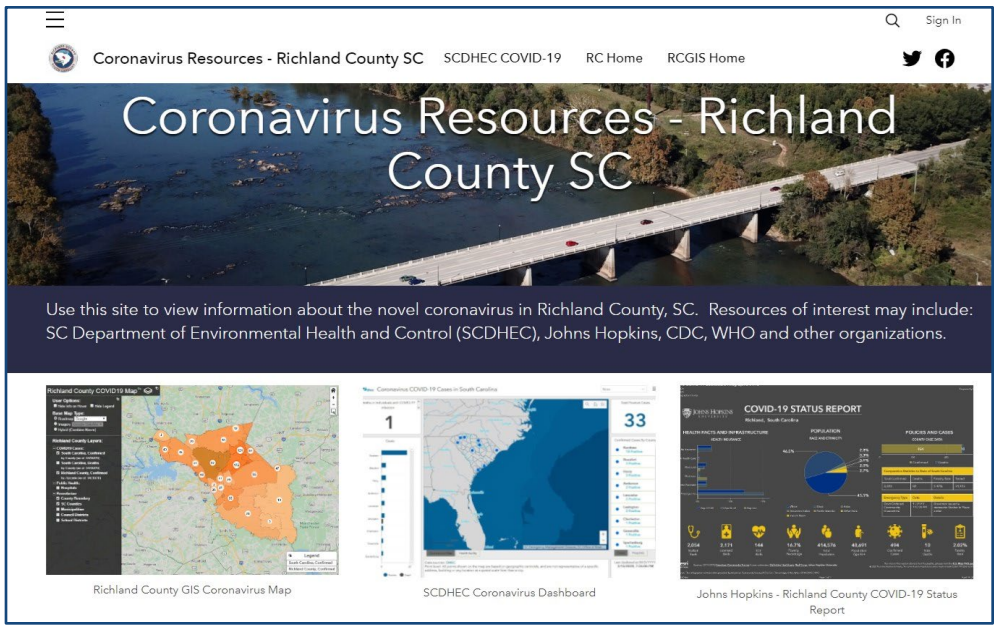


Figure 11 Richland County's ArcGIS Hub dashboard contains links to Coronavirus resources

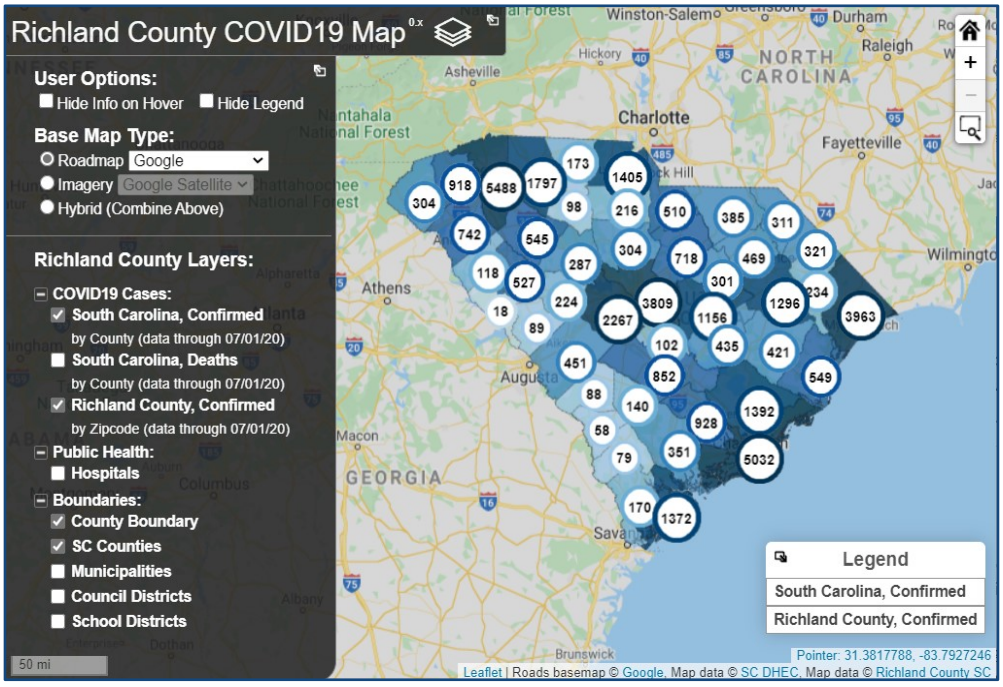


Figure 12 Statewide Map of COVID19 case counts by county

Internal Applications:

Dynamap

Dynamap provides a programmatic gateway into the Dataviewer application with an extended software interface to enable ad-hoc mapping of one or more addresses, complete with interactive support for tabular attributes. Developed at the request of the Business Systems division, this application is a notable example of the GIS team's potential to engage with other departments and add value.

Historic Parcel Viewer

Created for the Register of Deeds to enable interactive review of parcel data from prior years, the Historic Parcel Viewer provides separate parcel layers for every year since 2006. Archiving the year-end condition of the County's parcel information, including parcel boundaries, ownership and market information, and several years' worth of historic aerial imagery helps users research how the land records and the landscape have changed or how a property has changed hands.

Permit Lookup

Provides a map-supported interface for querying and reviewing county-issued permits. The app's search utility supports locating specific permits with identifying information, such as a permit number, address, parcel number, current owner, and/or approximate date range.

URL Redacted: In-House use only

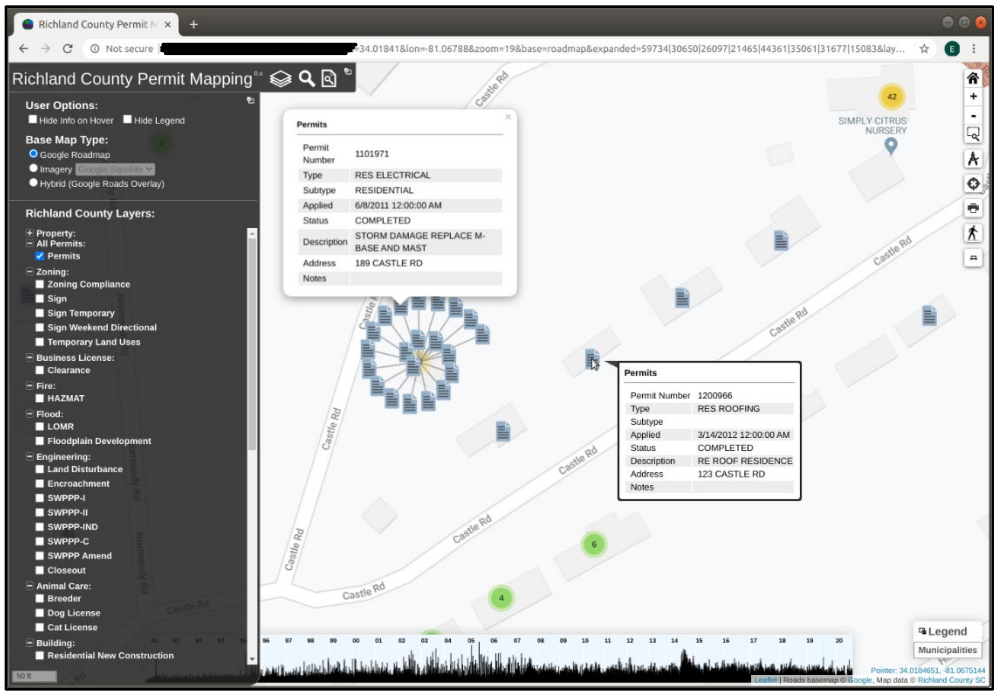


Figure 13 Permit Mapping app

Permit Activity Dashboard

Provides a calendar-density view of permitting activity, with day-by-day breakdowns visualizing the top-occurring permit types on any given day and their locations throughout the County.

URL Redacted: In-House use only

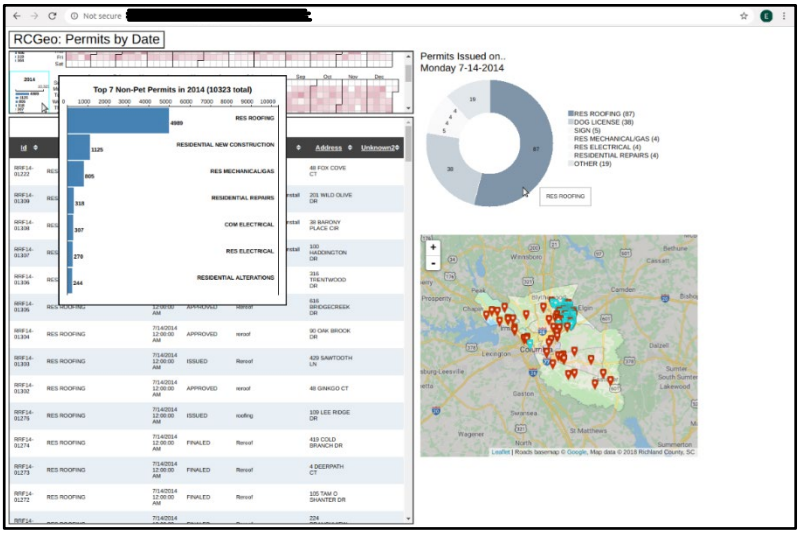


Figure 14 Permit Calendar Density Dashboard

Polling Manager

At the request of the county's Precinct Coordinator, the Polling Manager app was created to follow the operational status of voting locations in near-real-time as they open, close, or encounter issues.

Annexation

At the request of the Planning Department, this application was created to visualize and review City of Columbia annexations within Richland County, year-by-year, dating back to 1995. The application presents the market value and taxable value of annexed parcels, including population trends consolidated from US census data. Additionally, untaxed parcel and partially-taxed parcel layers were made available for review.

Crash Data Portal

At the request of the Richland County Transportation Director, the Crash Data Dashboard, also known as the "CrashBoard", provides an interface for viewing a subset of the South Carolina Department of Public Safety (SC DPS) data, where vehicular incident information can be reviewed to assess the impacts of roadway improvement projects on traffic safety (i.e. before/after). The team also created a scoring algorithm to visualize intersection dangerousness to help decision-makers recognize and rank intersections that may deserve consideration for future improvements.

URL Redacted: In-House use only

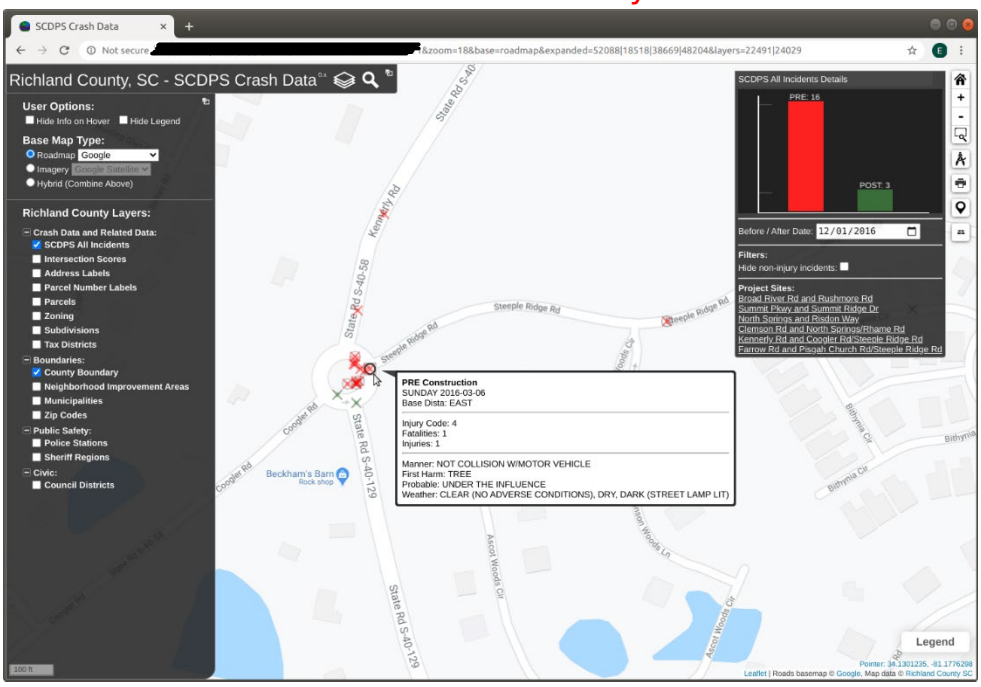


Figure 15 Crash Statistics at Kennerly Rd and Coogler Rd/Steeple Ridge Rd intersection.

Usage Statistics App

Created as RCGEO's internal tool for reviewing nearly five years of user engagement data, this tool provides information about application usage and session details. It provides which applications are being loaded, as well as users' in-app interactions, such as clicking on parcels, layer selection, feature measurement, and other observations helpful for inferring how applications are being used to show what is truly valuable to the public.

How:

Whether after a direct request for solutions or reaching out to a department when a potential opportunity is recognized, RCGEO works closely with end-user staff to identify the needs of their department or requested functions. After a thorough planning process, the initial design for a solution best suited to match the request is developed. Flexible design techniques allow for a robust, and efficient product. Continuous dialog with the end-user keeps the process on-track and provides the user the opportunity for feedback.

ROI:

Better Decision Making – GIS is a critical tool for querying, analyzing, and visualizing data for decision support.

Improve Efficiency – GIS helps organizations reduce or eliminate redundancy in workflow processes. By implementing focused GIS solutions, staff workloads can be reduced and new procedures developed, improving efficiency. For example, using tools on the Dataviewer app to pre-fill fields on the Legal Assessment and Assessment Appeal forms immediately saved staff an extraordinary volume of work.

Increase Productivity – GIS puts accurate, current information at a user's fingertips. Properly developed solutions built to service users' actual needs and output feedback that is easy to disseminate to other interested parties increases productivity.

Save Time – Making information available to the public through GIS-supported web applications has decreased face-to-face counter-traffic, reducing the demands on staff. Citizens also benefit, since public access to GIS-based solutions often mitigates the need to call or visit county facilities to get answers to common questions.

GIS Governance

Geographic Information Systems (GIS) technology provides a framework for organization-wide cooperation by using location as a common frame of reference, allowing individuals and departments to share information about locations. An enterprise GIS promotes interoperable technologies, standards, and methods, thus facilitating more efficient and effective use of geospatial technology. GIS is unique within Information Technology because of its spatial nature, its ability to unify disparate systems, and its ability to present very complex information in an understandable and usable context. Therefore, the challenges associated with managing a GIS are complex.

As the central GIS group, the GIS Division of the IT Department, known as RCGEO, enables departments to utilize GIS through the provisioning of software, training, data, and support. RCGEO is comprised of a Geographic Information Officer (GIO) and five qualified staff who provide GIS coordination, application development, data capture and management, web and field mapping support, and staff training for the Richland County users. Several departments throughout the County use GIS to support their daily tasks and operations. Key departments have data custodians who are responsible for maintaining their data layers and providing internal expertise on the use of GIS. A program that is this far-reaching requires a well-defined and mature governance strategy. If it is seen as just another technology, then it will fail to achieve the desired results.

By ordinance, the GIS Division of the IT Department is the central group for GIS and is responsible to "furnish various county departments with tools to measure, model, and map data regarding geographically related phenomena." The RCGEO central GIS support team should be promoted as the authoritative office for GIS core activities, including managing and maintaining software and licensing, application development, and data storage and distribution for all core geospatial systems. Additionally, the RCGEO team needs to promote the use of GIS through various educational methods. Because GIS is so varied and far-reaching, many non-GIS people do not understand the full power and possibilities of using GIS for their department. Therefore, the RCGEO team needs to focus on an ongoing education program.

Recommendations for several key components of GIS administration and management are detailed in this section.

Enterprise GIS Collaboration and Coordination

In order to promote the use and interoperability of spatial technologies throughout county business systems, the GIS division should be involved in enterprise application implementation project management. In the past, the Richland County IT department has not always included the GIS division or departments in the decision-making process on which business system software to be implemented or built in-house. This presents a problem when it is realized that GIS is needed as implementation progresses, but there are not adequate funds available in the GIS budget to build an integration platform. A best practice found in the most successful GIS and IT local government programs is ensuring that with any significant IT purchase (new or upgrade) a GIS team member is consulted to ensure that geospatial functions are considered and fully leveraged. Collaborative meetings of the three IT divisions (Network, Business Systems, GIS) can bring the teams together and put GIS integrative solutions together with IT systems bringing awareness to the indispensable nature of IT through GIS as an integrative tool.

Several departments have accepted data steward responsibilities for the maintenance and security of GIS data elements within their department. Promoting this trend will foster data ownership and use of GIS to make day-to-day operations more efficient and productive. Formalizing and documenting this arrangement with a policy or procedure will ensure clear lines of accountability and stability of the data maintenance processes.

GIS Job Classifications

Since the County's last job classification realignment in 2015, skillsets in the GIS industry have changed and position descriptions should reflect this. At Richland County, there is a need for a new job classification for Drone Operator. The level of skill needed to operate drone equipment and software requires FAA licensure and specialized training. Also, the education and experience required for professional GIS positions in the IT Department are different from user-level GIS positions in other departments. The County's job classifications should be adjusted to reflect this distinction. Further, as the expertise needed for core GIS operations requires advanced degrees and training comparable to that of numerous IT positions, any discrepancy in the pay range between the GIS and IT job classifications should be examined.

Customer Engagement

It is important to proactively engage customers to measure the relative benefits of implementing GIS technology, gather feedback about the efficacy the geospatial technologies in use, and explore how GIS solutions can be used to improve operations.

Previous quarterly customer service meetings held by RCGEO with departments were found to be productive and served to inform and educate the user community. The IT Department's Interim Director / Chief Information Officer (CIO) agrees with the GIO that reinstating the GIS stakeholder meetings would help to promote GIS to department end-users who would, in turn, forward their needs to the County Administration level.

Customer engagement roles and responsibilities could be assigned to one or more RCGEO staff members, with the purpose of conferring with department stakeholders to discover functionality needed, issues that need to be resolved, or barriers that limit the full use of the technology.

GIS Steering Committee

Many of the most successful GIS implementations involve executive-level staff in some components of GIS strategy and growth, often as a Steering Committee. It is important that an organization consider a GIS Steering Committee for GIS to be elevated as a primary information platform in the organization. The GIS Steering Committee provides executive oversight and typically shapes the funding for and the direction and policy of the GIS program. A Richland County GIS Steering Committee should be re-established and fostered going forward to provide direction and on-going support for the GIS program.

GIS Budget and Funding Strategy

Historical Budget Overview

The first coordinated budget for RCGEO was approved for fiscal year (FY) 1999. That original budget was for $2,046,423 and included partial funding for an orthophoto mission, elevation model development, parcel conversion, and street centerline creation and addressing. However, the majority of funds for capital projects budgeted by RCGEO in FY 1999 and FY 2000 were transferred to other County projects in the summer of 2001 as County administration shifted GIS project funding to a bond issue. Funding for GIS capital projects was rolled into a single bond issue (initially for upgrades at the Township Auditorium and Detention Center), which included $6,500,000 for the County GIS projects. These funds were intended for hardware, software, personnel, data collection/conversion, and any consulting contracts.

The central GIS operation of Richland County was established as a Division within the Information Technology (IT) Department by ordinance in 2000. Since the Division's inception, the RCGEO budget had been comprised of two specific accounts - operations and capital budgets. With the issue of the capital bond in 2001, only the operations funding was kept annually for GIS (not the capital budget), with personnel funding remaining in the IT annual budget. Thus, since 2001, the GIS Division's annual budget has been limited to operational funding and has declined from $336,850 at the beginning to $180,971 in 2020. Further, due to administrative and financial decisions, the GIS capital bond was redirected to other County needs and is no longer available.

Currently, the annual GIS operating budget is funded at a base of $180,971, with no major increase or decrease expected. The annual operating budget is used for all software licensing, contracted professional services, supplies, and intern salaries.

GIS projects were considered as a part of the Capital Improvement Project (CIP) budget for the first time during the 2020 budget cycle. The GIO consulted departments and identified several requests conforming to the CIP definition of non-consumable items costing over $5000. The requests for a large format plotter (for Assessors' office) and a new drone platform are under committee review as of August 2020.

GIS Funding Recommendations

Because GIS is becoming engrained in all tools used in local governments, the trend across North America is toward increased projects and funding, not the steady decline that Richland County has experienced. Counties and cities across the U.S. have attempted maintenance funding through a variety of methods. Exploring grants, cost recovery, revenue generation, and other funding options will allow the County to diversify the funding for the GIS initiative. It is recommended that the County investigate the use of a combination of enterprise fund fees and the general fund to fund the central GIS system. Water, sewer, stormwater, and solid waste disposal fees are common enterprise operations or utilities that fund County GIS. Federal and state grants should be also be explored, such as COVID-19 grant funding (CARES act) to cover IT/GIS infrastructure expenses.

While system development needs may be difficult to forecast, the most important phase of successful implementation is system maintenance. As GIS bond funds are no longer available, Richland County must transition to secure funding for the maintenance costs of the entire GIS system.

Despite the lack of capital and available operating funds, RCGEO has managed to acquire aerial imagery and LiDAR data, through partnering with the State, Google licensing, existing contracts, and a joint funding agreement with USGS. However, those resources are not assured and the County runs the risk of not having the option to obtain this data as often as necessary. The frequency of aerial data collection improves the timeliness of system data updates and increases the overall value and usefulness of the County GIS. It is recommended that aerial photography be flown every year, with LiDAR data captured every three years. Such regular data collection must be recognized as a necessity and budgeted for accordingly. To sustain the aerial imagery and LiDAR programs and provide timely updates, it is recommended that Richland County request the acquisition of such data in the capital budget, using endorsements from departments to justify the project.

At the beginning of the budget cycle, RCGEO should hold workshops with stakeholders and users to find what they need, so those items/projects can be included in the GIS and/or departmental budgets. Further, bi-annual funds should be requested to support the prevalent County goals and priorities.

Future Direction of the GIS Program

Sustainable enterprise GIS requires a considerable amount of discovery and deliberation. A documented assessment of existing conditions is a logical undertaking, as it allows for informed decision-making regarding the needs of each operating unit and the organization as a whole. As part of the annual work plan, goals and specific tasks should be revisited and re-prioritized. Key GIS team members should meet annually (at a minimum) with department stakeholders to identify the GIS needs and goals for each department. This section documents future projects and needs of the organization in regard to GIS as identified in meetings with the IT GIS team.

Needs and Initiatives

1. Governance

    a. GIS Strategic Plan – Bi-annual updates to the GIS Strategic Plan should be conducted.
    b. Job Classifications – Working with Human Resources, the value of the GIS designation in current positions should be examined, and drone operations job classification(s) created. Consideration of having GIS positions align with other IT positions based on required skill sets should be analyzed.
    c. Enterprise GIS Project Management Processes – Closer alignment with IT system acquisition will allow greater compatibility and opportunities for integration.
    d. GIS Steering Committee – Re-establishment of an executive-level committee to have visibility and buy-in from leaders who can understand and champion the technology is essential.
    e. GIS User Group – Expansion of RCGEO's interaction with L.B. Owens airport, Conservation Division, and Coroner's office, as well as engaging other departments, is needed to inform and educate the user community.
    f. Regional GIS – Interlocal Agreements (ILA) and/or Memorandums of Understanding (MOU) with the City of Columbia, University of South

Carolina, and other agencies in the area should be explored to guide the regionalization of GIS technologies between disparate groups of GIS users in the region seeking to pool their resources and achieve similar goals.

g. Measurement of Quality of Service – A formal project and customer service feedback mechanism should be adopted and annual user satisfaction and input survey (Voice of the Customer) conducted to measure sensitivity to user needs.
h. GIS Authority and Clear Lines of Responsibility – RCGEO should be promoted as the authoritative office for GIS core activities to direct users to the team for support and project initiation.
i. GIS Budget or Funding Model – The GIS capital budget needs to be solidified and alternative funding options explored for the sustainability of the GIS program.
j. Annual Detailed GIS Work Plan – A GIS work plan should be created each year with a list of projects/goals the GIS team intends on accomplishing.
k. Alignment with Organization's Vision, Goals, and Objective – An annual County goals alignment review and report should be prepared to outline how GIS intends on supporting the County's goals and priorities.

2. Data and Database

a. Digital Data Assessment – An evaluation of data quality using data assessment tools should be undertaken, initially, and at regular intervals.
b. Master Data List – A list of all central/core data layers should be prepared in an easy-to-read format and published in a way that is accessible to all users.
c. Metadata – A GIS metadata standard should be maintained. Basic metadata items must be created and/or updated for the core data layers.
d. Open Data Policy – The existing processes and policy for providing access to geospatial data to the public and external agencies should be formalized.
e. Data Needs – Datasets needed for staff to perform their duties need to be identified, then created, built, or acquired for county-wide or departmental use.

f. Drone Data – Continue to use drone imagery and data collection for special projects.
g. LiDAR – Acquire new LiDAR data.

3. Procedures, Workflow, and Integration

    a. Custom Enterprise Integration – Additional custom data integration opportunities must be identified and implemented to expand on the success of the completed responses to integration requests, such as showing a dynamic calendar on the Permitting app and the Weather Hawk app showing live data from several weather sites.
    b. Data Mining – Opportunities for geo-enabling data from IT systems should be explored, culminating in a map service where all data is available for users to access.
    c. Identify Opportunities and Gaps – Regular departmental customer service meetings can be held to find opportunities for new projects and data products and to discover gaps in service.
    d. GIS Standard Operating Procedures (SOP) – Standardized data maintenance procedures for regularly maintained GIS datasets should be documented, and as well as archiving, centralized storage, and indexing of the SOPs.
    e. Project Tracking System – Implement a software application for tracking and monitoring the progress on each project.

4. GIS Software

    a. Mobile Software – The results of the current Esri Survey123 pilot project will guide plans for the deployment of future implementations using this platform. Also, the expansion of the use of ArcGIS Collector and the feasibility of using ArcGIS QuickCapture and other mobile solutions should be explored.
    b. Mobile Resource Management – A formal centralized and collaborative mobile resource management plan and policy to guide the mobile deployments and solutions needs to be developed and adopted.
    c. Appropriate GIS Licensing – Continued use of open source software is recommended. An assessment of the levels of current licensing for ESRI, BCS, and Pix4D products is also recommended.

d. GIS Solutions – Internal and public-facing GIS applications and services needed by the organization should be identified, evaluated, developed, and deployed.
e. ArcGIS Pro – Create a strategy for systematic migration to ArcGIS Pro when it is appropriate.
f. Priority Projects – Identify priority high-profile projects annually for implementation (i.e. field apps, Story Maps, various Esri template apps). Possible projects for the Public Information Office (PIO) and Conservation were identified.
g. Portalization – Set up department-specific GIS portals and suites of software (viewer, dashboards, field tools, public-facing applications).
h. Consider New Tools – Evaluate and budget for new tools as appropriate (i.e. Esri's Insights). A formal evaluation process should be implemented to include use cases.

5. IT Infrastructure

    a. County-wide Strategic Technology Plan – RCGEO should coordinate with the IT department on the development of a Richland County Strategic Technology Plan to encompass GIS as an enterprise information system that is utilizing cloud and open-source software.
    b. IT Infrastructure Replacement Plan – Plans for future demands on the network and increased bandwidth can be made with the development and adoption of a formal IT hardware replacement plan.
    c. GIS Training for IT Professionals – Reintroduction of training of IT Professional on the concepts of GIS database and infrastructure will help them to better support the GIS platform.

6. Training, Education, and Knowledge Transfer

    a. Formal on-going GIS Training Plan – A comprehensive training and education plan based on projected GIS staff professional development needs should be prepared and executed.
    b. Multi-tiered GIS Software Training – Individual training on editing/maintenance for Analyst-level users should be incorporated into the training plan, as well as mobile software training and group training on web apps.

c. Departmental Specific Education – Training documents must be prepared for new applications and workshops held for departmental users, covering 1-2 apps per month.
d. ROI Workshops – Informative seminars will serve to educate the organization on the current and further value and return on investment of GIS at Richland County.
e. Professional Development – Membership and participation in professional organizations should be continued.
f. Informal Training Opportunities – The RCGEO team should host a series of informal training opportunities (Brown Bag Lunch Seminars) on various topics of interest to the organization or specific departments (i.e. How GIS is used for a specific department).

Key Performance Indicators for the GIS Program

Overview

One of the reasons that many enterprise GIS initiatives fail to reach full potential is the absence of metrics and goals. The relationship between metrics and goals is a cyclical one. Without metrics, there is no basis for setting goals and gauging progress. Without goals, there are no outcomes to measure based on metrics. The success of GIS in Richland County, SC can be measured with effective metrics and achievable goals. Therefore, the County should establish metrics and begin to benchmark performance and progress against these metrics. Committing to defining metrics and goals will help the County:

- Define success;
- Focus everyone on goals;
- Measure success and goals (what gets measured gets done);
- Encourage accountability;
- Provide an opportunity for small and large accomplishments;
- Provide a baseline for detailed annual goals.

This document focuses on establishing a comprehensive performance measurement framework and a set of Key Performance Indicators (KPIs) for the County GIS Division. The framework should serve as the basis for ongoing performance measurement, reporting, and management of the County's GIS program.

The GIS Outlook 2020 project included an assessment of the County's GIS program. In July 2020, the GTG team conducted interviews with the Richland County GIS staff and a review and analysis of current Richland County GIS performance measures, data collection methods, and systems. These were used to refine and score KPIs.

Six Pillars of Sustainability

The KPIs have been organized into the Six Pillars of Sustainability as defined by Geographic Technologies Group. These pillars are deemed crucial for the sustained success of an enterprise GIS program and are the major areas that must be planned and working well to have an effective GIS program. The Six Pillars are as follows:

1. Governance
2. Data and Databases
3. Procedures, Workflow, and Integration
4. GIS Software
5. IT Infrastructure
6. Training, Education, and Knowledge Transfer

GIS Benchmarking

A baseline from which to gauge the success and progress of the enterprise-wide GIS effort needs to be established for Richland County GIS (RCGEO). GIS Benchmarking is a structured methodology that uses the identified gaps in an organization to compare actual existing performance with a potential or desired future performance. It can also be used effectively to benchmark (scientifically compare) one organization against another organization with similar characteristics.

GIS Benchmarking Methodology

The Benchmarking Analysis (BA) is a subjective evaluation of the existing GIS conditions of the organization. It is a checklist of tasks that conventional wisdom and industry knowledge identify as prudent and essential to the success of any enterprise GIS. The six categories of the BA follow the 'Six Pillars of GIS Sustainability' (described above). Each component can then be used as a Best Business Practice (BBP) gauging mechanism for a successful strategic, enterprise, scalable, resilient, and enduring GIS.

Each of the six categories has a series of questions that are graded on a percentage scale – 0% being Poor and Needs Attention to 100% being Excellent and a BBP. Each component is weighted equally. No deference nor weight has been given to the importance of one category over another. Metrics that are rated at 60% or lower (denoted by the yellow dashed line in the KPI charts for each category) are considered a gap in the Richland County GIS Program.

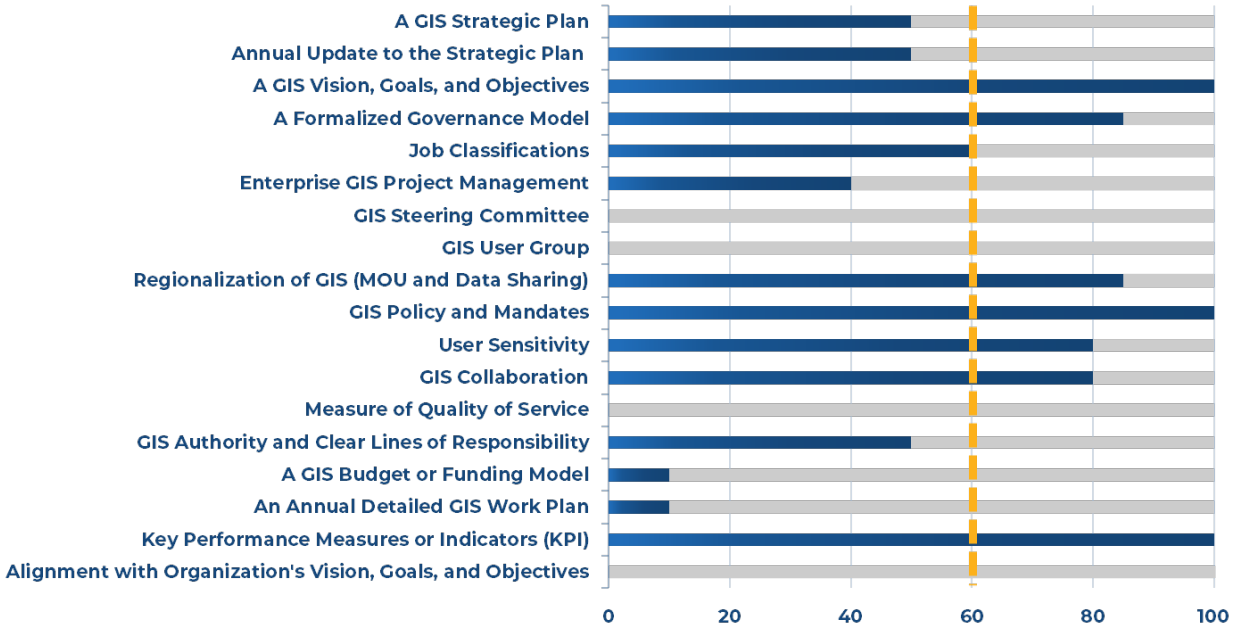
Key Performance Indicators

The result of the BA is a series of Key Performance Indicators (KPIs). These metrics are tools that will help measure performance over time. KPI's are task-driven and allow accurate and reliable monitoring of GIS performance.

The following are the KPI benchmarks created from discovery interviews with key RCGEO staff, categorized by the Six Pillars. A general description of the KPI is followed by the current conditions at Richland County and recommendations for improvement.

Governance KPIs

Arguably, good governance is the most important factor of a successful GIS program. Without good governance, a GIS program will be limited in its positive impact within the organization and its community. After a full benchmarking analysis was completed, the average score for Governance was calculated to be 50%. The County has a very skilled and knowledgeable GIS staff. Several factors keep the overall score from being higher (lack of executive direction, funding concerns, user feedback loops). See the Benchmarking Bar Chart on the following page to review the score for each Governance item. Each of the elements of the benchmarking is discussed after the chart.



Metrics rated 60% or lower (denoted by the yellow dashed line) are considered gaps in the Richland County GIS Program.

Metric 1: A GIS Strategic Plan – 50%

A sound GIS strategic implementation plan provides direction for an organization's development of successful implementation and leveraging of geospatial technology.

A GIS Strategic Plan for Richland County was originally completed 19 years ago with the assistance of Geographic Technologies Group (GTG). The plan has been updated twice in the intervening years. That plan and its updates were in effect for about nine years, so there has not been an updated document in place since 2010. This Outlook 2020 document can serve to advance a plan from which to move forward. It is recommended that the County invest the time and money into the creation of another 5-year GIS plan based on the findings of this report. This can be done internally or using a consultant. However, critical governance

issues identified in this document should be addressed prior to establishing a new baseline in an updated plan.

Metric 2: Annual Update to the GIS Strategic Plan – 50%

Ideally, the GIS Strategic Plan would be updated bi-annually because the County's roles, vision, and functions constantly evolve. The Plan should be updated to stay relevant to Richland County's vision and the practical aspects of implementation. Whether this is done internally or by a consultant, the goals and specific tasks should be revisited and re-prioritized. Additionally, the Plan update should highlight accomplishments since the inception of the current Plan.

This is Richland County's first GIS Strategic Planning effort in over ten years. The purpose of this Outlook Plan is to reestablish the intended role of GIS in the County and evaluate its position of effectiveness in the organization. This update will help decide the future of GIS in Richland County.

Metric 3: A GIS Mission, Goals, and Objectives – 100%

RCGEO has a mission, goals, and objectives for the GIS program. The GIS team should continue to maintain, review, and update these guiding documents. These goals should be aligned with the overall goals of the County. The larger GIS Mission must be broken down into concrete goals. The mission, goals, and objectives of GIS technology must align with the County's strategic priorities and have measurable objectives.

A Statement of Mission, Goals, and Objectives was completed for the fiscal year 2017-2018 budget and is planned to be updated in the next fiscal year budget. The statement included four broad goals and a specific objective for each.

Mission Statement:

The mission of the GIS Department is to establish a foundation of geographic information to support decision-making. Spatial information is becoming increasingly important for most local government functions and thematic departments. The GIS program will provide the technological vision and leadership to deploy appropriate spatial technologies to achieve this mission. Hereby, we will reinvent, reengineer, and streamline government wherever spatial technology can contribute towards increased efficiencies and effectiveness.

FY2017-2018 Goals:

- Build a framework of fundamental geographic data elements for use in County government operations.
- Coordinate most GIS activities and data concerning Richland County and to ensure that geographic information related services are delivered effectively and in a timely manner.
- Make County geographic information available to citizens while protecting county investments in data development.
- Empower County employees and citizens by providing appropriate tools for the retrieval and analysis of spatial data for use in answering practical, policy, and political questions.

Metric 4: A Formalized Governance Model – 85%

The term Governance Model refers to the constellation of relationships between individuals and departments within an organization. A Governance Model established lines of responsibility and the hierarchy of decision-making power within an organization. These lines connect executives, managers, and staff, or more broadly, the stakeholders. A stakeholder is any individual directly affected by an organization's activities. Formalizing a governance model allows an organization to maximize accountability and efficiency.

The current governance in place at the County is a Hybrid model, with well-defined central infrastructure, support and core data maintenance, and departmental usage of applications. Responsibilities are well defined in Richland County Ordinance No. 072–00HR (enacted in November 2000) that identifies and defines the duties of the GIS Division in the Information Technology Department. However, it is prudent to continue to educate the organization about GIS governance, lines of responsibility, and expectations. Two conduits for this are the GIS Steering Committee and GIS User Group which are discussed further below. Also, it is wise to review the ordinance and further define roles and responsibilities as part of an updated strategic plan.

Metric 5: Job Classifications – 60%

The various positions within an organization should be classified according to the formalized governance model. These job classifications denote the skill set, financial worth, decision-making power, hierarchical standing, and overall responsibilities of a given position within

the organization. Keep in mind that these job classifications may need adjustment over time. As various departments add GIS as a skill, the job classifications should reflect this.

In 2015, job positions were realigned to standardized classifications across the County that could be used in any department in the County. At the same time, GIS related job positions throughout all departments were converted to GIS position titles.

There is a need for a new job classification for Drone Operators because that level of skill requires licensure and specialized training. Also, an improvement could be made in job classifications to reflect professional GIS positions in the IT Department, as they are different from user-level GIS positions in other departments. The skills needed for core GIS operations reflect advanced degrees and training and are comparable to those of numerous IT positions. Some of these skills are related to databases, programming, server, and other components. Thus, pay grades should be comparable. For example, a GIS developer or database administrator merits the same pay grade as an IT developer or database administrator. If terminology is a hurdle, it would also make sense to simply classify similar positions with the same title and not use the GIS prefix.

Metric 6: Enterprise GIS Project Management – 40%

GIS Project Management is the art of managing, monitoring, and coordinating all GIS activity within local government organizations. The GIS Division should be involved in IT projects to promote the use and interoperability of spatial technologies throughout IT systems. As most data used and maintained by local governments has a spatial component, logically, GIS should be leveraged across enterprise systems. Thus, County projects and systems would have a standard component of location, providing staff with a comprehensive common operating picture.

Within the GIS Division, project management is informal, but structured, as the GIS team meets often to discuss project status. To facilitate project initiation, users should be made aware that they can come to GIS for effective and timely solutions. RCGEO staff works with department clients to define their needs and ensure they receive an appropriate solution. Currently, users are directed to send their needs to a manager in the IT Department instead of the GIS Division Director (GIO). Direct access to potential clients will help with technology growth. The GIO should compile and prioritize requests/projects and track each one of them in a formal (yet straight-forward) project management mechanism. Unfortunately, current practices are stifling enterprise GIS project management and preventing some projects from moving forward.

A formal project tracking application might be helpful, especially during this time when most staff are working remotely; however, project management processes should not be so

cumbersome that they are a deterrent to good project management practices. Basic online solutions, which are readily available, could be used to set up project steps and update statuses.

Metric 7: GIS Steering Committee – 0%

A GIS Steering Committee is a group that is composed of top-level organizational leaders and GIS liaisons who recognize the enterprise value of GIS. This group often includes key departmental directors of an organization, along with top financial and administrative officers and the lead GIS staff person. The GIS Steering Committee allocates resources for the organization's GIS needs and determines the schedule, priority, and policy issues that are related to implementation. A GIS Steering Committee is crucial for an impactful program, as it allows direct interfacing between executive decision-makers and GIS experts. Not having communication at the executive level can limit the effectiveness of a fully integrated GIS program.

In the first year of GIS implementation at Richland County, there was an overarching, consortium type of GIS Steering Committee, with regional participants such as the City of Columbia and the University of South Carolina (USC); however, there was no financial input from these external agencies, and the group disbanded. There is no internal GIS Steering Committee now.

The pervasiveness of GIS technology touches everything, so having visibility and buy-in from executives who can understand and champion the technology is essential.

Metric 8: GIS User Group – 0%

A GIS User Group is a cohort of stakeholders who share information and compare experiences with GIS technology for the benefit of all members. A GIS User Group is typically managed by a GIS division director and meets frequently, often every month or each quarter.

Previously, quarterly meetings were held with departments. These meetings were productive and served to inform and educate the user community. However, the user group has not met in years. It is recommended that RCGEO prioritize the relaunch of a GIS User Group.

Metric 9: Regionalization of GIS – 85%

Regionalization is a formalized agreement between parties or entities to cooperate. Concerning geospatial technologies, regionalization is the sharing of data, resources,

applications, training, and education and more between disparate groups of GIS users in the region seeking to pool their resources and achieve similar goals. Often, Memorandums of Understanding (MOUs) guide the regionalization of GIS technologies, where multiple organizations, grouped by geography, share data.

Regional GIS cooperation examples include:

- The City of Columbia and Richland County have a joint 911 Dispatch Center and Fire Department. RCGEO was tasked with ensuring GIS was interoperable with the new CAD (computer-aided dispatch) system. An RCGEO team member is tasked with working with Public Safety. Additionally, RCGEO works closely with the Fire Department and Communications regarding road issues.
- East Richland Public Service District has licensed Richland County data to facilitate its GIS program.
- School Districts license Richland County GIS data to maintain their street centerlines.
- The County is working on an MOU to provide bus line information for the Central Midlands Regional Transit Authority (COMET).
- In 2019, RCGEO entered into an Inter-Governmental Agreement (IGA) with the Town of Blythewood, SC, which is partially within Richland County, to assist with supporting their GIS operations. RCGEO's core responsibilities in the IGA include providing web mapping capabilities and acquiring and incorporating data from Blythewood and other government entities.
- McEntire Joint National Guard Base – Currently, there is no interaction with this US Air Force / South Carolina Air National Guard base. RCGEO would like more opportunities to conduct drone flights near the base and should pursue a cooperative agreement.
- Congaree National Park – There is no direct interaction with the National Park Service. The Fire Department recently requested addresses/aliases for 911 for the park property.

- Mutual Aid Agreements are in place between the County and most adjacent counties and cities. RCGEO has been called upon to fly drone operations during hurricane season and have been put on standby for the Emergency Operations Center (EOC).

Being the central GIS organization within the County, RCGEO should continue to be a conduit for the regionalization of GIS. An annual regional GIS meeting should be considered to share ideas and enhance regional engagement.

Metric 10: GIS Policy and Mandates – 100%

Policies are ratified procedural codes of conduct that are internally imposed and guide everything within the GIS initiative. Standard Operating Procedures (SOPs) are critical for the sustainability of the GIS effort and are needed to ensure that GIS success can be propagated.

The Richland County GIS Division has done an excellent job of creating the necessary policies, standards, and forms required to document procedures and mandates, and have updated them as needed. Formal documents prepared are listed below:

- GIS-0110 Internal Policy Concerning the Use of GIS Hardware, Software, and Data
- GIS-0200 GIS Data Distribution Policy
- GIS-0220 GIS Ordinance
- GIS-0240 GIS Data Product Licensing and Services Fee Schedule
- GIS-0260 GIS Data License Agreement
- GIS-0270 GIS Software License Agreement
- GIS-0280 GIS Data Distribution Fee Waiver
- GIS-0283 USC Data Request Form
- GIS-0285 Vendor Data Request
- GIS-0300 Digital Data Submission Standards and Policy
- GIS-0610 Position Description Questionnaire for New GIS Position or Reclassification
- GIS-0710 GIS Training Request Form

The annual work plan should include a review and update of these SOPs annually.

Metric 11: User Sensitivity – 80%

User sensitivity refers to the capabilities of the GIS team to fluidly respond to user requests for information. User sensitivity is an important measure of the relative benefits of implementing GIS technology. User sensitivity should be measured annually with a User Satisfaction Survey to gauge delivery of service and satisfaction and gather user input.

Overall, RCGEO feels that it provides good client service and are responsive to user needs. Some user feedback is received from the public-facing website; however, more formal, proactive mechanisms to get feedback are needed, such as service request comments, user group meetings, and online questionnaires.

Bureaucratic resistance to a customer feedback loop has been an issue in the past. The IT department has not instituted a systematic feedback mechanism with clients and has not actively supported such efforts. The GIS team does not have control over their priorities, which hinders efficient operations and the ability of GIS to respond to user needs, which, in turn, affects user satisfaction. Further, IT management permission would be required for GIS to engage in a formal feedback process. As discussed previously, the GIO should be given direct access to user requests. An annual user survey should be administered to gauge user satisfaction and identify areas for improvement.

Metric 12: GIS Collaboration – 80%

GIS collaboration refers to the productive cooperation between individuals and entities facilitated by the implementation of GIS technology. High levels of GIS collaboration allow an organization to derive maximum benefit from enterprise GIS technologies. It is both a by-product and end goal of geospatial technology.

The RCGEO staff collaborates well with each other and thematic departments but has struggled with being involved more in enterprise technologies. They have also collaborated extensively within professional organizations by giving presentations, moderating sessions, being panel members, and organizing meetings and collaborative programs. Unique to the RCGEO team are their contributions to the profession through the publication of white papers, peer-reviewed journal articles, books, and book chapters. Overall, the GIS department has good communication with the community, professionals, and department users, but they need ways to reach out and break barriers within the organization (see previous Governance KPIs).

The collaboration techniques recommended in this GIS Outlook, such as GIS User Groups, customer service meetings, and ROI workshops, can be employed to promote collaboration and to approach other departments or divisions and external organizations that are not participating fully in GIS today.

Metric 13: Measure of Quality of Service – 0%

Measuring quality of service refers to an organization's capacity to gather feedback data about the efficacy of its geospatial technologies. The County's quality of service as related to GIS can be examined through questionnaires and interviews or metrics that are related to user interface and objective goals.

Currently, there is no formal feedback loop available for the GIS program. A formal project and customer service feedback mechanism should be put into place. An annual online questionnaire should be administered to identify strengths and weaknesses and track progress over time.

Metric 14: GIS Authority and Clear Lines of Responsibility – 50%

A line of responsibility describes the vertical chain of liability and authority in an organization. In common-sense terms, a line of responsibility formally lays out who is responsible for what and to whom.

The authority of the GIS Division has been formalized in an ordinance (072–00HR). The GIS Division of the County IT Department should be promoted as the authoritative office for GIS core activities. A centralized technical support system could help in directing requests to the proper team. This is particularly helpful when users are not aware that the GIS division in IT should be contacted for support, new project initiation, or other GIS-related tasks. As mentioned in the previous KPIs, a GIS User Group would be beneficial in further educating the organization about expectations and lines of responsibility.

Metric 15: A GIS Budget or Funding Model – 10%

In the context of a GIS Program, a funding model explains how the geospatial technology initiative will be funded to support the County's core GIS products and services. The GIS budget should be reviewed annually and budget items proposed to support the annual goals. The KPIs and resultant work plan can be used to help determine gaps and priorities.

The GIS program at Richland County has been historically funded through a bond fund. However, since bond funds are no longer available, it is critical for a revamped funding model

to be promptly addressed by the County. The lack of visibility and understanding of a viable model may jeopardize the County's investment in GIS. In turn, this could make employees uneasy about their future, which could lead to losing key staff. This Outlook 2020 document contains a section discussing the imminent need for a reliable funding model to be identified. Until such time, most of the gaps identified in this KPI are in limbo.

Metric 16: An Annual Detailed GIS Work Plan – 10%

A work plan proposes the schedule and budgeting for a specific project. It not only offers a step-by-step description of the ways that a plan will be enacted but also projects a timeline and explains how funding will be deployed within the plan's framework. The work plan associated with a GIS initiative should be updated on an annual basis to reflect the evolving needs and priorities of a GIS enterprise organization. Essentially, it lays out a work plan for the GIS team as it relates to the priorities of the GIS Steering Committee and each department. In addition to updating the GIS Strategic Plan, a formal work plan should also be created bi-annually. This work plan should be shared with the organization after each update and progress reports given to the GIS Steering Committee and User Group.

Historically, RCGEO has taken an informal plan to outline priority projects for the upcoming year. The GIS Outlook 2020 report can serve as a catalyst for formal work planning for all projects. The GIS Division Director should work with the GIS Steering Committee to identify enterprise projects that will have the largest impact on County operations.

Metric 17: Key Performance Indicators (KPI) – 100%

Key Performance Indicators (KPIs) are organizationally ratified metrics that gauge whether and how specific goals are met by the organization. These numeric representations of success or failure are crucial when comparing the costs and benefits of the GIS initiative.

These KPIs should be used as the beginning of tracking KPIs. These should be reviewed annually and updated appropriately. The input from the recommended User Group, Steering Committee, and the annual user survey will be instrumental in the annual KPI update.

Metric 18: Alignment with Organization's Vision, Goals, and Objectives – 0%

The vision, goals, and objectives for the GIS program should be formalized and updated regularly to align with the organization's changing goals. The GIS program can support the County's vision by identifying areas that need improvement and giving decision-makers the capacity to set realistic, data-backed goals. The vision of GIS technology must align with the

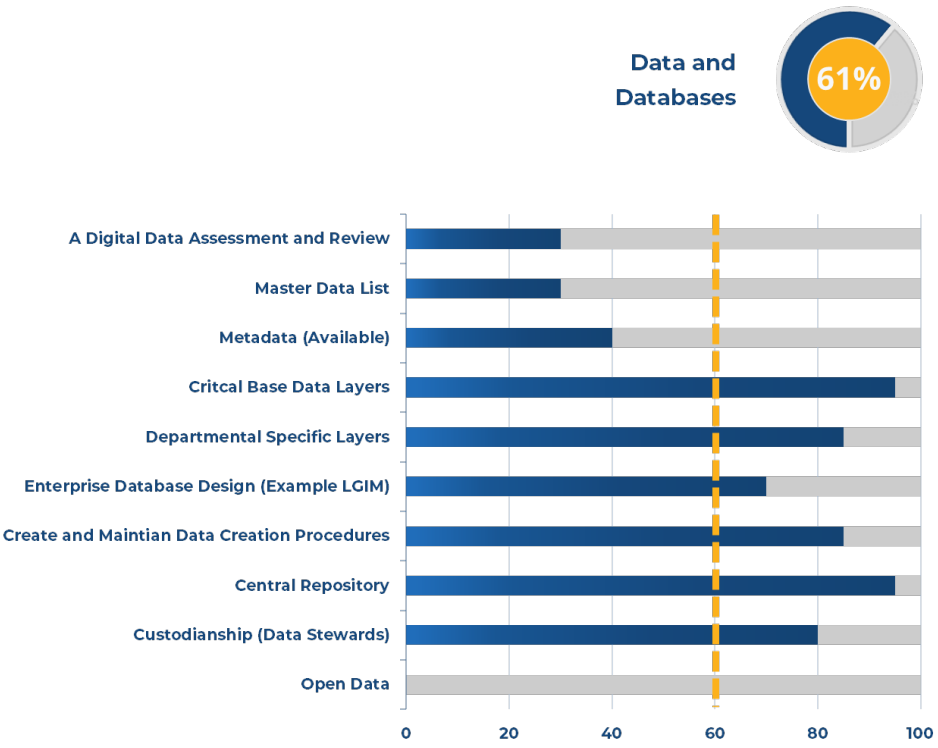
County's strategic priorities, be broken down into concrete goals, and have measurable objectives. A review of the Richland County website did not readily identify executive-level goals. However, the online budget document does include several overarching goals and vision. The document includes the county's mission, vision, and many goals/objectives. This document should be reviewed and analyzed to determine how GIS can align to achieve these goals. This alignment exercise should be shared with the Steering Committee with the intent of creating an annual alignment report. The County leadership should be made aware that in order to accomplish county-wide goals, GIS will be needed.

With five new members on the Council starting in January 2021, it will be necessary to do a GIS alignment exercise after the Councils' annual strategic vision meeting in early 2021.

Data and Databases KPIs

Data is the most expensive component of a GIS program. Organizations spend millions of dollars creating and maintaining data (spatial and non-spatial). One of the most powerful aspects of GIS is that it should become the primary tool for viewing data within a local government organization. As stated previously, '80-90% of all data maintained by a local government is related to geography,' *(Huxhold 1991)* (such as an address or parcel id). Viewing the data spatially empowers staff to analyze and manage data in new ways. Additionally, GIS should be used to 'geo-enable' the wealth of data that resides in the various IT systems maintained by the County.

After a full benchmarking analysis was completed, the average score for Data and Databases was 61%. One of the major strengths of the RCGEO program is the maintenance and quality of its core GIS data layers and the departmentally maintained key datasets. The County's central repository for GIS data also meets IT and GIS best practices. See the Benchmarking bar chart and metric analysis below to review each Data and Databases KPI.



Metrics rated 60% or lower (denoted by the yellow dashed line) are considered gaps in the Richland County GIS Program.

Metric 1: Digital Data Assessment – 30%

A digital data assessment examines the completion and breadth of an organization's existing data layers. It evaluates the accuracy, completeness, and overall health of the existing digital data layers within an organization. Once the data are assessed, gaps and weaknesses are identified and subsequently, a plan to implement improvements should be developed.

Currently, there are no formal data assessment processes in place to review and assess the quality of Richland's GIS data. The Richland County Assessor's office has procedures for quality assurance and quality controlling the data layers they are responsible for maintaining. While it is 'best practice' that data quality is the responsibility of the data steward departments, RCGEO should consider reviewing and recommending improvements to the departmental data quality processes and documenting the procedures. Also, the RCGEO team should use available tools such as the ArcGIS Data Reviewer to analyze the veracity of the core GIS data layers and to identify and fix any issues found.

Metric 2: Master Data List – 30%

The Master Data List (MDL) is an inventory of all data sets that an organization has in its enterprise GIS implementation. The datasets should be detailed by type and source and assessed in terms of their quantities, accessibility, and formats. The list should also be accessible and structured to allow department heads, executives, and elected officials to determine what data is available and how it may be utilized for decision making.

While users can see a list of all layers within the database, Richland County has no documented or published MDL. Only employees who have access and are interacting with the geodatabase have an understanding of the complete suite of County maintained GIS data available. This is likely limiting the ROI of the County's investment in its GIS data and associated maintenance. An MDL should be available in a polished, easy to read format for GIS users, or non-GIS users, to reference and may include such information as Source, Update Frequency, Stewardship, and Status.

Metric 3: Metadata (Available) – 40%

Metadata describes the collective characteristics of data. In short, metadata is data about data. Metadata details how, when, and where data was created or collected and documents its scale, accuracy, resolution, and other properties. Metadata has critical value when determining if a dataset is appropriate for use with analysis or decision making. It also is especially important when sharing with other organizations/entities.

Metadata for the County's GIS layers was last updated in 2007, but there was no process put in place at that time to maintain it. Thus, the information is out of date and could be misleading in some circumstances. Opportunities to improve the integrity of the GIS data include, formally adopting a GIS metadata standard, updating the metadata for all datasets, and drafting and implementing a process to maintain the metadata on at least an annual basis.

Metric 4: Critical Data Layers – 95%

In the context of geospatial technology, a data layer is the visual expression of accumulated data of a particular type. Critical base data layers refer to the data that are central to the GIS initiative and are mandatory for the successful use of GIS at a County.

The RCGEO data store includes the critical layers for Parcels, Address Points, Street Centerlines, and Aerial Photography. These datasets are primarily maintained by

departmental data stewards and have well-defined data update and maintenance procedures in place. The procedures are following best practices for address, parcel, and street centerline maintenance. These critical data layers are considered well maintained, reliable data sources, and accessible to all County users that need to use the data to perform their duties.

Metric 5: Departmental Specific Layers – 85%

Departmental Data Stewards maintain identified datasets based on their proximity to the business process from which the data originates. Some of the data layers are utilized across the organization. Department-specific layers are mapped representations of data that correlate to the goals and objectives of the department(s).

Several Richland County departments maintain data layers that pertain to their business. Data steward departments are listed below with the data they maintain:

Department	Data Layer(s) Maintained
Public Works	▪ Stormwater ▪ Road Attributes
Utilities	▪ Water ▪ Sewer
Sheriff	▪ Crime Data / Incidents
Planning	▪ Address Points ▪ Roads ▪ Zoning ▪ Permitting Data Maintained in TRAKiT ▪ Digital Submissions
Assessors	▪ Parcels ▪ Subdivisions ▪ Tax Districts ▪ Annexations
Animal Care	▪ Animal Care Zones ▪ Vector Control Spray Zones ▪ Bee Hives ▪ Special Needs

RCGEO houses these data and provides support from a database administration perspective. There is an opportunity to advise data stewards on any data improvements via data maintenance best practices and to facilitate an ongoing dialog on potential valuable new departmental layers or new attributes for existing data.

Metric 6: Enterprise Database Design – 70%

Enterprise database design refers to the way that an organization crafts a data repository to meet objectives and further the goals of the organization. Enterprise database design usually includes focusing on the data, the use of standard data models, and integration strategies. The organization may elect to use parts of different data models, thus creating a custom data model to accommodate business needs.

The RCGEO team puts careful thought into the data model design at the start of every project before creating a data set schema. The RCGEO process for database design historically has not followed any formal data standard; however, the data design process is driven by business requirements defined during the project at hand. Best practices are followed by the use of domains and established naming conventions. RCGEO should continue to improve the process of facilitating, recommending, and documenting best practices based on stakeholder business requirements as new data are designed and built.

Metric 7: Data Creation Procedures – 85%

Data creation procedures are the standardizing guidelines by which the organization's data are collected, cataloged, and turned into information products. This is an important set of procedures, as it protects against redundancy and needless work, both of which reduce overall cost-effectiveness and maintain staff efficiency.

The procedures for maintaining major datasets including street centerlines, parcels, and addresses are well documented and adhered to. Opportunities exist to standardize data maintenance procedures for other regularly maintained GIS datasets; however, while RCGEO can advise, the creation of these procedures should be managed by the departmental data stewards.

Metric 8: Central Repository – 95%

A central repository is an organization's aggregated collection of GIS data, gathered from all information resources. Pooling data in this manner allows for ease of maintenance,

monitoring, and collection of metadata. A central repository of GIS data is a characteristic of an enterprise solution.

Richland County maintains a central SQL Server Geodatabase that serves as the centralized GIS data repository for the enterprise. The organization's GIS data is centrally maintained and administered from this database following industry best practices and workflows. Direct access to the data is provided based on user needs (editing, analysis, read-only). Data is widely shared via web GIS solutions that RCGEO has built to allow for browser-based data query, discovery, and analysis.

Metric 9: Custodianship (Data Stewards) – 80%

Data stewards are responsible for the administration and upkeep of specific digital data layers. Any department-specific layers that are created must be assigned a data steward. Data custodians are responsible for the storage of the data and implementation of business rules. The custodianship needs to be formalized with agreement from each data steward department.

The RCGEO team act as data custodians for the Richland County GIS system, warehousing and administering the County's enterprise geodatabase. Several departments are data owners within the enterprise geodatabase and have identified data stewards of their department's data (see table above) who are responsible for the maintenance and quality of the departmental data. Formalizing and documenting this arrangement with a policy or procedure will ensure clear lines of accountability and stability of the data maintenance processes.

Metric 10: Open Data Community Policy – 0%

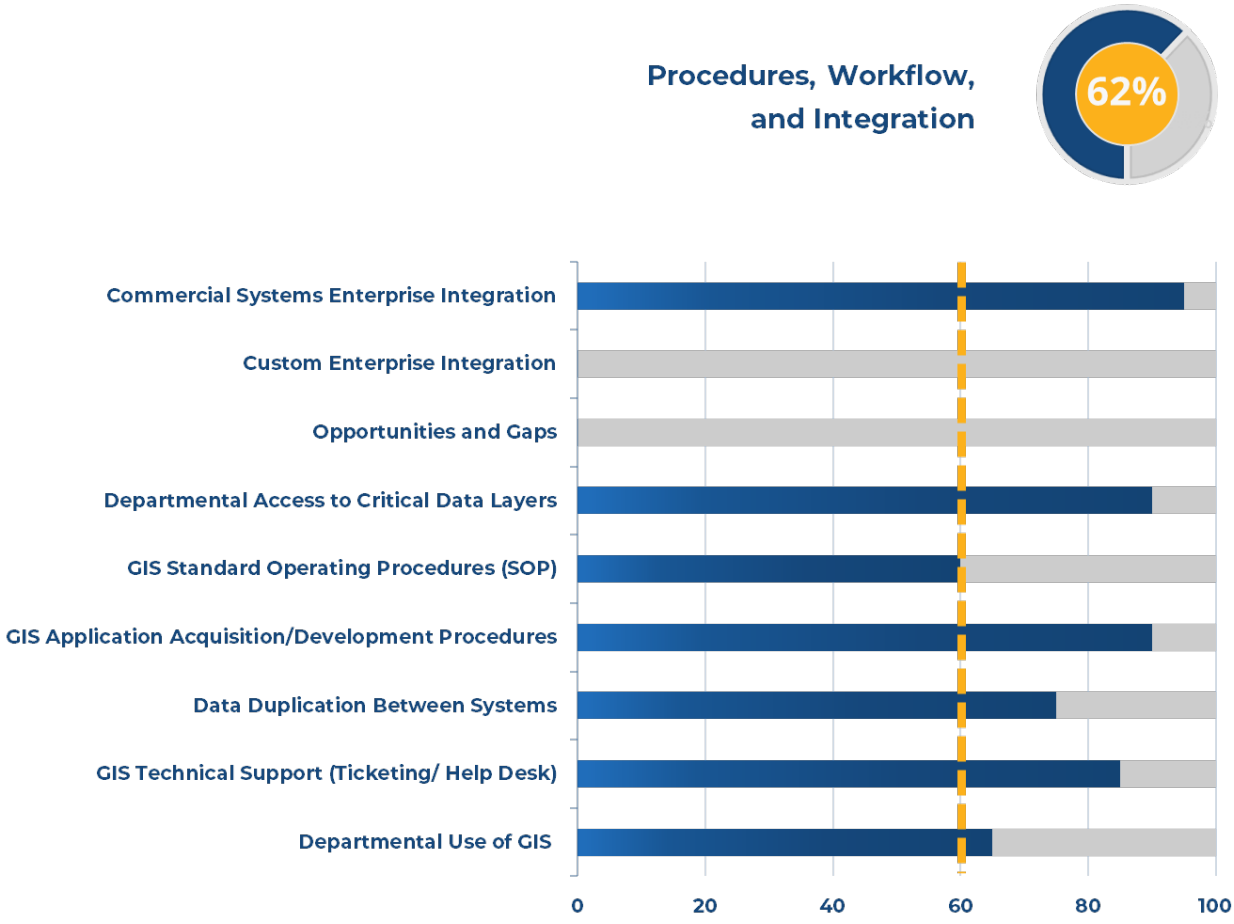
Open data and open government describe an increasingly prevalent policy that allows citizens, stakeholders, and non-stakeholders access to an organization's GIS-based data and data layers. Residents and visitors to the county can see the results of a GIS initiative; thus, a more transparent, open government is the end goal of this policy. Open data tools should be considered if they add additional value over the organization's current available methods.

Richland County has had an informal policy of providing access to geospatial data. To meet this objective, the County has made web apps and WMS services available to the public. There are instructions on the County website on how to add the WMS services to several GIS packages.

Procedures, Workflow, and Integration

A prevalent misconception about GIS is that it is just a compilation of computerized hard-copy maps. In reality, it is a digital map that is integrated with data that enables users to analyze, query, understand, and compare datasets. GIS implementations often fail because the GIS is seen as a stand-alone mapping technology; however, in reality, it is a primary integrative tool that should serve as an organization's portal into all of its data. One of the key components to any successful GIS is how well it integrates with other systems and how it improves the overall workflow of the organization.

After a full benchmarking analysis was completed, the average score for Procedures, Workflow, and Integration was 62%. Gaps were noted for enterprise integration and documentation of procedures. Also, there is a lack of methods to seek out opportunities to integrate GIS with more business systems. See the Benchmarking bar chart and metric analysis below to review each procedure, workflow, integration, and interoperability KPI.



Metrics rated 60% or lower (denoted by the yellow dashed line) are considered gaps in the Richland County GIS Program.

Metric 1A: Commercial Enterprise Integration – 95%

An effective enterprise GIS should identify and integrate all databases that will provide organizational value and offer extensive interoperability. Interoperability means the ability of the GIS to work with other systems within and across organizational boundaries. This includes local, state, and federal data sources. Enterprise integration describes the process whereby existing business system data are integrated into the GIS. This could include real-time integrations or export, transform, and load (ETL) processes. The many systems are designed to be optimally configured to allow 2-way integration with real-time viewing and editing data seamlessly from both the business system and GIS.

At Richland County, many major GIS datasets have some level of integration with 3rd party business systems. Examples include:

- TRAKiT Permitting system - data transfer only
- TriTech Computer Aided Dispatch (CAD) - data transfer
- BCS - The Addresser - Address and Road Centerline Maintenance

Metric 1B: Custom Enterprise Integration – 10%

Export, transform, and load (ETL) processes can be used to feed data from one system to another to meet operational requirements.

At Richland County, ETL integrations include:

- CAMA (Computer Aided Mass Appraisal) Property Assessment system - data transfer
- Crime Analysis - geocode of incident addresses

There are opportunities to identify and implement additional custom data integrations and automation. A survey of County staff will assist in identifying business needs and potential ROI of these custom data integration opportunities.

Metric 2: Opportunities and Gaps – 40%

Gaps in the enterprise and integrated GIS solution need to be identified and documented. Opportunities are those databases that could potentially be incorporated into the enterprise GIS initiative.

There is an awareness of some integration opportunities tied to business needs at Richland County. Specifically, the Ombudsman office has requested GIS integration with the 311 system. The RCGEO team should explore ways to identify more opportunities for integration. As suggested above, a well-designed staff survey will provide the necessary feedback to identify business needs for integration and to translate the needs into implemented integrations. The results of the survey should be documented, prioritized, and scheduled for implementation based on a level of effort/ROI matrix.

Metric 3: Departmental Access to Critical Data Layers – 90%

Critical departmental data layers are those that are crucial to the GIS enterprise. Departmental access refers to the ease with which various organizational departments may access these layers. Departmental accessibility is a critical component of success.

RCGEO is eager for departments and contractors to use the data; therefore, access is provided to all known users based on the need. The team should explore ways to identify potential users in niche areas who may not be aware of or may not have access to GIS at present.

Metric 4: GIS Standard Operating Procedures (SOPs) – 60%

Standard operating procedures (SOPs) are the formally ratified blueprint for actions to be taken in pursuit of the desired objective. They are step-by-step, formulaic, and repeatable. In the geospatial context, SOPs prevent redundancy in data compilation and unnecessary effort. The adoption of SOPs also decreases organizational liability and increased organizational stability.

Other SOPs drafted and maintained by RCGEO include:

- Digital Data Submission Standards – for CAD data submissions
- Parcel Maintenance
- Address Point and Street Centerline Maintenance
- Utility maintenance
- Server environment build-out details and configuration notes

Opportunities exist to formalize the SOP archiving by centralizing their storage and indexing.

Metric 5: GIS "Application Development" Procedures – 90%

A GIS application simply refers to the deployment of GIS technologies to generate an information product. GIS application acquisition/development procedures are a subset of SOPs detailing how GIS technologies are to be developed and acquired by the organization, as well as how software is modified, to meet user needs. These procedures dictate how a local government manages software acquisition and/or software development. They also help the organization understand the pros and cons of configurable off-the-shelf (COTS) solutions and custom software development.

The RCGEO GIS application development process has developed organically over several years. A project request is received from a stakeholder to build a GIS solution. The team collects the requirements for the project and collaborates with the stakeholders to determine the best solution for a requested application. RCGEO has been very successful and productive following the current process for application development. Opportunities

exist to formalize the process and the expectation of collaborative participation through documenting the procedure.

Metric 6: Data Duplication Between Systems – 75%

The most common GIS data layers that are duplicated in local government are street centerlines, address points, parcels, and, to a lesser extent, boundary layers. Sometimes duplication or replication is necessary as the end use of the layer dictates.

RCGEO tries to limit duplication internally; however, it has been necessary to replicate some geospatial data into non-GIS database tables for use by enterprise systems. Also, several datasets are exported to cloud storage outside the security system to populate public-facing websites. The team is cognizant of these data duplication scenarios and valid business requirements exist to support these duplications. The team is doing a good job limiting the duplication of data between systems to only situations where it is required based on system limitations or security. There is uncertainty as to whether there is data duplication within departments. This can be addressed within the GIS user survey provided to GIS staff at the County.

Metric 7: GIS Technical Support (Ticketing/ Help Desk) – 85%

Like users of any technology system, GIS users often need help or encounter problems while navigating GIS technologies. The team responsible for an organization's GIS technical support will walk users through issues and provide readily available troubleshooting information.

The Richland County IT Help Desk routes requests to the GIS Division as needed. Users who are familiar with GIS staff often make contact directly. When a ticket is submitted by contacting a team member, the staff should enter a support ticket on their behalf. The statistics of these Help Desk tickets can be used to measure the quality of services and user satisfaction. The GIS staff has access and tools to support any help desk requests from users and has provided responsive support to the organization.

Metric 8: Departmental Use of GIS – 65%

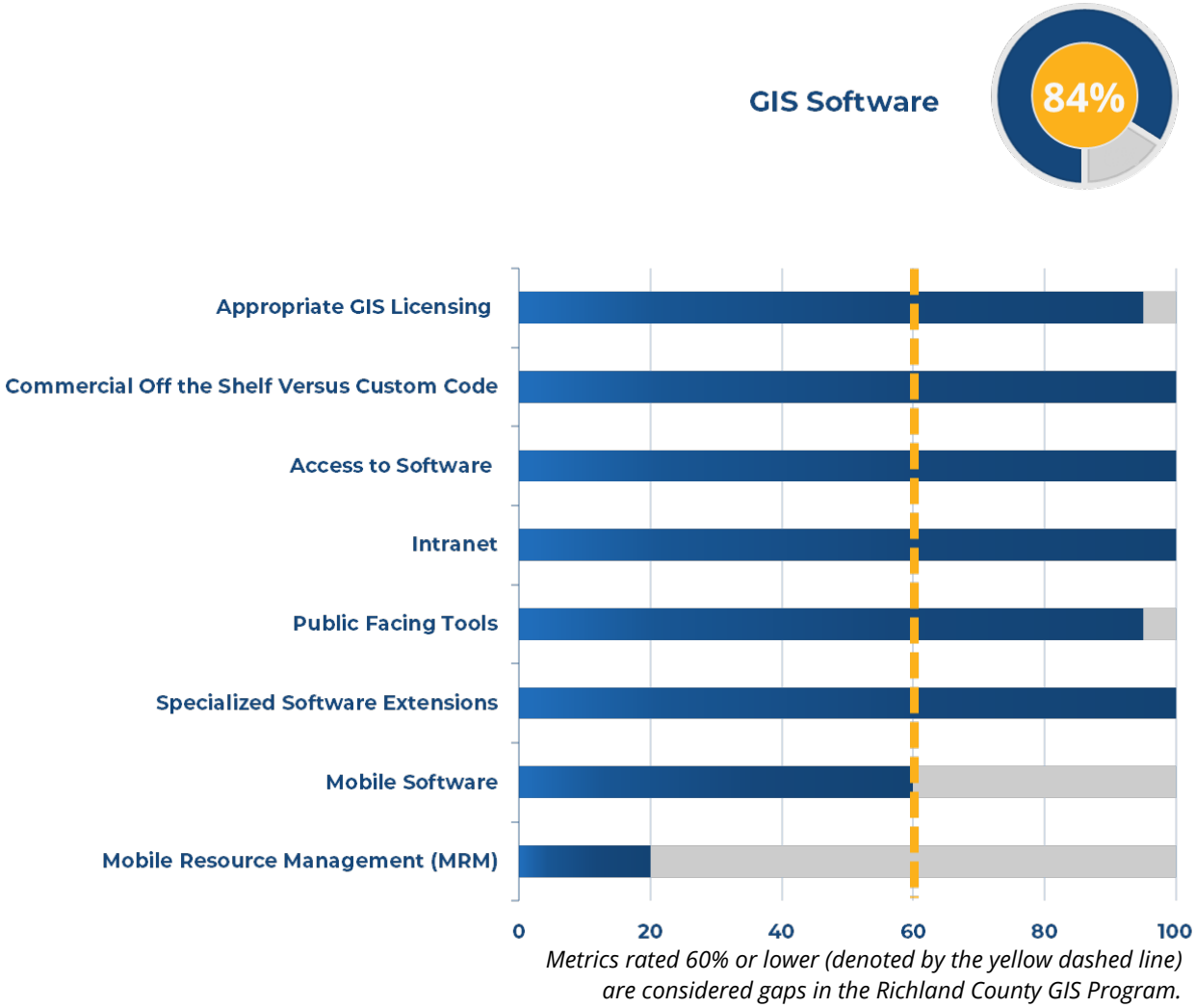
This is the actual utilization of GIS within all departments of local government. In the context of geospatial technology, departmental use implies a decentralized implementation of GIS technologies. This component should examine how effectively the departments are deploying the technology for different needs.

Where they have influence, RCGEO has given access to GIS in several departments. The team has worked with data stewards and editors in many departments to ensure proper access to users maintaining data and the stakeholders within the departments using the data for decision making. GIS could have more impact throughout the organization with greater departmental use. Given the opportunity, RCGEO could explore ways to expand GIS technology into more departments and County operations. A user survey distributed to staff across the organization would assist in understanding the usage of GIS within departments and help to identify opportunities to expand the GIS use and ROI.

GIS Software

Software is the manifestation of investment in GIS. Over the past few years, the focus of GIS software development has shifted from desktop software used primarily for data creation to tailored browser-based applications used by specific user groups for data viewing with targeted analytical tools. Many local government organizations are redistributing their efforts towards this model to provide solutions that staff throughout the organization can use to get their job done more effectively.

After a full benchmarking analysis was completed, the average score for GIS Software was 84%. This is clearly where Richland County GIS shines. See the Benchmarking bar chart and analysis below to review each GIS Software KPI.



Metrics rated 60% or lower (denoted by the yellow dashed line) are considered gaps in the Richland County GIS Program.

Metric 1: Appropriate GIS Licensing – 95%

Successful organizations have enabled staff with the appropriate tools for their level of need. A license agreement is a legal agreement entered into by the organization and a GIS software vendor that stipulates the limitations, liabilities, and appropriate applications of the vendor's technology. An Enterprise License Agreement (ELA) or Enterprise Agreement (EA) permits deployment of a software program that is both organization-wide and uncapped in terms of user, data, or hardware restrictions. The objective of the metric is to measure how available and pervasive GIS software is throughout the organization and create an optimum and cost-effective licensing strategy.

ArcGIS Desktop and ArcGIS Enterprise licensing levels are appropriate for Richland County's use at this time. RCGEO and the data stewards within departments have access to ArcGIS Desktop to perform data maintenance and analysis. RCGEO utilizes several open-source geospatial products such as QGIS for GIS Desktop, Geoserver for serving GIS data over the internet, PostgreSQL databases, and other various web GIS development tools which do not require licenses, and, therefore, keep costs low. The team has done an excellent job managing the GIS licensing and keeping these costs low for the County.

Metric 2: Level of GIS COTS versus Custom Code – 100%

Commercial off-the-shelf (COTS) products are packaged solutions which are then adapted to satisfy the needs of the purchasing organization, rather than the commissioning of custom-built solutions. *(Wikipedia, 2019)* An example of COTS is Esri's ArcGIS Solutions, which can be downloaded and configured for the specific organization or use case. Third-party (or 3rd-party) software is a program developed by an entity other than the original vendor of a development platform and can range from complete pre-packaged software applications to add-ons extensions. Open-source software is software that is freely available for anyone to acquire, use, and modify. It is made available with an open-source software license that explicitly allows for this open availability and customization.

RCGEO has implemented an excellent balance of COTS solutions and open-source custom-built applications to support the organization's GIS needs. There is a team-based collaborative workflow in place to ensure the best COTS or custom solution(s) to implement and satisfy the business requirements of the solution.

Metric 3: Access to Software – 100%

Access to software describes who can interact with what software, and to what extent. The objective is to evaluate how much access there is to GIS software within the organization.

At Richland County, the GIS team provides access to GIS applications and tools on an as-needed basis throughout the organization. Departmental data stewards and analysts have appropriate access to Desktop GIS software and associated tools and extensions to allow efficient data maintenance and analysis. GIS users across the organization have access to browser-based web GIS applications for needed data query, discovery, and widget-based analysis.

Metric 4: Intranet Solution – 100%

An Intranet is a web-based GIS solution that is accessible only to an organization's employees. All staff at Richland County have access to several Intranet map viewers. These internal viewers were built using COTS Esri tools and include data deemed sensitive and not appropriate to be provided to the public. These sites are on the Richland County domain and require Windows login to access them. Internal sites available for County staff include:

- Dynamap Interface
- Historic Parcel Viewer
- Permit Lookup
- Permit Activity Dashboard
- Polling Manager
- Annexation
- Crash Data Dashboard (along with custom-built tools)

See the Success Stories section for a description of each site.

Metric 5: Public-Facing Tools – 95%

A public access portal is a website where members of the public are able to interact with GIS information. GIS public access portals increase access to civic information for residents and are an outlet for the County to disseminate information to citizens.

The County has developed and deployed several targeted public viewers:

- Dataviewer
- CompSales
- GeoInfo
- Delinquent Tax Sales
- COVID-19 Resources Hub

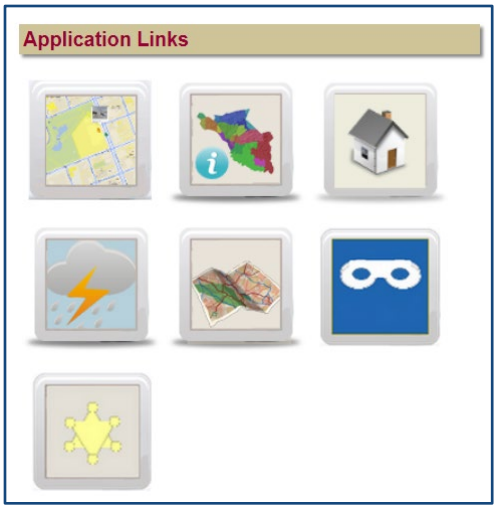


Figure 16 Richlandmaps.com gallery of public applications.

Except for the COVID-19 ArcGIS Hub site, these apps have all been built with open source software platforms (Leaflet), which have proven to be more performant than the Esri Web AppBuilder solution, and configurable for rapid deployment. These apps can be accessed through the County GIS website at the following link:

http://www.richlandmaps.com/.

See the Success Stories section for a description of each site.

Metric 6: Specialized Software Extensions – 100%

The maturation of GIS has resulted in a wealth of specialized software products. Esri has traditionally called these extensions. as they extend the functionality of the core product. Esri's ArcGIS software extensions include Network Analyst, Spatial Analyst, 3D Analyst, and a host of others.

RCGEO currently has the extension licensing needed to support applications and operations and are monitoring and managing their use. Esri's ArcHydro is used by Utilities for hydrologic modeling which requires the Spatial Analyst extension. Also, a 3rd-party software package called The Addresser is used for the standardization of address and street centerline maintenance. The County's Esri licensure includes Spatial Analyst, Network Analyst, 3D Analyst, Geostatistical Analyst, Publisher, although not all are activated or used. There are no known unfulfilled needs for specialized software extensions.

Metric 7: Mobile Software – 60%

Mobile software refers to GIS applications that are designed for mobile use on a tablet or a smartphone. The mobility of GIS is a critical component of any successful enterprise GIS. This

is a burgeoning area of GIS. The latest mobile software solutions work very well via cellular networks on a variety of hardware platforms (tablets, smartphones, laptops, and other mobile devices). Esri has introduced the Collector for ArcGIS, Survey123, and QuickCapture specifically for mobile data collection. Other tools such as the Esri Web AppBuilder and open-source software allow for the implementation of platform-independent software for viewing and analysis in the field.

Richland County is beginning to migrate to an Esri solution for mobile software. The RCGEO team is developing a mobile implementation plan to guide these mobile deployments and solutions. A pilot project utilizing Esri's Survey123 is underway, and results will guide the deployment of future implementations using this platform. Also, Collector for ArcGIS has been deployed and is currently being used successfully by the Utilities Department to update and collect asset data in the field. More deployments are in progress in Public Works, with the goal of moving field workers away from using paper forms. Formally documenting the mobile needs and an associated implementation plan is recommended to ensure efficient deployment of future mobile GIS solutions.

Metric 8: Mobile Resource Management (MRM) – 20%

GIS is a technology that is integrative to most other local government technologies. Most local governments are using Global Positioning System (GPS) enabled mobile devices, from Automated Vehicle Locations (AVL) and handheld GPS receivers to smartphones and tablets. Collectively, all of this technology can be referred to as Mobile Resource Management (MRM). GIS data can be displayed on mobile devices, showing live locations if so desired. This is critical for public safety events such as calls to an emergency or a disaster, as well as for field data collection. MRM in a local government organization may be an IT policy with the best practice of mobile deployments and management of the mobile workforce being handled at the enterprise level, from procurement to setup/configuration, deployment, and training. GIS has a big role in MRM due to the geospatial aspect and concern for locational data accuracy.

At Richland County, no formal MRM policy exists. The IT department handles all mobile phone and tablet hardware acquisitions and RCGEO has historically had no input on these device acquisitions. The RCGEO team coordinated the implementation of AVL for the County's Fleet Management division; however, responsibility and maintenance for the implementation have been handed off to Fleet Management staff. Mobile device selection is usually handled at the department level and consists mostly of tablets with Verizon packages

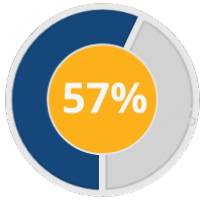
on them. RCGEO has also acquired and manages external GPS units that are compatible with County supplied mobile devices. Opportunities exist to formalize MRM at Richland County as the processes are currently siloed and disjointed spread across IT, RCGEO, and various departments. Putting a collaborative MRM policy in place will ensure the organization's mobile device management is cost-effective and efficient.

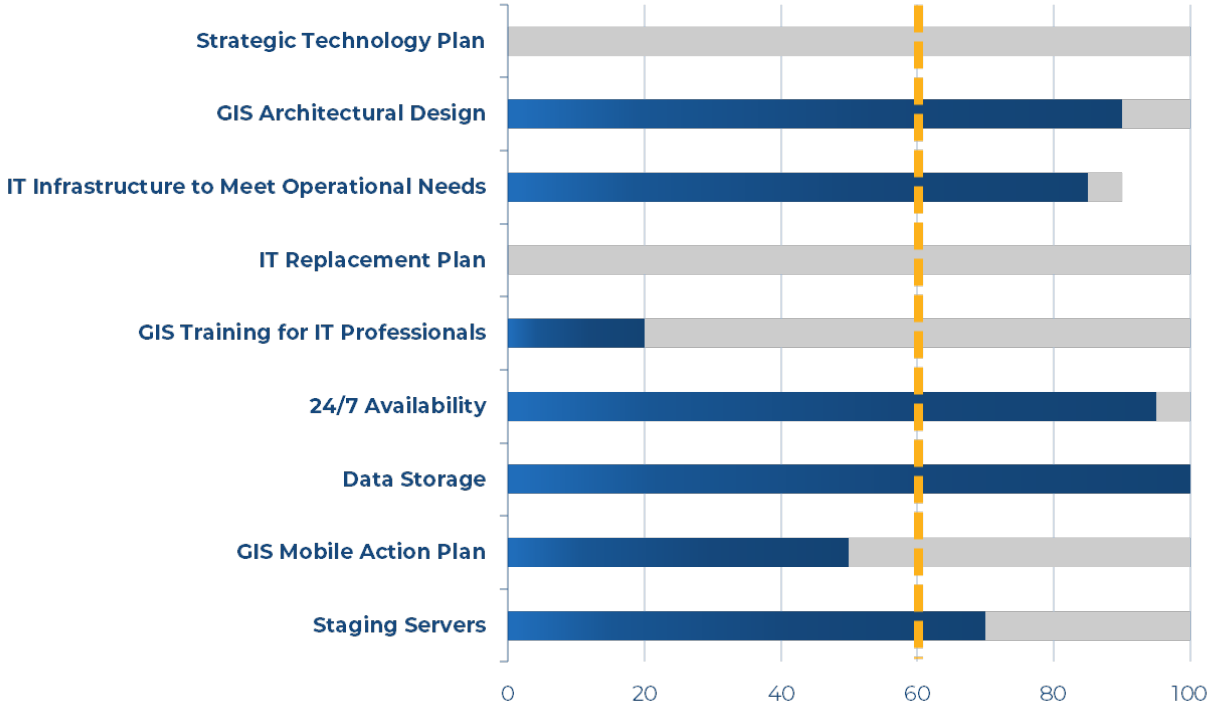
IT Infrastructure

Infrastructure refers to the network of structures, both physical and systemic, that support an organization's activity. Information technology (IT) infrastructure refers to a dynamic web of processes, networks, hardware, and software resources that support the activities of an integrated IT department. These benchmarks measure how well the County is ensuring that the IT infrastructure of the organization meets the current business needs and whether they are positioned to support future needs.

After a full benchmarking analysis was completed, the average score for Infrastructure was 57%. Major gaps were found in strategic planning for technology advancement and infrastructure replacement. See the Benchmarking bar chart and metric analysis below to review each IT Infrastructure KPI.

IT Infrastructure





Metrics rated 60% or lower (denoted by the yellow dashed line) are considered gaps in the Richland County GIS Program.

Metric 1: Strategic Technology Plan – 0%

A strategic technology plan describes an organization's current and future relationship with technology and outlines how this technology will further the goals of the organization. The components of this plan serve as the bedrock for the GIS platform.

No strategic technology plan has been prepared for Richland County information technology. GIS has had several strategic plans in the past. While the lack of an IT plan has been a hurdle, it has not prevented RCGEO from meeting many of its strategic goals. A Richland County Strategic Technology Plan should be based on IT best practices and focus on how technology can and should be used or implemented to assist the County in achieving

its organizational strategic goals. The plan should include and encompass GIS as an enterprise information system ensuring GIS is supported from an IT system perspective currently and into the future.

Metric 2: GIS Architectural Design – 90%

GIS architectural design is the plan that focuses on GIS software technology, capacity performance, and IT infrastructure including hardware, network communications, software architecture, enterprise security, backup, platform performance, and data administration.

RCGEO has implemented a GIS Architecture that embraces both on-premise and cloud-based infrastructure. The system supports an on-premise implementation of ArcGIS Enterprise supported by an enterprise geodatabase that serves as the organization's centralized GIS datastore. The on-premise architecture is also supported by a separate development environment to allow the RCGEO team to test changes to the system before promoting the changes to the production environment. The cloud infrastructure supports the organization's public-facing web GIS solutions and is built on open source technologies (Linux, Leaflet, GeoServer, etc.) which allow the County to serve public-facing solutions with no software licensing costs.

The specifications for on-premise servers, cloud servers and services, GIS software, and databases have been documented.

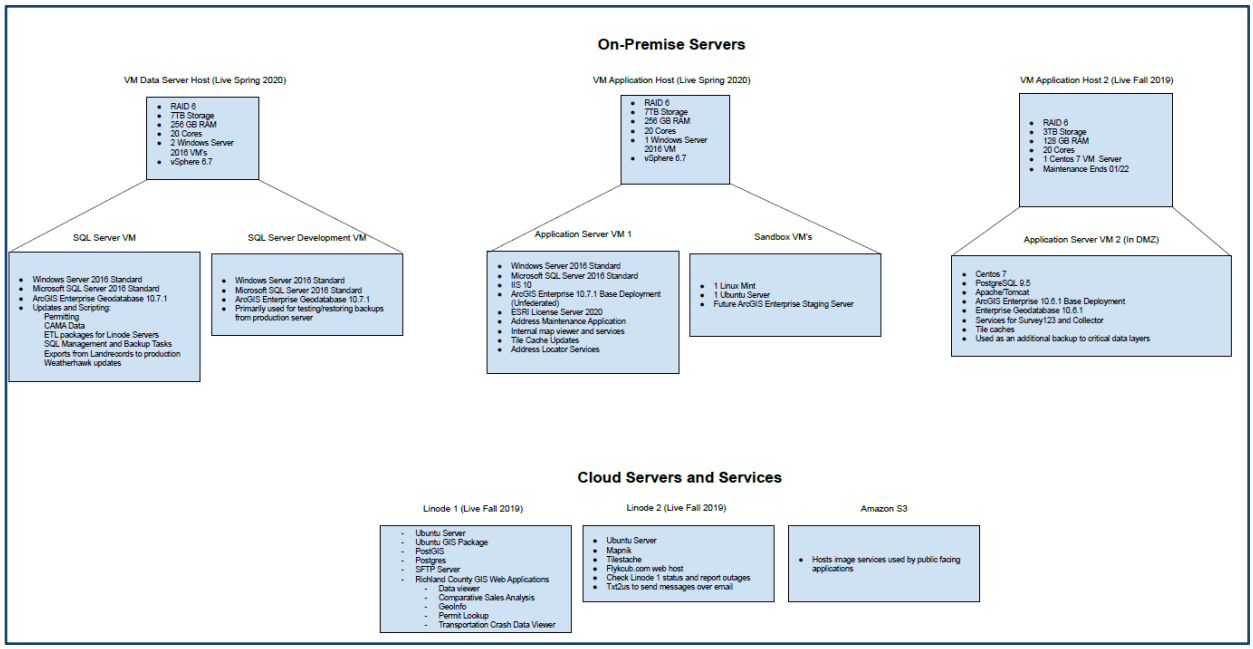


Figure 17 RCGEO Server Infrastructure

Metric 3: IT Infrastructure – 85%

IT infrastructure refers to a dynamic web of processes, networks, hardware, and software resources that support the activities of an integrated IT department.

RCGEO relies on IT for network and recommendations on the setup of virtual machine (VM) hosts and servers. The GIS staff manages the VM servers the GIS is deployed on. These VMs are configured with IT best practices, are well maintained, and have been reliable for the GIS. The network occasionally has some intermittent performance issues, but these have not

been problematic, and the network is generally perceived as reliable by the organization. There is however a bandwidth bottleneck that has been identified by the RCGEO team that is limiting the deployment of some GIS solutions that require higher network speeds to be performant. The current network bandwidth will continue to limit deployment of future GIS technology solutions that place a higher demand on the network unless bandwidth is increased. The County should begin planning for future demands on the network and implement the increase in bandwidth before larger performance issues are encountered.

Metric 4: IT Infrastructure Replacement Plan – 0%

An IT replacement plan is a formal plan for updating hardware and software resources in the future. Budgetary concerns, goals, and long-term objectives should be considered. County IT departments should develop and adopt formal IT hardware replacement plans. Such a plan will ensure the County is protecting the network by maintaining IT hardware following IT industry best practices and will allow the County to efficiently budget for replacement costs.

IT infrastructure hardware replacement is under the responsibility of the IT Department. A formal IT hardware replacement plan was not available for review during this project. However, all GIS servers have been replaced within the past year.

Metric 5: GIS Training for IT Professionals – 20%

The organization's information technology staff should receive the appropriate training in GIS concepts and technological requirements to support the GIS effort. GIS is an enterprise information system and it is critical that IT support is available for GIS database, application, and web tiers of the system to ensure staff has 24/7 availability. IT professionals with an understanding of the GIS systems and components will be prepared to efficiently troubleshoot issues, and support and maintain the GIS.

At Richland County, the Information Technology Department includes three divisions - GIS, Network (Infrastructure), and Business Systems. In the past, there was an effort to train Business System staff on GIS systems and components, however, there has been no training of late. The IT Professional GIS training needs to be reintroduced into the regular training of appropriate IT staff members.

Metric 6: 24/7 Availability – 95%

The term 24/7 availability refers to the availability of IT infrastructure and GIS technology at all hours of the day, every day of the week.

The expectation is that Richland County IT and GIS systems are available 24/7. Outside of scheduled maintenance, the systems are typically reliably online. The GIS team's cloud servers are highly reliable and are supported by 3rd party system redundancy that ensures a high level of system uptime. Scheduled maintenance to the system per best practice is scheduled after business hours with appropriate communication to system interruptions so staff can plan for the outage appropriately.

Metric 7: Data Storage – 100%

GIS is data intensive and requires a voluminous amount of storage, especially with the advent of LiDAR and drone imagery. With the low cost of data storage and improvements in storage technology, a huge array of disk space can be made available at most local governments.

Richland County GIS currently has no issues with data storage availability. The RCGEO team estimates that there is currently enough available data storage onsite to handle data needs for the next 3-5 years. The County has additional data storage space that can be utilized if needed via access to the County's Storage Area Network (SAN). Cost-effective cloud-based data storage is also being utilized by RCGEO for public-facing solutions adding to the storage options the County has to support the organization. These data storage solutions will support the County's GIS for many years to come.

Metric 8: GIS Mobile Action Plan – 50%

A mobile action plan is an outline of the tactics that the organization will deploy in order to increase GIS accessibility and ROI on tablets and smartphones.

There is no strategic plan for mobile GIS deployment at Richland County. All requests for mobile GIS solutions are currently handled ad hoc. The RCGEO team has the beginning of a

mobile action plan in place with short term plans for mobile deployments (See GIS Software - Metric 7: Mobile Software). Developing a formal GIS mobile action plan is recommended as the County is just beginning to expand its mobile GIS solutions. A plan will ensure that mobile GIS needs are met for each implemented solution and that the right software and hardware are selected to meet the requirements of each solution. A departmental survey should be done to identify mobile GIS needs that may currently be unmet.

Metric 9: GIS Staging and Development Zone – 70%

It is best practice for each production system to have a development environment that mirrors production. A staging or development server is a copy of a server and the sites hosted on it that can be used to test and develop new code, try configurations to optimize your server, update your site, and test applications before putting any of it on the production server. Performing development work, unit testing, and staging in a virtual environment offers great flexibility, uses few hardware resources, and is relatively easy to set up.

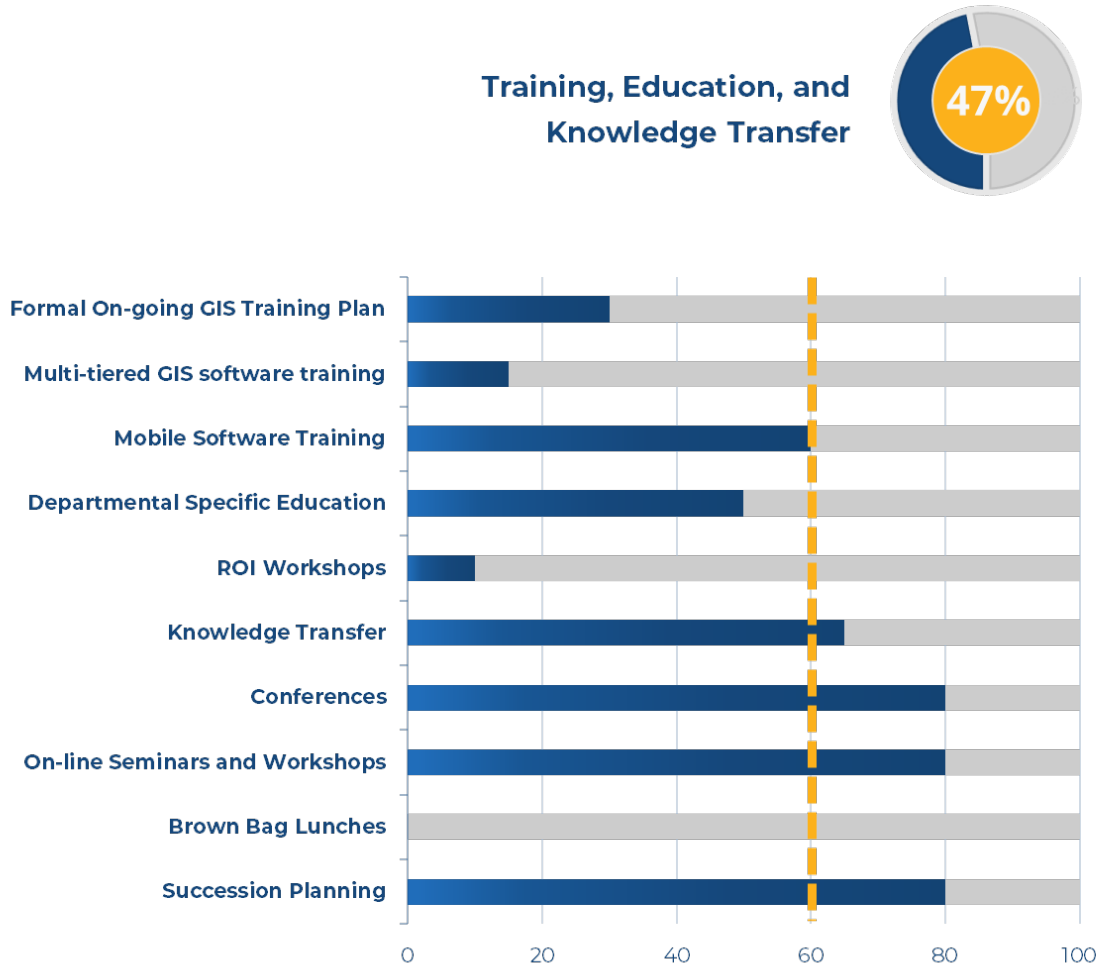
RCGEO has an internal development server in place that allows the team to perform tests before applying changes to the production environment. This development environment currently does not mirror the production GIS environment, thus limiting the testing possible before making changes in the production environment in some cases. It is recommended that RCGEO implement a development or test environment that fully mirrors the production environment to ensure the integrity and uptime of the main system. Change management procedures should also be developed and documented to formalize the process for applying changes to the production GIS environment.

Training, Education, and Knowledge Transfer

Training, Education, and Knowledge Transfer are the most important components to a successful enterprise-wide GIS effort; however, it is the one pillar of GIS success that is most often overlooked or underdeveloped. Many excellent GIS implementations languish because the power of GIS is not understood. Some organizations mistakenly believe that software training is enough. However, education and understanding of what GIS can do for the end-user are equally (if not more) important. Training, education, and knowledge transfer are necessary to sustain the success and growth of the GIS program.

After a full benchmarking analysis was completed, the average score for Training, Education, and Knowledge Transfer is 47%. There are many avenues that the County can take to

improve on this score. See the Benchmarking bar chart and metric analysis below to review each training, education, and knowledge transfer KPI.



Metric 1: Formal On-going GIS Training Plan – 30%

A formal ongoing GIS training plan is a ratified outline of steps, schedules, and costs for continuing to train the organization's employees. It is important to have an ongoing training plan, considering that GIS is a rapidly evolving technology, and organizational needs are ever-changing.

There is currently no formal GIS training plan in place at Richland County. GIS training is typically addressed in an ad-hoc manner when an explicit need presents itself. RCGEO should create a comprehensive training and education plan that is updated each year based on projected GIS staff professional development needs. Internal training and education

workshops should also be offered throughout the year and should be focused on how GIS can help the end-users better understand and utilize the technology. Engaging end-users in this process through the GIS User's Group will ensure the information on available training is accessible.

Metric 2: Multi-tiered GIS Software Training – 15%

The formal training plan must include multi-tiered GIS software training using a standardized process for training employees in the use of GIS technology.

The GIS training plan should include GIS training for all levels of Richland County GIS users. This includes staff using browser-based GIS applications for data search, query and discovery, GIS Analysts and Editors, as well as training for GIS and IT professionals that are maintaining and administering the GIS systems and databases. Training opportunities include both internal courses offered by RCGEO and external courses, webinars, and conferences. In addition, end-user training on each deployed GIS application or solution is imperative to the success of an implementation and should be part of each GIS project's plan.

Metric 3: Mobile Software Training – 60%

Mobile software training is the process of teaching users how to engage with GIS technology on their mobile devices. The formal training plan must include mobile software training.

For previous ArcGIS Collector deployments, the RCGEO put a formal workflow together for field data collection and training field workers. With the current momentum and recent initiation of several mobile GIS projects, there is an opportunity for RCGEO to leverage the current mobile GIS stakeholder audience to develop formal mobile GIS training for staff. This will assist the team with efficiencies in deploying upcoming mobile GIS deployments by leveraging group training opportunities or reusing training materials that are developed as part of the projects. The mobile GIS training should be incorporated into all mobile GIS projects.

Metric 4: Departmental Specific Education – 50%

Departmental-specific education provides specialized training procedures according to a department's specific needs.

The Richland County Assessor's Office conducts training for their staff, with RCGEO conducting training when needed. Beyond this, the RCGEO team does not have visibility into

any other departmental training that may be taking place. Additional undefined opportunities likely exist for departmental specific training that will expand the use of GIS throughout the organization and improve efficiencies. The County should ensure that all departmental GIS users have an awareness of and access to the GIS training opportunities that will create efficiencies within their subject matter workflows.

Metric 5: ROI Workshops – 10%

Return on Investment (ROI) workshops are specific workshops that are related to the value and ROI that GIS offers the County. Each department is an important component in the success of an enterprise GIS; ROI workshops should include information specific to each department.

GIS ROI efforts have been few at Richland County. The last ROI related organizational communication was Key Projects listed in the Richland County IT/GIS Annual Summary - Fiscal Year 2019 document. Educating each department about how GIS can benefit their process is necessary to sustain and scale the GIS. There is extensive opportunity to educate the organization on the current and further value and ROI of GIS at Richland County.

Metric 6: Knowledge Transfer – 65%

Knowledge transfer refers to the process of communicating the GIS know-how and knowledge among different entities in the organization. Knowledge transfer is the act of transferring knowledge from one part of the organization to another.

A 'GIS User Group' email group exists for communication with all users at one time; however, these emails are no longer sent regularly. There needs to be a strategy for transferring and documenting knowledge to ensure that the GIS program is sustainable. Knowledge transfer techniques that could be employed include newsletters, customer service meetings, blogs, email, and social media.

Metric 7: Conferences – 80%

An important part of the training plan is networking with other GIS professionals by attending GIS conferences, being active in professional organizations, and joining area or regional user groups. In addition to their regional and national users' conferences, GIS professional associations often offer important peer-to-peer connections, professional journals, technical publications, training classes, and other learning forums.

RCGEO has done a good job of attending conferences and other regional and industry-specific conferences, such as Open Source, NACIS, and GIS/CAMA conferences. Team members have also presented at the FOSS4G and APWA conferences. The County has sent employees in some user departments to GIS-related conferences; however, staff in the other IT divisions are not attending GIS conferences. The GIS knowledge base within the organization can be improved through attending appropriate GIS conferences.

Metric 8: Online Seminars and Workshops – 80%

Online seminars and workshops should be further promoted to others in the organization. Monitoring of usage of these opportunities needs to be done and become a part of individual growth plans.

RCGEO offers online seminars and classes regularly, such as Open Source 101 and FAA Workshops. It is unclear how often GIS staff or users in other departments are attending externally offered GIS seminars or workshops regularly, however, there is an opportunity for the RCGEO team to communicate to end-users when applicable offerings are scheduled.

Metric 9: Brown Bag Lunches – 0%

This term refers to a free-and-easy meeting, generally held over a meal, where employees can discuss opportunities or concerns with GIS in a social setting.

There is currently no brown bag lunch forum in place at the County. Brown bag lunches are a low-pressure forum that has minimal operational or administrative overhead and can contribute to adding value to the GIS by building relationships and opening lines of communication across organizational boundaries.

Metric 10: Succession Planning – 80%

Succession planning refers to an organization's strategy for ensuring that staff knowledge is not lost upon staff turnover. When key personnel retire or leave the organization, the information they had accumulated during their time with the organization leaves as well. It is important to have a succession plan that focuses on program sustainability. The plan should include cross-training of GIS staff and a disciplined approach to documenting processes and procedures. This ensures there will not be a lag in organizational capacity when staff turnover occurs.

There are good cross-training and communication within the RCGEO team. This along with existing documentation, Richland County's GIS is in a good position should staff turnover

occur. The next step should be to formalize the succession plan with documentation specifically speaking to succession planning so that when individuals leave the organization, the GIS training and institutional knowledge they acquired are passed to other individuals efficiently.

Mission, Goals, and Objectives

Having a Mission, Goals, and Objectives is critical to the success of any GIS program. The Mission Statement clarifies the overall purpose of the GIS initiative and gives clarity to GIS staff and users.

Mission Statement

The mission of the Richland County GIS Team (RCGEO) is to establish a foundation of geographic information to support decision-making. Spatial information is becoming increasingly important for most local government functions and thematic departments. The GIS program will provide the technological vision and leadership to deploy appropriate spatial technologies to achieve this mission. Hereby, we will reinvent, reengineer, and streamline government wherever spatial technology can contribute towards increased efficiencies and effectiveness.

Goals and Objectives

As the lead GIS agency for Richland County, RCGEO has the stated the following fundamental goals. Specific objectives for meeting these goals are listed below each goal.

GOAL 1: GOVERNANCE: Build a framework of fundamental geographic data elements for use in County government operations.

- Objective 1: Bi-annually update the GIS Strategic Plan.
- Objective 2: Examine the value of GIS designation in current positions and create Drone Operator job classification(s).
- Objective 3: Conduct an annual user satisfaction and input survey. Measure sensitivity to user needs.
- Objective 4: Engage with leadership – Re-engage an executive-level GIS Steering Committee at appropriate intervals.
- Objective 5: Establish a GIS Users Group with membership reflecting the end-user community and meet monthly or quarterly.
- Objective 6: Revamp the current GIS funding model to build a sustainable budget.

- Objective 7: Create an annual work plan and share it with the organization.
- Objective 8: Create an annual alignment with goals and objectives document.

GOAL 2: DATA AND DATABASES: To coordinate all GIS activities and data concerning Richland County and to ensure that geographic information related services are delivered effectively and in a timely manner.

- Objective 1: Create, build, or acquire the following datasets identified as needed for county-wide use:
    - Building footprints
    - Annexation mapping
    - Preliminary Damage Assessment Mapping
    - Annual or bi-annual aerial imagery and LiDAR data acquisition
    - Other department layers
- Objective 2: Evaluate data quality using data assessment tools.
- Objective 3: Publish an easy-to-read Master Data List and make it accessible to all users.
- Objective 4: Adopt a GIS metadata standard and update metadata.
- Objective 5: Formalize an Open Data process and policy.

GOAL 3: GIS SOFTWARE: Make geographic information available to citizens while protecting county investments in data development.

- Objective 1: Identify, evaluate, develop, and deploy GIS solutions, services, and applications to share critical information with County staff:
    - Department Portals - Geo-enable data and create a targeted portal for each department
    - Search and Rescue Tracking
    - Departmental drone support

- Objective 2: Continue to configure mobile tools for departments to collect data in the field. Develop and adopt a formal centralized and collaborative mobile resource management plan and policy to guide the mobile deployments and solutions.
- Objective 3: Continue/expand the use of open-source software and evaluate the current levels of licensing for ESRI, BCS, and Pix4D products.
- Objective 4: Implement a software application for tracking and monitoring projects.
- Objective 5: Identify priority projects annually for implementation.
- Objective 6: Create an ArcGIS Pro migration strategy.

GOAL 4: PROCEDURES, WORKFLOW, AND INTEGRATION: To empower County employees and citizens by providing the appropriate tools for the retrieval and analysis of spatial data for use in answering practical, policy, and political questions.

- Objective 1: As part of a county-wide review team, identify and implement additional custom business system integrations.
- Objective 2: Geo-enable business system data and publish a service where all geospatial data is available for users to access.
- Objective 3: Standardize data maintenance procedures for regularly maintained GIS datasets. Formalize SOP archiving, centralized storage, and indexing.

GOAL 5: COMMUNITY: Fostering data-sharing partnerships with both governmental and private sector entities to facilitate the County's involvement in economic development, environmental conservation, public safety, land use, and infrastructure initiatives.

- Objective 1: Explore Interlocal Agreements (ILA) and/or Memorandums of Understanding (MOU) with the City of Columbia, University of South Carolina, and other agencies in the area to guide the regionalization of GIS technologies.

GOAL 6: TRAINING, EDUCATION, AND KNOWLEDGE TRANSFER: Identify methods for improving the GIS knowledge base for internal and external GIS users.

- Objective 1: Prepare and execute a formal, ongoing training plan incorporating individual training on editing/maintenance for the Analyst-level users, as well as mobile software training and group training on web apps.
- Objective 2: Engage Knowledge Transfer Strategy with the following events–
    - GIS Day – Annual worldwide education event in November
    - Presentations to County Council – Annual high-level presentation to the Council detailing how GIS is improving the City and expanding services
    - ROI Workshops – Informative seminars for stakeholders/leadership related to the value and return on investment that GIS offers each department
    - User Engagement – workshops, lunches, etc. to highlight, share, and discuss among user departments.

GIS Outlook 2020 Conclusion

Richland County's GIS program has a solid foundation from which to build future success. As evidenced by the key performance indicators, the County has reached a mature implementation of the technology. However, technology continues to evolve and advance. Many opportunities exist to expand the use of GIS within departments and with the public. Staff throughout the County must continue utilizing GIS technology to conduct daily tasks effectively and with insight. GIS use in local government is going to become more prevalent. GIS will become the de facto portal for managing and analyzing data at the County (spatial and non-spatial). The spread of GIS tools has been significant over the past few years. Also, residents are equipped with an ever-increasing array of GIS-based tools. They have location-aware phones and an assortment of mobile devices. Over the next decade, this will become more widespread. Users will expect local governments to automatically provide location-based services on such critical information as road closures or work in their area, the location of the nearest County facility with desired amenities, the location of special events, utility services, and the location of projects throughout the County. This can only be accomplished through the use of GIS. The County has invested in GIS and will continue to do so. The importance of GIS at Richland County should continue to increase. Therefore, it is critical to the success of the organization as a whole that the recommendations made in this Outlook are implemented, ensuring that the County's GIS investment will be viable and able to meet the ever-increasing demand.