SENECA REGION / GIS PARTNERS:
SHARED-SERVICES
REGIONAL GIS PLAN

FINAL

LGIF GIS Study

Submitted to:

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August 18, 2015

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1. INTRODUCTION

1.1 Executive Summary

This Plan marks the end of the study phase of the GIS Partners Regional Geographic Information System (RGIS) project. Its purpose is to provide necessary background information and a road map to guide full RGIS development and implementation.

The project was led by NCORCOG, but included participants from other key organizations. A large number of business processes which can be supported by the RGIS were identified and ranked. The business needs evaluation was the basis for the definition and prioritization of applications—which is the basis for RGIS design and development. While this project has a strong focus on facilities and infrastructure management and maintenance, the RGIS is being positioned as a resource for all area agencies including academic organizations.

Section 1 provides information about the project background, context and scope. Section 2 provides a comprehensive assessment of the current GIS and document management status and RGIS business requirements user needs—including an identification of future applications. Section 3 presents a preliminary design of the technical components of the system configuration and database.

Section 4 includes a number of key items to demonstrate the implementation plan details. To provide a strategic foundation for the detailed development activities, it presents an RGIS "strategic foundation" which includes a mission statement, guiding principles, and high-level goals. This strategic foundation gives a long-term picture for multi-year system development.

Emphasizing the key point that RGIS success is not only derived from its technical capabilities, Section 4 addresses organizational requirements for an RGIS Program—including an organizational structure, staffing, and management procedures and policies. Section 4 also provides a detailed, multi-year road map for RGIS development and operation, including detailed tasks and timing. These detailed tasks are organized under the following Phases.

Phase 1: Development and Early Operational Implementation: All very high-priority GIS design and architecture elements are implemented. The majority of in-process document management tasks are completed for the key document sets. Procedures are in place to efficiently maintain the GIS and document database. All "Very High" priority applications are in place and improved procedures and policies are established for efficient operations for use of RGIS applications.

Phase 2: High Priority Implementation and Deployment: The RGIS will continue to expand and thrive serving a broader user community. Any High-priority application development and document database quality assurance, testing, and deployment work will be completed in this Phase. All identified Very High and High priority applications are in place.

Phase 3: Full Implementation and Deployment: The RGIS will continue to expand and thrive serving a broader user community. Any application development and document database quality assurance, testing, and deployment work not finished in Phase 2 will be completed in this Phase. All intended applications are in place and additional applications are developed as desired.

The intent is to deploy and operational system (focusing on the highest priority functionality) in Phase 1—in a 12-month period. Phases 2 and 3 address system expansion and additional functionality.

Sections 4 also presents a cost estimate to be used as a basis for budgeting and contracting for implementation services. Section 4 concludes covering roles and responsibilities for implementation tasks, quality assurance procedures, and recommended project management and reporting procedures and tools.

Summary of Recommendations

As the study was conducted, many items were made clearer through interviews and discussions. Recommendations have been made based on that information. These recommendations cover infrastructure/technical (Section 2.6.1), information architecture (Section 2.8.2), and organizational structure (Section 4.3.2). The phased approach helps your organization evolve to where you ultimately need to be.

Information Technology is key to a project such as this. For this project to succeed, some organization must grab on to this role and execute is solidly. Within Section 2.6.1, we recommend that NCOESC be that organization. While the GIS server platform will be new to them, the task of managing enterprise applications in a shared services model will not. NCOESC seems to be unique in that qualification and they have built-in infrastructure that can serve users within an extended region very naturally.

As is detailed in Section 4.3.2, the final configuration calls for a GIS Office to be created. This GIS office will house the core RGIS expertise, but it will also coordinate with GIS staff that are within other organizations. Ultimately, it is recommended that this GIS Office reside within the Seneca Regional Planning Commission. While they are currently not equipped (neither personnel, nor equipment-wise) to accept these responsibilities at present, they do appear to be the organization best positioned to support a wide variety of users. RPC is very close to the source data that is created and maintained by the Engineer and the Auditor, yet not so focused on a narrow range of topics that varied GIS requests would be a distraction or inconvenience.

1.2 Project Background and Objectives

This study has been commissioned to evaluate the feasibility of, and provide recommendations for, implementing a shared services Geographic Information systems (GIS) model in Seneca County. It evaluates GIS use and capabilities of participating agencies and identifies opportunities to share resources along with administrative and technical recommendations on how to implement these shared resources.

In 2012, five (5) government / regional organizations in the Seneca County region of the state of Ohio partnered to embark on a shared services GIS planning study. These partners include North Central Ohio Regional Council of Governments (NCORcog), Seneca County Board of Commissioners, North Central Ohio Educational Service Center (NCOESC), City of Tiffin, and Seneca Regional Planning Commission (SRPC). NCORcog, as the lead agency, began laying the foundation for this study by acquiring resolutions that supported the application for a grant to accomplish the study. The grant was part of the Local Government Innovation Fund made available through the State of Ohio. Application was submitted and the successful grant award was announced in December 2014. That grant has made this study possible.

The map below shows the geographic relationship between the partners:

Figure 1: GIS Partners Map

GIS has been utilized in Seneca County since 1992. To investigate coordination and expansion, a basic GIS plan was completed by SRPC and presented in January 2014. While that plan represented some significant work for identifying some of the shortcomings of the existing GIS utilization, it did not present enough details of the desired improvements, technology components, or associated costs to prepare a road map for implementation. This new study has taken into consideration the findings from that study and would refer the reader to that for additional support for the problem statement and need for changing the GIS landscape.

The vision and mission of the proposed shared services GIS is multi-faceted. It is clear that GIS can be used to facilitate decision making which is of benefit to the citizens of the area. This is accomplished as organizations work in partnership to provide accurate, consistent, accessible, and comprehensive GIS resources for decision-makers and the public. The overarching strategy encompasses the following concepts in an effort to fulfill the mission and vision of this plan:

- ✓ Lower cost or cost sharing in GIS database development
- ✓ Reduce redundancy and increase efficiency in database maintenance
- ✓ Mechanism for joint project collaboration
- ✓ Promote GIS use and GIS end-users within the region.
- ✓ Provide easy access to geospatial data for users without extensive training with GIS software.

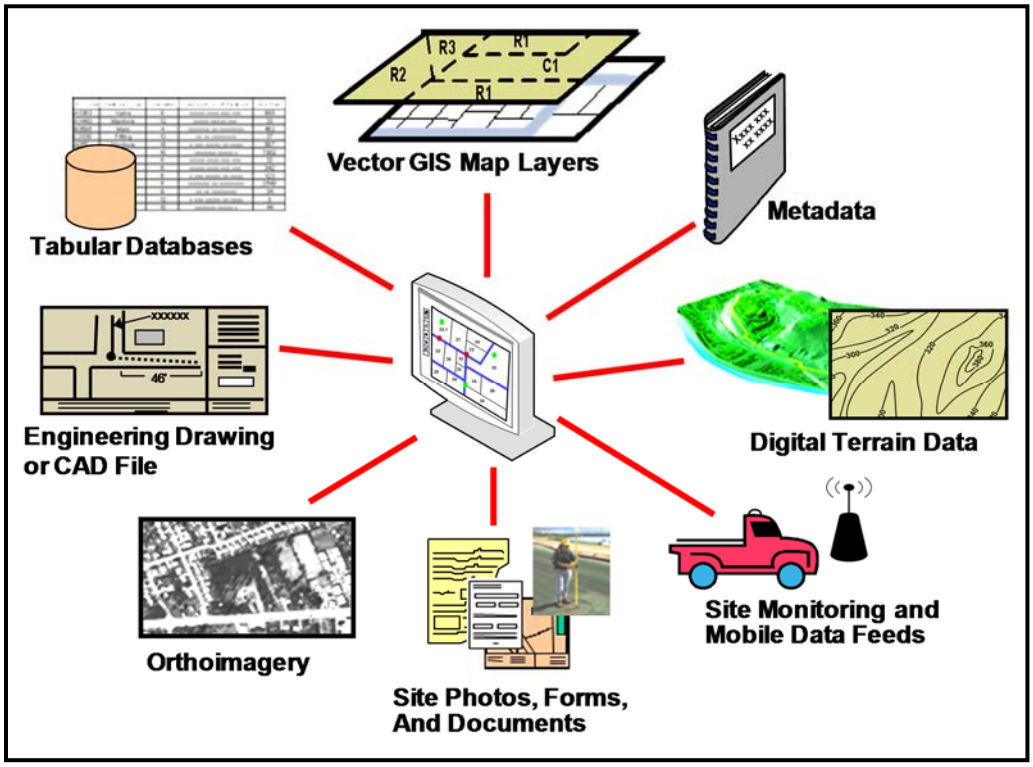
- ✓ Promote inter-organization (region-wide) participation in the sharing of standardized GIS data and GIS resources to reduce costs.
- ✓ Secure geospatial data in one place—with appropriate security so that only authorized staff can make changes.
- ✓ Provide real-time capability for data verification and location with GPS.
- ✓ Promote GIS technology training and education opportunities in order to develop and maintain appropriate skills levels for operation and use of GIS.
- ✓ Facilitate coordination and communication
- ✓ Promote the value of GIS in decision-making

The GIS Partners recognize the importance of developing a high-quality GIS database and efficient procedures for ongoing database maintenance as a basis for a successful regional GIS program. There is a strong desire to have a clear picture on how to proceed with the GIS plan. It must be actionable in order to implement it and begin to reap the rewards missing as a result of lost opportunities. An example is how GIS is an underutilized tool for economic development in the County. Providing a one-stop-shop for GIS information will make it easier for the Seneca County Industrial and Economic Development Commission to market the community.

For the purposes of this project, the term "geographic information system" (GIS) includes the data, software, hardware/network infrastructure, and applications used for mapping, geographic-based queries, and spatial analysis. Existing GIS within the region use ArcGIS from Esri as its main software suite. For the purposes of this project, the term "document" is used in a broad sense to include any hard copy or digital drawing, text report, spreadsheet, photograph, or other item with defined content. The types of documents on which this project focuses are those that are geographically-referenced or can be associated with facilities and infrastructure—supporting the concept of an integrated Regional GIS.

The "regional" theme is central to RGIS development and operations. This means that the system will accommodate and provide access to a wide range of geographically-referenced data as depicted in Figure 2. Further, this scope encompasses a wide range of external organizations with which NCORCOG collaborates and shares information—the local community, city and county agencies, utility companies, state agencies, and other organizations.

Figure 2: Regional GIS Data Concept

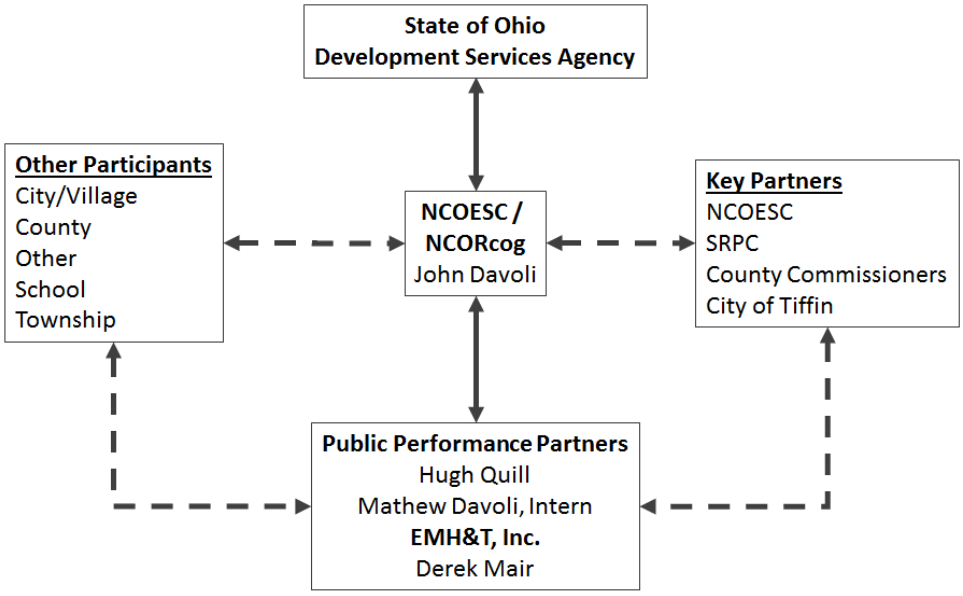


While NCOESC has experience in the implementation of automated systems and applications that directly support its users, GIS is new to the organization. Building a comprehensive GIS database and using software tools for mapping and a range of special projects will be a major undertaking, but the future benefits are clearly worth the investment. The design of the system will take into account existing systems and leverage them with GIS and document management technology to deliver maximum benefits for constituents.

1.3 Organizational Environment

The EMH&T team is working with representatives from a number of agencies who participated greatly in the data gathering tasks. Figure 3 shows the overall project structure.

Figure 3: Project Organizational Structure



1.4 Regional and Infrastructure Environment

The focus of this project is on providing data and tools to better manage facilities and infrastructure for the GIS Partner. This work encompasses a range of work areas covering planning, design, construction, monitoring, operational control of facilities and infrastructure inside buildings and distributed locations.

For the purposes of this project, the collective term "facilities and infrastructure" encompasses all physical assets (in general non-mobile) assets that support the participants' activities covering buildings, grounds, utilities, and transportation assets. Table 1 more comprehensively explains the scope of facilities and infrastructure that are the subject of this study.

Table 1: Listing of Main Types of Facilities and Infrastructure

- Buildings and other structures
- All infrastructure and systems inside buildings (HVAC, electricity, lighting, plumbing, equipment)
- Roads
- Parking areas
- Sidewalks and paths
- Above ground and underground utilities including: electric distribution, steam heat, water, sanitary sewer, storm sewer
- Voice and data communication lines including cabling (copper, coax, fiber) and Wi-Fi transmission
- Signs (road, parking, building)

- Traffic/pedestrian control and warning devices
- Exterior street, pathway, and building lighting
- Landscaping and grounds including lawns, plantings, landscape elements (e.g., walls, statuary, exterior furniture, etc.)
- Fences, gates, other barriers
- Other structures and facilities (bike racks, flag poles, bus stop shelters)

1.5 Project Approach

The following outlines the process used to complete this shared services planning study:

Step 1 – Information Gathering

The project team met directly with all of the GIS Partners to discuss the regional approach and to further learn about their current operations, constraints, and objectives with respect to a regional approach. Emailed survey documents were also used to collect information from partner agencies regarding GIS data needs and GIS/document related business processes. In addition, small group face to face interviews were conducted with specific partners to document resources, staffing, data, and GIS tasks.

These interviews and the review of associated data was instrumental in helping to determine the feasibility of combining resources scattered throughout the county and create an implementation plan. The extensive information gathering provides a sufficient understanding about organizational roles, work processes and flow, and the status of information technology tools to assess the current situation and readiness for expanded use of GIS and document management technology. In addition, this information provides a basis for identification of needs for new or enhanced applications using GIS and document management technology.

Step 2 – Needs Assessment

The project team consolidated the analysis of written information and documentation of current GIS with findings from the meetings and interviews. Then, using this information, the project team developed a set of key programmatic objectives and a conceptual plan for a regional approach.

Step 3 – Recommendations and Analysis

The project team performed analysis of the programmatic objectives to create analysis for future funding, and compiled the suite of programmatic objectives and recommendations into a single plan framework. Of critical importance was the need to outline the governance model for the solution. It was also important to chart a blueprint for sharing costs of implementation and governance for a regional GIS solution that can be used by other cities and counties.

Step 4 – Implementation Plan Development and Presentation

The project team compiled the results from the preceding three steps into a comprehensive Shared Services Plan (this document), prepared an Executive Summary, and prepared a final presentation.

1.6 The Shared Services Model

The goal of a shared GIS services model is to increase GIS efficiency, reduce costs, improve GIS services, and ultimately save taxpayer dollars. A shared service model can mean many different things. For example, it can be as simple as sharing key GIS datasets across jurisdictions, or as sophisticated as one or more of the entities managing GIS operations for the region. Often, as the level of sharing and integration increase, so do the cost savings. However, with increased sharing there can be a loss of some autonomy. In the context of this project, the recommendations will fall somewhere in the middle, maximizing the benefits of sharing while respecting organizational independence.

The partner agencies involved in this study are of varying types and sizes, and have a wide range of GIS needs. Therefore, a key concept of this plan is that each agency will be able to choose which shared services they participate in, thus selecting only those that meet their agency's needs and business practices. Not all agencies will participate in all shared service recommendations. This will allow for maximum flexibility within each agency and not force unneeded solutions or programs on any agency.

There is much precedent for such a shared services GIS model in within the state and nationally as well. A recent study titled "Report on National Survey of Multi-Organization GIS Programs" presents findings and best practices for 38 multi-organizational GIS programs across the country. Some of these programs have operated for more than 40 years and have saved participants millions of dollars. This plan has drawn on that study for many of the best practices concepts and principles for recommendations.

2. SITUATION ASSESSMENT AND NEEDS

2.1 The Seneca County Area

Implementing a successful shared services GIS model in any area is a challenge. Challenges typically include budget constraints, staff levels, and wide geographic dispersal of agencies with varying objectives. Agencies in the area that have historically had GIS capabilities have been of great assistance over the years. Some have been able to provide software and services to support GIS business processes on an as-needed basis for other organizations – outside of their own organizational mission. This model has become less and less feasible as the GIS needs of all agencies have grown.

With the rise of technology including the connectedness provided via the Internet, the public has come to appreciate the need for computer word processing, spreadsheet analysis and emails as a necessary and helpful part of government/agency function, but GIS as a whole does not enjoy this level of public recognition. Many times, the face of a GIS is a public map viewer. Those who use the public map viewers find them indispensable and it saves county/agency GIS staff considerable time by not having to answer basic data questions. Providing effective and beneficial GIS services to both government agencies and the public starts with a strong web presence, in the form of user-friendly GIS web mapping capabilities

In terms of public map viewers, two partners currently have public map viewers of different levels of sophistication and technology implementations. This leads to redundancies in data storage and the potential for incongruent data versions and end-user confusion (i.e. which viewer has the most recent and "best available" data?). Resources and in-house skills both influence how decisions are made, and ultimately whether a GIS program can succeed long-term. The lack of in-house programming skills (e.g. to build a GIS map viewer) will drive the decisions made when implementing a GIS viewer.

Finally, a common theme discussed in the interviews was the staffing and the ongoing need for professional development, likely in the form of training and knowledge sharing. GIS technologies are constantly changing and keeping up with latest technologies and tools can be very challenging when also trying to balance daily GIS maintenance responsibilities. The partners could benefit from collaborating on professional development, both in terms of shared training and sharing GIS experience and best practices.

2.2 Partner Agencies

2.2.1 NCORcog

This organization exists to help area school districts and other political subdivisions reduce their costs while maintaining and improving their services and purchase activities through shared services model. While they have no present GIS capability, they have vision and have been able to represent a very solid management structure which has provided the necessary energy and inertia to bring this project to this point. They will be vital in continuing that role during development and related outreach and oversight during ongoing operations.

2.2.2 NCOESC

The North Central Ohio Educational Service Center offers programs and services to help school districts meet their unique needs. They have an experienced staff with in-depth knowledge on a wide variety of topics. NCOESC currently serves more than 33,000 students from Marion, Seneca, Wyandot and Union counties and has specialists provide contracted services in over 40 school districts in Ohio.

NCOESC does not currently have any GIS capabilities. They will play a key role in this project long-term as the IT function for the shared resources hardware / software.

2.2.3 Seneca Regional Planning Commission

The Seneca Regional Planning Commission is, among other things, currently responsible for maintenance and distribution of the County's Geographic Information System (GIS). They have some hardware, software, and peripherals, but are very limited in their ability to respond to GIS requests. There are only two individuals that staff the office, including the Director. Some recent GIS training was received from ESRI (the GIS software vendor) and this was an important investment in this team. While they have some GIS capability, they do not have the data or resources to handle more than the most routine requests. This is recommended to be upgraded during the course of implementation and ultimately house the GIS Office.

2.2.4 City of Tiffin

The City of Tiffin has been working with GIS for a number of years now. As is true in many engineering offices, they use a mix of AutoCAD and ArcGIS and have beginner / intermediate users in each of those software tools. They do have a number of basic data layers available which indicates that they have a decent level of competency in using the software for more than simple map creation. Tiffin will clearly play a role in the development of the system as well as an agency responsible for the update and maintenance of a portion of the system after full implementation. With the variety of business processes that the City needs to complete, the quantity and types of GIS applications required will be quite large and quite interesting. It will be important for Tiffin to continue to contribute their voice as the system is designed and implemented.

2.2.5 Seneca County

Seneca County agencies represented, by far, the most current GIS capability among the key GIS Partners. The Auditor's office and the Engineer's office are included as County offices. Each of these offices is responsible for key data layers – namely the parcels and the transportation network. The Engineer's office has historically been the keeper of the ESRI licenses and makes them available to other departments upon request. The Engineer is pursuing some of the latest/greatest technologies such as Parcel Fabric and GIS in the Cloud. The Auditor is in the process of making a GIS hire to enhance capabilities for that office and the County in general. The project has a much better chance of success with these two offices participating and contributing time, talents and resources.

2.3 Participating Agencies

In addition to the GIS Partners, the study sought the input from other agencies in the area representing cities, villages, school districts, and townships. The organizations that participated in the study via interviews or completed surveys include the following, which have been classified by organization type:

2.3.1 City/Village

- Village of Attica
- Village of Bettsville
- Village of Bloomville
- City of Fostoria
- Village of Green Springs
- Village of Republic
- City of Tiffin

2.3.2 County

- Auditor's Office

- Commissioners' Office
- Board of Elections
- Emergency Management
- EMS/DPS
- Engineer's Office
- General Health District
- Park District
- Seneca Regional Planning Commission
- Sheriff's Office
- SEIDC
- Transportation Agency

2.3.3 Other

- Fostoria Area Chamber of Commerce
- Fostoria Economic Development Corporation
- OSS Solid Waste District
- Soil and Water Conservation District
- Natural Resources / Wildlife - District 2

2.3.4 School

- Bridges Community Academy
- Buckeye Central Local
- Calvert Catholic
- Clyde / Green Springs Exempted Village
- Fostoria City
- Hopewell-Loudon Local
- Lakota Local
- Mohawk Local
- New Riegel Local
- North Central Academy
- Tiffin University
- Vanlue Local

2.3.5 Township

- Clinton
- Eden
- Jackson
- Liberty
- Pleasant
- Scipio
- Venice

2.4 Common Challenges and Concerns

During the course of the partner interviews, participants were asked to discuss their GIS challenges as well as their concerns regarding shared services RGIS implementation. Below is a summary list of the items that came up in several interviews, indicating that these are common themes shared by many of the partner agencies.

COMMON CHALLENGES

- Data distribution - availability of needed data layers through a central hub
- Data quality and currency
- Data organization - additional data layers are needed
- Lack of adequate funding for training/professional development
- Outreach and training for GIS users

- Letting people know what is available and teaching them what it can do for them
- Need mobile apps for use in the field
- Data collection, data viewing
- Lacking utility data from private agencies
- Supporting other organizations beyond own mission
- Need to manage related historical information, not just current state
- Access to related documents is missing in most cases

COMMON CONCERNS

- Choosing the proper governance model to ensure continuity
- Need full-time access and little to no downtime
- Need advanced GIS personnel to manage work, complete work and support others
- Lacking necessary hardware and software
- Loss of flexibility, autonomy, control of data, etc. due to participating in a shared service
- Need to be able to support legacy applications with updated architecture
- Need to have detailed analysis functions, not just high-level availability
- Multi-phase plan must be actionable and evolving with solid recommendations
- Making data widely available while still controlling access and updates
- Each agency playing their part in a multi-agency response network

Some other obstacles that were included within the National Survey of Multi-Organizational GIS Programs report included the following:

- Legal, policy, or political obstacles to cross-organizational collaboration
- Getting start-up and ongoing funding will be difficult
- Loss of control or effective management of GIS programs in participating organizations

It is the goal of this study to address as many of these challenges as possible through the findings and recommendations, while keeping in mind the concerns voiced by the participants. Section 4 describes these strategic goals and recommendations.

2.5 Facilities and Infrastructure Management Business Processes

A business process is an activity or collection of related activities for which organizations are responsible to meet their program objectives. Each business process follows some flow of steps with a defined result (e.g., completed repair). A large number of activities and business processes depend on various documents and geographic information. In most cases, these business processes are required through one or more "mandates"—ordinances, regulations, executive orders, administrative resolutions, contract, formal policies, and other formal authorizations. Understanding business processes and their dependence upon

documents and GIS data and tools is the first step in defining technology needs. EMH&T has identified numerous business processes related to facilities and infrastructure management that fall into the following categories:

- Infrastructure Project Planning, Design, Execution: All preparation, information collection, specifications, design, execution, management, and monitoring for projects involving construction and major improvements of buildings, sidewalks, roads, utilities, and other infrastructure.
- Infrastructure Monitoring and Maintenance: Inventory, condition monitoring, major and minor repair and maintenance activities, work order management, for roads, sidewalks, utilities, communication lines, and other infrastructure (not including landscaping and interior building work).
- Building and Fixed Asset Monitoring Design, Construction, and Maintenance: Business Processes involving design and construction work for new buildings and interior and exterior work on buildings and related structures (e.g., parking garages) including: a) Routine maintenance and repairs (cleaning, plumbing, electrical, painting, etc.) b) Major improvements and renovations (remodeling, flooring, rewiring, structural improvements), c) Fixed asset (equipment, furniture) management, and d) Installation and management of building systems (utilities, security, building automation).
- Grounds Maintenance and Landscaping: Work related to design, development, and maintenance of landscaping including grass areas, trees, beds, plantings, irrigation systems, and related elements (sculpture, statues, monuments).
- Permitting, Regulatory, and Safety Activities: Application, review, processing, and reporting for compliance with any university, local government, state, or federal permitting and regulatory requirements.
- General Administration and Reporting: Information access, management, and reporting activities and requirements not including in other categories.
- Document and GIS Data Maintenance and Management: Activities that involve maintaining documents and GIS databases and making this information accessible to users.
- Special Projects and Studies: Any special projects, not identified in other business process categories that involve the capture, use, analysis of infrastructure and facility information.

Table 2 identifies and describes the facilities and infrastructure management business processes that are used as a basis to define RGIS needs. Eight of the partner agencies were provided detailed questionnaires which allowed the project team to rate the priority ("H"- high, "M" – medium, and "L" – low) of each business process. This average priority is then reviewed and included in Table 2 to represent the recommended phase to address each business process during implementation.

Table 2: Facilities and Infrastructure Management Business Processes

BUSINESS PROCESS ID / CATEGORY	DESCRIPTION	FOSTORIA	TIFFIN	EMA	EMS	ENG	RPC	SIEDC	SWCD	PHASE
1 - Infrastructure Project Planning, Design, Execution										

BUSINESS PROCESS ID / CATEGORY	DESCRIPTION	FOSTORIA	TIFFIN	EMA	EMS	ENG	RPC	SIEDC	SWCD	PHASE
1-1	Infrastructure Project Planning	M	H			H	M	M	H	1
1-2	CIP Planning and Prioritization	M	L				L	H		3
1-3	Infrastructure Project Design (in-house)	M	L			H	M	L	H	1
1-4	Prepare Specifications/Bid for Infrastructure Project Design	M	L			H	M		H	1
1-5	Prepare Specifications/Bid for Infrastructure Project Execution	M	L			H	M		H	1
1-6	Contractor Bid Evaluation and Selection		L				M	M	H	2
1-7	Surveying/Property Line or Easement Mapping		L			H		H		1
1-8	Infrastructure Project Management	M	L				L	M		2
1-9	Traffic Engineering and Design	M	M							2
1-10	Infrastructure Project Inspection and Approval	M	M			H				2
1-11	As-Built Drawing Preparation and Approval		L							3
2 - Infrastructure Monitoring and Maintenance										
2-1	Work Scheduling/Work Order Generation					H	M		H	1
2-2	Facility Inventory						L			3
2-3	Call/Complaint Processing						H		H	1
2-4	Routine Repair/Maintenance	L				H			H	1
2-5	Emergency Response/Maintenance	L		M	H				H	1
2-6	SCADA Monitoring	L		M			H			1
2-7	Pavement Inventory and Management	L	L							3
2-8	Sign Inventory and Tracking	L				L				3
2-9	Hydrant Flushing/Testing	L								3
2-10	Sewer Televising	L	L			L				3
2-11	Snow/Ice Removal and Treatment	L								3
2-12	Underground Utility Location and Marking	L	H					L		3
2-13	Major Maintenance and Rehabilitation	L	L					M		3
3 - Building Monitoring and Maintenance										
3-1	Scheduling/Work Order Management for Routine Maintenance			H	H				M	1
3-2	Routine Maintenance Execution and Reporting			H	H				M	1
3-3	Fixed Asset Identification and Tracking		L	H	H				H	1
3-4	Building Security Monitoring				H					1
3-5	Preliminary Design and Planning for Building Improvement Projects						M	H		1
3-6	Detailed Specifications and Design for Building Improvement Projects						M	H		1
3-7	Bid Preparation and Contractor Selection						H	L	L	3
3-8	Building Improvement Project Monitoring						L	M	L	3
3-9	Building Operations Monitoring							L		3
3-10	Building Space Management Studies									-
4 - Grounds Maintenance and Landscaping										

BUSINESS PROCESS ID / CATEGORY	DESCRIPTION	FOSTORIA	TIFFIN	EMA	EMS	ENG	RPC	SIEDC	SWCD	PHASE
4-1	Grass Maintenance								M	2
4-2	Tree/Landscape Maintenance								M	2
4-3	Landscape Planning and Design								M	2
4-4	Landscape Project Design								L	3
4-5	Landscape Project Execution and Management									-
5 - Administration and Reporting										
5-1	Call/Complaint Tracking			L	L		H		H	1
5-2	Standard Reporting			L	L				H	3
5-3	Utility Service Account Management									-
5-4	Meeting/Hearing Preparation									-
5-5	Logging, Indexing, and Filing of drawings and documents								H	1
6 - Special Projects										
6-1	Building Space Management Studies						L	M		2
6-2	Electric Distribution Load Analysis									-
6-3	Emergency/Disaster Planning			L	L					3
6-4	Energy Efficiency Studies						L			3
6-5	Environmental Assessment			L			L	H		3
6-6	Hydraulic Modeling/Pressure Zone Analysis		L	L						3
6-7	Inflow and Infiltration Studies		L							3
6-8	Insurance Coverage and Claim Processing			L						3
6-9	Land Acquisition, Leasing, and Sale		L				H	H		1
6-10	Legal Case Research							L		3
6-11	Parking Capacity Evaluation		L				L	M		1
6-12	Site Suitability Evaluation		L				H	H		1
6-13	Special Event Planning and Coordination		L	L	L			H	H	3
6-14	Special Map Preparation		M	L	L		H	H	H	1
6-15	Special Surveys and Research Projects		L	L			M	M	H	2
6-16	Storm Run-Off Calculations and Modeling		L				L		H	3
6-17	Support For Lawsuits and Legal Proceedings		L					L	H	3
6-18	Transportation Modeling/ Planning			L	L		L			3
6-19	Utility Demand Analysis and Projection									-
6-20	Fixed Asset Identification and Tracking			L	L					3
6-21	Building Security Monitoring				L					3
6-22	Preliminary Design and Planning for Building Improvement Projects						L			3
6-23	Detailed Design for Building Improvement Projects						L			3
6-24	Building Improvement Project Management						L	M		2
6-25	Scheduling/Work Order Management for Routine Maintenance									-
6-26	Building Operations Monitoring									-

BUSINESS PROCESS ID / CATEGORY	DESCRIPTION	FOSTORIA	TIFFIN	EMA	EMS	ENG	RPC	SIEDC	SWCD	PHASE
6-27	Building Space Management Studies							L		3
6-28	Watershed Delineation							H		1
7 - Permitting, Regulatory, and Safety Activities										
7-1	Construction Permit Processing		H							1
7-2	Special Use Permitting		L							3
7-3	Environmental and Safety Permit Processing			L						3
7-4	Floodplain Permits								H	1
8 - Miscellaneous/Other										
8-1	Solid Waste Collection and Disposal									-
8-2	Vehicle Routing/Tracking			L	L					3

2.6 Current Information Resources and Systems

2.6.1 Information Technology Architecture

NCOESC is a partner organization that has experience for planning, procurement, installation, management, and support of computer systems and networks in a shared services model. This includes servers, mass storage, and desktop computing resources used by academic and non-academic users. For the purposes of this Plan, NCOESC will represent the Information Technology function. Stated needs will refer to them. Several key aspects of the NCOESC information technology environment will influence design and development of the RGIS:

- While there is no prescribed standard for server operating systems, Microsoft Windows Server is the most frequently used. It is assumed that the RGIS will operate in a Windows Server environment.
- With NCOESC support, there are certain recommended standards that are accepted as a foundation for RGIS development including:

  - Server operating system: Microsoft Windows server.

  - Desktop computers: Windows-based PCs with specifications suitable for different types of users.

  - Database management software: Both SQL Server and Oracle are supported but SQL Server is recommended for the GIS ArcSDE database.

  - Office software: Microsoft Office is the main standard.

  - Mobile devices: Allow use of Windows and Apple iOS tablet and smartphone devices but for the near-term, Windows (version 7 or 8) for notebook and tablet computers is recommended for field-based access.

- A data center with considerable server and storage capacity is required to support new GIS software and applications. Most physical servers are configured in a virtual hardware environment providing efficient allocation of server resources for specific systems. These server resources will be required to support

current Phase 1 GIS development and operations and will be upgraded to support future expansion-based on capacity estimates.

2.6.2 GIS Status and Resources

Current GIS Staffing

There are many users that have GIS experience throughout the Partner Agencies. As far as full-time GIS positions go, there is currently a full-time GIS position in the Tax Map Department who is responsible for all GIS management and operations for that organization and does spend some time helping other organizations with GIS needs. Notably, in SCPRC and the Auditor's office they are configured with GIS software, but GIS capabilities are low – primarily because of the need to perform core duties that are unrelated. The Auditor's office is currently trying to remedy that with the creation of a new GIS position situated in the Auditor's office. There does not seem to be much utilization of student interns to fill GIS capacity at any significant level.

Current GIS Software

ArcGIS software is the primary tool used for GIS applications. The ArcGIS suite includes a set of capabilities that support GIS database maintenance and administration. Currently the County Engineer, County Auditor, SWCD, SRPC, and the City of Tiffin have desktop GIS software installed and configured. The County Engineer also actively uses cloud-based GIS through ArcGIS Online. The County Engineer also is licensed for ArcGIS for Server, but is not actively using that for any mission-critical applications.

The SWCD is worth a special mention in that they are an organization that has really embraced GIS as a part of the way they work. The ArcGIS for Desktop licenses they have are provided by the NRCS and they have approximately 13 users taking part in that. Included among those users are beginner, intermediate and advanced levels of expertise. SWCD has also used ArcPad to some extent as well as custom software developed specifically for them. SWCD's experience with custom software came as a result of frustration with customizing core products and then having configurations become non-functional with software updates.

There are currently two web-based GIS viewers representing Seneca County, both of which are publically accessible. The Engineer's office maintains one that primarily serves the Townships, while the Auditor's office publishes one that is geared toward the public records search. At the best, this arrangement is confusing. In the worst case, one or both of these systems could publish information that is wrong or out-of-date.

Current GIS Database

The layers that have historically been given the most attention are the parcels and transportation network. This has been a joint effort between the Engineer's office and the Auditor's office. The Engineer's office has also invested heavily in migrating the parcel base to ESRI's parcel fabric data model and is nearly complete with that effort at the date of this writing. Other agencies have created a small number of layers, but technical challenges as well as lack of opportunity to spend time in such endeavors means that not much has been developed in terms of GIS data layers.

A step of the information gathering steps presented Partner Agencies with a questionnaire related to geographic data needs. It presented the reader with more than fifty (50) data layers and asked them to

rate each in terms of importance and also to indicate whether the layer was currently available to them digitally. In addition, the reader had the opportunity to offer additional explanation and detail. The results are representing in Table 3, below. The importance factor ("H", "M", and "L") allowed the project team to rate the priority of each data layer. This priority is also included in Table 3 and represents the recommended phase during which the data layer will be addressed.

Table 3: GIS Data Layer Inventory and Priority

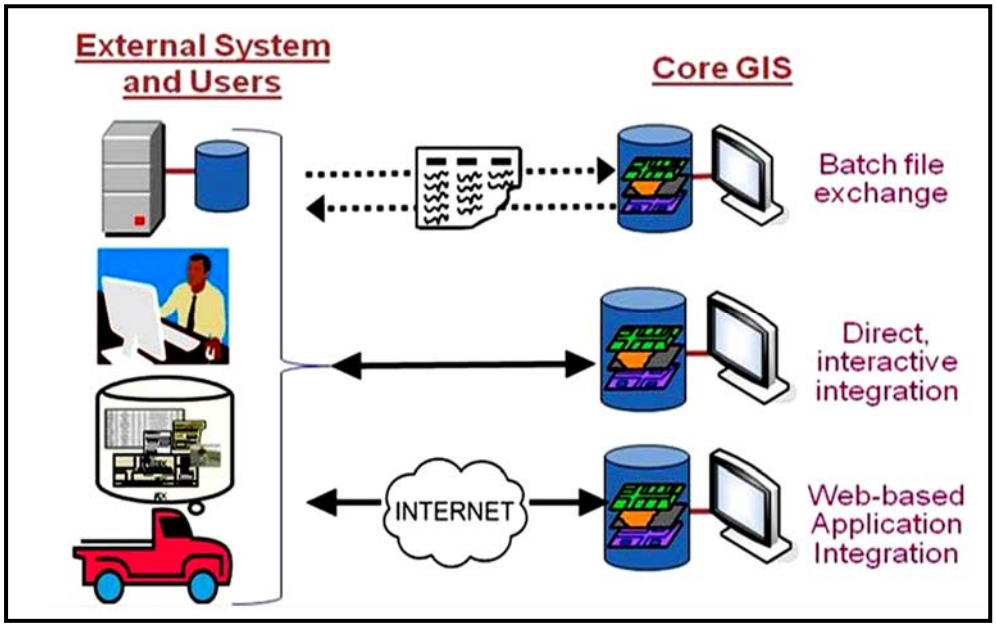
Line	Geographic Data	City/Village	County	Other	Schools	Township	Phase
1	Addresses	**H**	**H**	**H**	**H**	**H**	**1**
2	Administrative Boundaries	**H**	**H**	**L**	**H**	**M**	**1**
3	Agricultural Land	**L**	**H**	**L**	**L**	**H**	**2**
4	Buildings/Structures-Planimetric View	**H**	**H**	**M**	**L**	**H**	**1**
5	Buildings/Structures-3D View	**L**	**L**	**L**	**L**	**L**	**3**
6	Critical Emergency Facilities	**L**	**H**	**H**	**H**	**H**	**1**
7	Complaints and Response	**M**	**L**	**H**	**L**	**M**	**2**
8	Easements	**H**	**H**	**L**	**L**	**H**	**2**
9	Economic and Business Activity Statistics	**L**	**L**	**H**	**L**	**L**	**3**
10	Electric Distribution	**L**	**L**	**L**	**L**	**L**	**3**
11	Elevation—Contours	**L**	**H**	**L**	**L**	**H**	**2**
12	Elevation—Digital Elevation Models	**M**	**H**	**H**	**L**	**M**	**2**
13	Exterior Furniture	**L**	**L**	**L**	**L**	**L**	**3**
14	Gas Transmission/ Distribution	**L**	**L**	**L**	**H**	**H**	**2**
15	Flood Zones	**H**	**H**	**L**	**L**	**H**	**2**
16	Flood/Drainage Protection Facilities	**L**	**H**	**H**	**L**	**H**	**2**
17	Geology	**M**	**H**	**L**	**L**	**L**	**3**
18	Land Use	**L**	**H**	**H**	**H**	**H**	**1**
19	Landscaping	**L**	**L**	**L**	**L**	**L**	**3**
20	Land/Infrastructure Development Project Areas	**L**	**H**	**H**	**H**	**H**	**1**
21	Orthoimagery	**L**	**H**	**L**	**L**	**M**	**3**
22	Parcels and Legal Lots	**H**	**H**	**H**	**H**	**H**	**1**
23	Parking Facilities	**L**	**L**	**H**	**L**	**L**	**3**
24	Parks/Recreation Facilities	**H**	**H**	**H**	**H**	**M**	**1**
25	Permit/License Information	**L**	**H**	**H**	**L**	**H**	**2**
26	Railroad Lines and Rights of-Way	**H**	**H**	**H**	**L**	**H**	**1**
27	Sidewalks, Trails	**L**	**H**	**H**	**L**	**L**	**2**
28	Street/Road Rights-of-Way	**H**	**H**	**H**	**L**	**H**	**1**
29	Sampling/Monitoring Sites	**H**	**L**	**L**	**L**	**M**	**3**
30	Sanitary Sewer Facilities	**H**	**H**	**L**	**L**	**L**	**2**
31	Signs	**H**	**H**	**H**	**H**	**H**	**1**
32	Social/Health Services Program Information	**L**	**H**	**H**	**H**	**L**	**2**
33	Soils	**L**	**L**	**L**	**L**	**H**	**3**

Line	Geographic Data	City/Village	County	Other	Schools	Township	Phase
34	Solid Waste Collection Facilities	**L**	**L**	**L**	**L**	**L**	**3**
35	Storm Sewer Facilities	**H**	**L**	**L**	**L**	**H**	**2**
36	Street/Road Centerlines and Address Ranges	**H**	**H**	**M**	**H**	**H**	**1**
37	Streetlights and Control Facilities	**H**	**L**	**L**	**L**	**L**	**3**
38	Surface Hydrography	**H**	**H**	**L**	**L**	**H**	**2**
39	Survey Control Points/Monuments	**H**	**L**	**L**	**L**	**H**	**2**
40	Transportation Routes	**L**	**M**	**H**	**L**	**H**	**2**
41	Trees	**L**	**L**	**H**	**L**	**H**	**2**
42	Telecommunications	**L**	**H**	**L**	**H**	**H**	**2**
43	Traffic Counts, Flow	**L**	**M**	**H**	**L**	**H**	**2**
44	Transportation/Traffic Facilities	**L**	**L**	**L**	**L**	**L**	**3**
45	Water Utility Distribution	**H**	**L**	**L**	**L**	**L**	**3**
46	Water/Sewer Supply and Treatment Facilities	**H**	**L**	**L**	**L**	**L**	**3**
47	Voter Registration/Election Information/Polling Places	**M**	**L**	**L**	**L**	**L**	**3**
48	Wetlands	**L**	**H**	**H**	**L**	**H**	**2**
49	Zoning	**H**	**H**	**H**	**H**	**H**	**1**

2.6.3 Non-GIS Systems and Databases and Integration with GIS

GIS technology provides tools for integration with external systems and databases. In fact, GIS technology is fundamentally designed to be a platform for the access and use of data, from external systems, that is geographically-related. The ArcGIS software being used by most Partners has tools to enable this integration and many third-party software developers have put in place features (application programming interfaces or “API”) to support integration with little need for complex software or database customization or configuration. Integration of external systems or databases with GIS can operate in one of several modes as depicted in Figure 4. Each of these modes implies a different system and connectivity environment. Which is appropriate for a particular scenario depends on user needs, network connections in place, and technical features available to implement the integration.

Figure 4: Illustration of Modes for System or Database Integration with GIS



In all cases, GIS integration with and external system or database is dependent on a common, unique identifier stored in the GIS and the external system that can be used to establish the integration. That unique identifier could be one of three main types:

- A map coordinate providing a direct means to establish location for data from an external system.
- A common, unique code, associated with a feature or data record that links external data with a feature mapped in the GIS. Some examples which are often used in facilities and infrastructure management environments are, “asset number”, “building name and/or ID”, and parcel ID number.
- An address geocode which in the GIS could include point features (e.g., address points at building entrances) or address ranges assigned to street segments. GIS capabilities can define location for any external database that has an assigned valid address—either by matching with an address point or interpolating along an address range for a street segment.

Table 4 identifies the main systems and databases that are candidates for integration to support the applications explained in Section 4. Other external systems and databases, not identified in this table may also be used to support future applications.

Table 4: Main External Systems and Databases for Possible Integration with GIS

External System	Explanation	Likely Integration Mode
Document management tools	This is not a specific system but encompasses a range of document types and tools available in multiple software packages for creating, accessing, and processing documents stored in many formats (Word, PDF, JPEG, TIFF, etc.). Document management integration is central to this project and will use available tools.	Will use capabilities for document management in existing software (MS Office, GIS, SQL Server) to enable real-time and batch file transfer integration. May use additional, third-party software packages.
Computer-aided drafting/design (CAD)	This refers to AutoCAD and the need for efficient, two-way transfer of data from/to CAD files (e.g., engineering plan and as-built drawings) and the GIS. Line work, annotation, and attributes in CAD system are converted to GIS features and attributes.	Makes use of existing CAD to GIS batch data file translation and exchange—with georeferencing of CAD files if needed. May also use direct, real-time integration tools in AutoCAD and ArcGIS to view CAD and GIS together.
External Web services	This may include access, from the GIS, to a range of publically accessible mapping services (e.g., Google Earth, Google Maps, and Bing Maps).	Use of GIS tools to access and view Web service data and access its services from the GIS interface
External GIS	Involves access to data and possibly direct access to GIS databases maintained by other organizations	In most cases, this involves batch extract and loading of data from one GIS to the other (with file reformatting if necessary) but there are opportunities to make this a more dynamic Web service integration environment.

External System	Explanation	Likely Integration Mode
Work Order and Asset Management System	This is the system for handling work requests, work order generation, tracking work actions, and supporting facility and infrastructure inventory and reporting. Most systems includes a comprehensive database of assets (i.e., equipment and other fixed assets inside buildings). A standard coding scheme is usually used to allow the linking of activities to assets.	Integration could work in batch mode (e.g., extract maintenance history from Asset management database) and load file in GIS or it could work as a real-time connection. Which mode is used depends on the specific application. Integration is facilitated by the standard code used in most systems. It is important to note that existing documents must also be related to assets.

There are other external systems and databases which, in the future, may be considered for integration with GIS (e.g., public safety incident data).

2.6.4 Documents Supporting Facilities and Infrastructure Management

Documents are a key part of the information repository related to facilities and infrastructure management. Managing those documents along with GIS makes a great deal of sense and offers efficiencies related to the storage and retrieval of those documents whether by map-based or attribute-based search.

For this study, we included eight (8) specific types of documents within the questionnaire for GIS and document-related business processes to inquire as to their importance and priority for each business process. As the reader assessed the importance / frequency of a business process, they were also able to indicate the need for associated document. The available document types included the following:

- Engineering Plan Drawings
- As-Built Drawings
- Operation and Maintenance Manuals
- Project Specification Books
- CAD Files
- Field Notes / Inspection Reports
- Maps
- Site Photographs

As the results of these surveys were compiled, some indication of priority and phasing could be determined based on the frequency that a particular document type was counted as key based on the

priority of the associated business process. Table 5 summarizes the importance of the document types that were presented.

Table 5: Types and Priority of Identified Documents

Document Priority	High			Low			None		
Phase of Related Business Process	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Document Type									
Field Notes/Inspection Reports	22	2	7	1	7	15	1	0	11
Maps	21	2	8	1	8	21	1	0	4
Site Photos	18	2	8	3	8	18	2	0	7
Engineering Plan Drawings	16	3	7	1	7	15	6	0	11
CADD Files	16	2	7	3	8	16	4	0	10
Project Spec Books	15	2	5	4	7	10	4	1	18
As-Built Drawings	10	2	6	4	8	11	9	0	16
O&M Manuals	6	0	1	2	4	2	15	6	30

The table has been sorted to promote those document types that are involved in an important way in the highest number of high priority business processes. This makes it clear that while users see supporting office documentation would be nice to have, most users have a strong desire to record the details of what they are seeing / doing in the field through photographs, field notes, inspection reports, and maps / sketches.

It should be clearly stated that planning for the bulk-conversion of all historical records, regardless of priority, is usually a huge proposition in that these records have been accumulating for decades and are quite numerous. A sensible approach is to manage improvement by automating document creation and capture with technology (i.e. digital forms) so that the archive does not continue to grow and then accomplishing the conversion of the older (hardcopy) documents over-time, usually with less-costly labor hours.

2.7 Overview of System Functionality and Application Needs

2.7.1 GIS and Document Management System Architecture and Functionality

The major GIS software functions needed to support the RGIS needs are described in Table 6. These functions are provided off-the-shelf in a commercial GIS software package. Many agencies currently have the majority of this functionality available through licenses with ESRI and its ArcGIS suite of software products.

Table 6: Core GIS and Document Management Software Functionality

Core Software Functions	Explanation
Document Management Functionality	

Core Software Functions	Explanation
Scanning and Post-scanning Processing	Software supporting hardware devices for the optical scanning of hard copy documents and post-scanning processing for the generation of a raster image. Scanners are differentiated by their type (drum feed or flat-bed); media type accepted, including microfilm or other hard copy; size of media accommodated; speed in inches or pages per second; ability to handle black & white, gray tones, or color; capability for automatic processing like speckle removal or file compression; and ability to duplex (two-sided scanning). The scanning software includes the required device drivers, functions for users to adjust scanner settings (speed, contrast), image display and review, and post-scanning processing (image cropping, contrast adjustment, image rotation, or raster file translation.
Database Indexing and Posting to Document Repository	This capability, normally provided through a relational database package, allows a user to define several database fields for identifying and describing a raster document or drawing. These fields can then be used to drive search and retrieval for the documents and drawings. This requirement includes the capability to design intelligent data entry forms, data quality control, automatic data entry through selective optical character recognition, and other database indexing tools. Depending on the document management software in use, there may be a process to import a document and its index data into a document repository managed by the software.
Database Query and Document Access	This includes the standard capabilities of a database package (normally a relational database package) to perform queries of the database to select and retrieve desired documents or drawings. Searches would be performed on database indexes entered for each drawing or document. Searches could return a single document (e.g., if the search is based on drawing #), or the search could be more global involving multiple indexes to select multiple drawings that satisfy the criteria.
Image Viewing and Manipulation	This functional area covers the full range of interactive workstation controls allowing a user to view and manipulate images (large-format or small-format) viewed as windows on a large-format workstation screen. Included are standard functions like pan, zoom, rotate, contrast and color enhancement, and many other useful display features.
Document Printing	Printing refers to small-to-medium format printing of documents, including letter and legal size (8.5" x 11" and 8.5" x 14") up to ANSI “B” size (11” x 17”). This printing accesses local or network-accessible devices (normally using a Microsoft Windows-based print configuration) commonly using black & white laser and color ink-jet printers.

Core Software Functions	Explanation
Large-format Plotting	Plotting of large-format documents requires plotters supporting ANSI C-Size (22" width) or larger. These devices may be low to medium speed ink-jet color devices or high-speed laser potters (usually just black & white). Supporting these large-format devices usually requires special hardware drivers and software that may support batch and remote plotting.
Automated Mark-up and Redlining	This capability allows an operator to add notation or mark-ups to a document at a workstation in the office or field using a mouse or pen-based entry method. These mark-ups are saved in a specific layer (associated with the Main document), or a new version of all of the drawings is created and stored.
Forms Management	Forms management software provides special functions for the creation and use of a special form with a standard layout (partitioned sections, check boxes, etc.). The software creates a form view and provides for formatted and intelligent entry with error checks, pick lists, etc. The entered content of the form is stored in a text file or database. The forms management software is invoked to generate formatted displays or hard copy printing.
GIS Functionality	
Central Geographic Data Management	Database administration tools for managing data access by users, locking data during edit, providing version control, and other spatial data management functions.
Metadata Maintenance and Management	Functions to support the automatic generation and user entry of metadata for map layers and map features. These functions populate specific fields in a metadata schema as new GIS data is loaded or as existing layers are edited.
Tabular Attribute Data Management	Software environment and capabilities for storing and managing database attributes linked to map features in the GIS database. May involve use of a vendor-proprietary system for attribute storage or a commercial relational database management package.
GIS Data Capture and Editing	A range of interactive and batch processing functions for entry of map data through such means as board digitizing, coordinate geometry entry (COGO), scanning, and heads-up digitizing, along with capabilities for editing GIS data, performing error checking and resolution, map rectification, and transformation of coordinate systems and map projections.
Map Design and Composition	Interactive capabilities for the design of map plots and displays, automatic creation of thematic maps and legends, and modifying map symbology and annotation for custom map displays.

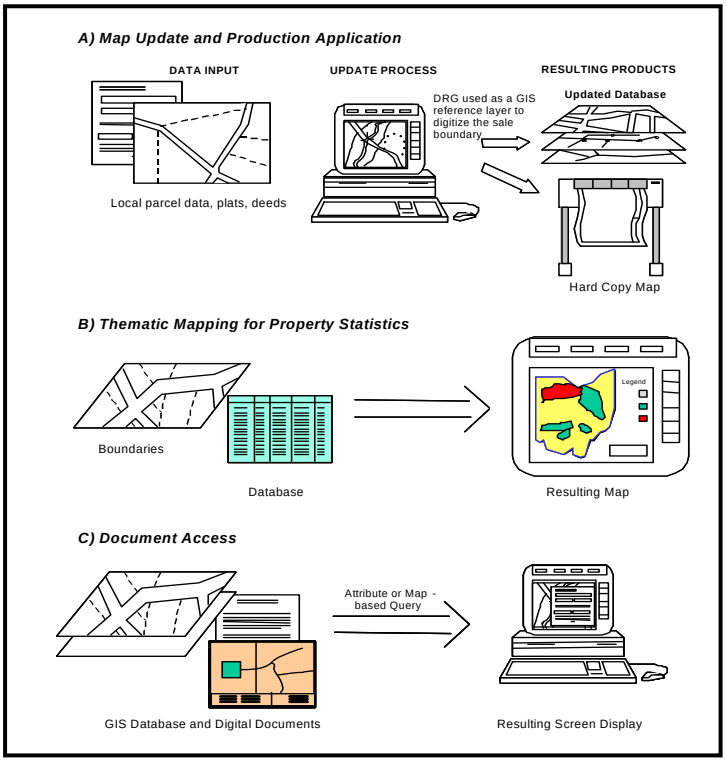
Core Software Functions	Explanation
Basic Geographic Query and Display	Basic tools for performing attribute or map-based queries, including display of attributes for a selected map feature or identification of map features that satisfy selected database criteria. This category also includes tools to create special thematic maps where areas or linear features are shaded based on their attribute values or classification.
Server-based Web GIS Query and Map Display	Basic query and map viewing functions accessible on a server using a Web browser.
Address Matching/ Incident Mapping	Automatic mapping of point features from an imported file with site addresses through interpolation along a street segment coded with address ranges (right and left side of street). Locations are mapped as point symbols with designated offset and user-defined symbols.
Tabular Report Design and Production	Allows users to design tabular reports from GIS data or derived from GIS applications.
Area and Distance Measurement	Interactive or batch functions that will calculate the length or perimeter of a line or polygon feature or the area of a polygon feature.
Radius/Buffer Zone Analysis	Buffer area automatically generated around a point, line, or polygon feature based on a distance input. The buffer zone created can then be used to perform GIS operations within that area.
Map Feature Aggregation	A process of generalization in which features falling inside defined areas are counted, and that count becomes an attribute assigned to the areas. The aggregation process can also be described as point-in-polygon, line-in-polygon, and polygon-in polygon overlay. This function is useful for generating counts of features falling within predefined boundaries (maintenance districts) or ad-hoc areas delineated by a user.
Map Overlay Modeling	Use of spatial modeling capability to combine multiple layers to derive a resultant layer. It normally uses weights assigned to features on map layers that are combined to generate a result. One example might be an analysis of runoff potential based on information on slope, land cover, and drainage features.
Network Analysis	Spatial analysis operations based on linear networks (e.g., road or pipeline systems), including such operations as “shortest path tracing” and “region allocation.” Network analysis capabilities in GIS packages often allow users to design network models based on attributes of network segments.

Core Software Functions	Explanation
Dynamic Segmentation	A network management capability that uses a linear referencing scheme to allow the ad-hoc definition of point locations and segments of the network based on linear offsets from defined anchor points on the network. This allows a user to define information about physical conditions and events on a network without having to create fixed network segments or points. Such a capability is most frequently used for a road network.
Terrain and 3-D Data Processing and Analysis	Capabilities for storing three-dimensional data normally in a grid or triangular integrated network (TIN) format with functions for 3-D analysis such as contour mapping, 3-D display, draping of map features over a 3-D display, slope and aspect analysis, etc.
Raster Image Processing Capabilities	Capabilities for manipulation and processing of raster images (e.g., digital aerial photos or orthophotography, satellite images), including functions for the import and rectification of raw imagery, digital image enhancement, and automated classification of multi-spectral imagery.
Application Development Tools	Programming environment for customizing applications accessing software functions provided by the package, including proprietary languages included with the GIS software package or industry-standard tools (e.g., C++, Visual Studio, scripting languages, Web development tools) that may be used for application development.

2.7.2 Overview of GIS and Document Management Applications

RGIS applications define the specific use of automated tools and data to generate a certain result or product needed by users. That product may be a retrieved document or drawing, hard copy map or map display, an updated file or map layer, statistics resulting from a geographic inventory or analysis, or some other tangible result. An application that uses the basic software tools of commercial software packages (relational database, GIS, office automation, etc.) provides easy-to-use screens and menus, combinations of individual GIS functions to support a more complex process, and customized outputs. Figure 5 illustrates several types of GIS applications.

Figure 5: General Concept of Applications



GIS, relational database management, and other software packages provide a wide range of basic functions for data query and exploration, mapping, analysis, and reporting that can be used to build an almost unlimited set of applications that meet users' needs for real estate data access and management. This range of GIS applications useful to the RGIS may be generally described as falling into one of four types:

DM: GIS and Document Database Update, Maintenance, or Export—this category includes applications that allow authorized users to easily update the GIS database and new or edited documents. For GIS database update, this includes GIS data capture in the field or office-based updates from available sources along with associated quality control and quality assurance activities. For document database update, it includes import of documents already in automated form with any required document format conversion and scanning and indexing of hard copy documents. This category also includes the extracting and exporting of data (and reformatting if necessary).

QV: GIS and Document-based Queries, Retrieval, and Visualization—this application category includes attributed-based or map selection queries to retrieve information or documents associated with a map location or GIS feature(s). It also includes more complex GIS queries that select and identify map features with custom display or highlighting based on attribute criteria entered by the user.

CM: Custom Mapping or Document Production—Use of GIS and document editing capabilities to design a custom map product with appropriate border, title, legend, symbols, colors, etc. and custom document displays involving extract of document data, mark-up, or enhancement for use in a report or other product. Custom maps may be configured as Web services allowing users to access current data and use simple commands to select geographic area and features to display.

SA: Spatial Analysis—Use of capabilities and functions in the GIS software (or external packages) for performing analysis of spatial patterns and relationships and generating results in map and/or database form. This includes a range of network analysis applications (e.g., hydraulic flow modeling, transportation route, proximity analysis, overlay modeling using multiple map layers).

This end result or product of a GIS application may include any of the following:

- Answer in response to a particular system query (e.g., response to question about the age or condition of a pipe segment).
- Retrieved digital drawing or document based on map selection or attribute query.
- Updated GIS or document database from an application designed for efficient GIS data maintenance, document import or scanning, etc.
- New GIS layer or extract derived from the GIS database in a desired file format (e.g., GIS data extracted for a project area for use in an engineering design or planning project and formatted as a Shape File or AutoCAD DWG).
- Database table derived or extracted from the RDBMS (e.g., data for a specific area or part of a pipeline network for input to an external pipeline flow model).
- Hard copy or screen map display using GIS functionality or a Web service that provides a dynamic, interactive map using current GIS data and map display choices for the user.
- Hard copy or screen displayed text report or raster document.

It is assumed that RGIS applications will use, to the greatest extent possible, off-the-shelf (OTS) functions of existing software (GIS, relational database, office automation) as well as special-purpose packages that may be in use or acquired for future use. It is also assumed that many of these applications will be Web-based which allow users to access the applications and GIS database through a Web-browser (without a need for desktop software). Most of the applications presented in this section will make substantial use of the existing OTS functions and interface but in many cases some configuration or customization will be required. In a few cases, major development work may be required for implementing an application. The following types of customization may be required:

- Creating new or modified graphic user interfaces that simplify and add efficiencies for users to get desired results
- Automating access or integration with external systems or databases, or import/export of files with external databases and applications (e.g., Asset management integration with GIS)
- Designing and developing “intelligent” interactive forms for attribute or graphic data entry (includes use of dropdown pick lists, automatic error checking, and other controls)
- Developing application scripts that can be launched by a simple menu pick and combining a number of individual functions
- Designing and storing, for later use, custom map displays or textual reports

- Creating data quality control and quality assurance applications using validation tools provided by the software package
- Creating a library of standard queries that can be accessed through a menu
- Programming complex analysis functions using basic GIS processing commands
- Building custom numerical or GIS analysis models (polygon overlay, network tracing) using modeling tools provided with the GIS package.

Table 7 lists the major GIS applications identified for potential development and deployment. These applications are organized into the four categories explained above. The table describes the application, expected products or results, and the user access mode. Table 7 also presents technical information about the potential applications. First, it describes the environment and devices for user access. The column labeled "environment" identifies whether the application operates in a Web-based or on a desktop computer (operating locally or on an office network). Some applications would be configured and set-up in a desktop environment but deployed for Web access. The table identifies external (non-GIS) systems and databases that would support or operate in conjunction with the GIS to enable the application. The last column gives a general picture of the level of customization required to design and deploy the application. As explained above, this may use off-the-shelf menu capabilities of the software or might involve some level of customization (custom interface, map template design, interface with external system, or more complex programming work).

Table 7: Potential GIS/Document Management Application Details

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM1: Hard Copy Document Indexing	Efficient, highly automated process to scan hard copy documents (page size and large-format drawings), perform routine quality checks and image enhancement, enter index fields (including links to GIS features), and move to document repository. This is for use with new hard copy documents after the initial database has been built. Menu-driven indexing tools will support population of index data for scanned and already automated documents (TIFF, PDF, or other format).	No application in production use	Digital document with index data	O	D	D	Document integration	2
DM2: Document Image Enhancement	Automated procedures to perform special enhancement to improve image quality (contrast, brightness, speckle removal, etc.).	No application in production use	Digital document	O	D	D	Document integration	2
DM3: Scanned Document with OCR	Access optical character recognition for scanned text document to convert to text format and save in Word, PDF, or other document format.	No application in production use	Digital text document	O	D	D	Document integration	3
DM4: Import and Reformatting of Digital Documents	Import of documents from other sources and use of automated tools to reformat documents into a different file format so that it can be used more effectively by specific applications (e.g., JPEG or TIFF to PDF format).	Some image enhancement work being done with Acrobat and other software.	Digital document (reformatted)	O	D	D	Document integration	2

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM5: Import of CAD Drawings or GIS files	Easy-to-use tools to import AutoCAD DWG or DXF files or GIS data (e.g., Shapefiles) to support database update. Provides all capabilities for: a) selection of files, b) translation of AutoCAD files, c) AutoCAD layer and object import into proper GIS data fields, and d) geographic registration to the GIS if necessary. The application might also have to address the need for text annotation import and assignment of proper symbology in the GIS. NOTE: Could benefit from a set of layering standards for AutoCAD files and standards for georeferencing—obviously accompanied by formal requirements for contractor submittal.	No application in production use	Data file for export or import	O	D	D	CAD integration (batch)	2
DM6: Quality Assurance Checking and Posting	Use of GIS software tools with improved procedures that guide a process of automated and manual checks in data quality—to meet established standards for graphic integrity, map feature content and accuracy, annotation, attribute accuracy, file naming, etc. This application drives periodic data updates and posting to the active GIS database. Specific application parameters would be established for different GIS datasets (geodatabase feature classes).	Much of this is in production with the Parcel Fabric, but is lacking for other Feature Classes	Enhanced "rules" for Feature Classes in geodatabase, Updated GIS dataset, Hard-copy tabular Report	O	D	D	NONE	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM7: Metadata Entry	Use of automated tools and templates that are incorporated into ArcGIS data models and tools. The application would reference templates that comply with metadata standards (FGDC/ISO) and support a mix of automated and manual population of metadata fields. Metadata entry is normally a part of the GIS update process.	Some feature-level metadata (e.g., source, dates) captured but no formal dataset metadata	Updated GIS database, Hard-copy tabular Report	O	D	D, W	Possible batch file load from external database	3
DM8: Parcel/Real Property Import and Update	Includes tools and automated steps to create a parcel boundary layer in GIS with selected real-property information (owner, appraised value, area, improvements). This includes import of parcel boundaries and data from other sources and tools to improve accuracy of parcel boundaries based on use of legal records (deeds, surveys) or field data collection. May also include the capture and storage of parcel-related documents (legal records).	Opportunities exist for a more efficient work flow and data sharing.	Updated GIS dataset	O	D	D, W	External GIS	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM9: Utility Data Update from Drawings	Menu-based tools to facilitate update of underground utility lines and related surface features from engineering plan and as-built drawings. It provides all functions for extraction of features (e.g., from AutoCAD drawings) or heads-up digitizing and attribute entry. Application includes quality checking and posting to the master GIS database. This update capability should be rule-based to facilitate and enforce the logical connectivity of features and attribute domain checks and QC checks and correction for proper geometric and logical connectivity. These update applications would be adapted to support update for specific utilities.	ArcMap update tools from atlases have been used. May be able to customize process to eliminate some manual steps.	Updated GIS dataset	O	D	D	CAD integration (batch)	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM10: Road/Parking Area Update	Menu-based tools to facilitate update of paved areas (i.e., roads and parking areas). It provides all functions for extraction of features (e.g., from AutoCAD drawings) or heads-up digitizing (from raster drawings or orthoimagery) and attribute entry. Application includes quality checking and posting to the master GIS database. This update capability should be rule-based to facilitate and enforce the logical connectivity of features and attribute domain checks and QC checks and correction for proper geometric and logical connectivity. These update applications would be adapted to support update for specific pavement areas. Note: There is some ambiguity in determining feature class for updates driven by re-paving actions (e.g., classified as road, service drive, parking area). This requires clear mapping rules to guide consistent update actions.	No application in production use.	Updated GIS dataset	O, F	D, N, T	D, W, FD	CAD integration (batch)	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM11: Building Footprint and Wire Frame Update	Use of ArcGIS georeferencing and data import of building floor plans to GIS layer. Structure GIS polygons for building exterior and rooms. Application is driven by new building construction and renovations. Ideally, this would be enabled by import of CAD files and capture of attributes for building and room number when assigned in Asset Management System. Application should accommodate field capture of data if CAD data not available.	No application in production use	Updated GIS dataset	O	D	D	CAD integration (batch)	3
DM12: Easement Capture and Update	Use of interactive tools to capture the boundaries of existing or new easements (utility, drainage, transportation from plats and legal descriptions), and entry of this data in a GIS layer. Note: Source for easement data capture and update in GIS is not consistently available in convenient, accessible form.	No application in production use	Updated GIS dataset	O	D	D	NONE	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM13: Field-based GIS Capture of Infrastructure	Use of GPS-enabled and pen-based handheld computers and custom applications in the field to capture map feature and attribute information for above ground and underground infrastructure assets (utilities, street lights, structures, sidewalks, etc.). Underground utilities may be captured during the construction process as ditches are exposed. The application would provide an easy-to-use menu interface for the data capture work and a feature to allow easy upload of data to the GIS database.	Currently in place but enhancements might improve efficiency	Updated GIS dataset	F	N, T, G, S	W, FD	NONE	3
DM14: CAD File Output from GIS	Generate an CAD DWG file based on the extraction of a specific geographic area and selected layers from the GIS. This requires the creation of rules that define the export of specific GIS features to proper layers in CAD.	No application in production use	Data file for export or import	O	D	D, W	CAD integration (batch)	2
DM15: Sign Inventory and Update	Use of GPS-enabled capture devices or pen-based handheld computers and custom applications in the field to capture signs (parking, traffic, and building) and basic attributes (type, condition, etc.). May also include capture of photograph with index to the map sign feature.	No application in production use	Updated GIS dataset, Linked document (site photo)	O, F	N, T, G, S	W	NONE	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM16: Address Data Capture and Updates	Custom interface that allows entry of points representing unique addresses (building entries and other addressable features).	Addresses assigned as points associated with building locations but are not up-to-date	Updated GIS dataset	O	D, N, T	W	External GIS	4
DM17: Street Centerline and Address Range Update	Custom interface for the update of road centerlines (segments broken at intersections) and basic set of attributes (e.g., surface type, number of lanes) also includes the capture of from-to address ranges. Note: this GIS layer supports routing and incident mapping related to addresses. Note: Address ranges are not currently assigned to street segments and may not be needed—because of the campus street configuration and building locations.	Current centerlines from State	Updated GIS dataset	O	D, N, T	D, W	External GIS	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
DM18: Report on Maintenance Actions not Tracked by Work Management System	Purpose is to provide information for GIS data update for maintenance activities that currently could "fall through the cracks". Examples include routine activities such as pavement/sidewalk patching, sign installation, utility work. This could be deployed on a tablet computer or smartphone and allow a field person to capture a redline markup (on ortho imagery) and enter key attributes for the activity. The mark-up and data (with tagged GPS position) would be directly accessible to GIS staff—to be used for GIS update or to trigger a field visit to capture additional information for updating the GIS database.	No application in production use	Mark-up data captured in field, Updated GIS dataset	F	N, T, S	W	NONE	4
DM19: Other GIS Data Capture and Update	This is a general category to encompass the capture of features not covered by the other categories. This would employ field-based or office-based tools to capture location and attributes	N/A	Updated GIS dataset	O, F	D, N, T, G	D, W, FD	CAD and document integration supporting import, geo-registration or heads-up digitizing.	2 to 5
QV1: Geographic Navigation and Selection for Area of Interest	Menu-driven tools to allow a user to select a geographic area based on a map pick. Allows user to select specific location.	Use of ArcMap interface currently. Can be customized in Web-based interface.	Screen map display	O, F	D, N, T	D, W	NONE	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV2: Ownership Search and Notification	Application supports investigations for property acquisition investigations or other research on ownership of parcels. It provides a menu-based tool for selecting a location (map selected point or parcel or a parcel to generate a buffer distance around the point or parcel). Based on the buffer distance which would be selected by the user, the application identifies all parcels that fall fully or partially inside the buffer. Ownership information (name, address, other contact info) is accessed and imported to a table. The data in the table may be used to generate letters or mailing labels for postcard notification or for the automatic notification by other means including email or a manual or automated phone call.	Some ad hoc use of the GIS but enhanced application would add efficiencies	Data file for export or import, Screen Display, Hard-copy Map, Tabular Report	O, F	D, N,T	W	External GIS	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV3 Real Property Transaction Tracking	This application relies on a updated database that captures historical information on real property, land and improvements on the land, for all land in which an agency has an ownership or use interest (i.e., land that: is currently owned, has been sold in the past, has been acquired through purchase or gift, has easement or use rights/restrictions, is leased, or is being leased to another party). These categories of real property interest, with dates, would be attributes assigned to parcels and would be used for query and map display. The application includes tools for update and for query and map display	Not currently in place.	Updated table, Screen Display, Hard-copy Map, Tabular Report	O	D, N	D, W	Possible document integration (property records)	4
QV4: Pavement Management	Access and display of paved areas with information on surface type and condition and tools to evaluate costs and priority for major maintenance, repaving, or striping work. Includes tools for projecting costs for repaving work. Must take into account paving surfaces corresponding to different GIS feature classes (road, drive, parking area).	Not currently in place.	Screen display, Hard-copy map, Hard-copy tabular report	O, F	D, N	D, W	NONE	5

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV5: Cut/Paste/ Customize Map Display for Reports and Presentations	This application provides interactive tools allowing a user to extract a portion of the map for markup and customization and for pasting into a Word document or Presentation file (PowerPoint). Uses standard Windows tools for cut-and-paste and standard graphics tools to allow mark-up (addition of notes, title, arrows, special symbols, etc.). This application could be customized to support dynamic linking between custom GIS displays and presentation tools (e.g., PPT).	Used in ad hoc manner as needed.	Screen display, New document	O	D, N	D	Document integration (Office software)	3
QV6: Interactive Web Map Selection and Display (Public Internet)	This is a general application area encompassing a range of query and mapping applications designed specifically for the public. This would include the general public and external organizations. This Web environment offers easy to navigate tools for query and map display. This application area also encompasses GIS support to existing web pages to enhance their functionality with mapping.	Not currently in place	Screen Display with maps and information in response to queries	O	D, N, T	W	External Web service (integration with GIS)	4
QV7: Distance and Area Calculator	Provides an easy-to-use tool allowing users to measure distances and areas through interactive mouse picks on a map display. Could use directly from ArcMap interface or customized for a specific user interface.	Tools available and used as needed	Screen display	O, F	D, N,T	D, W	NONE	2 to 4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV8: GIS for As-built Drawing Verification	Import and georeference contractor As-built drawings for overlay with selected GIS data layers to check As-built drawing content and accuracy. Also may include a field-based tool designed for laptop or tablet computers to support field inspections and approval after as-built submittal.	Not currently in place	Screen display	O, F	D, N, T	D, W	CAD integration	3
QV9: Digital Submittal and Review of Construction Plans and As-Built Drawings	Based on digital plan drawings submitted by engineering contractors, plan would be distributed to necessary parties electronically and plan review and mark-up would occur in a digital environment using mark-up tools. Could be set-up in a collaborative environment with access to a drawing set on the server by all reviewers (with red line mark-up in which application tracks mark-ups by multiple reviewers). Application would have basic tracking tools to track status.	Not currently in place. No formal, mandated standards for submittal.	Marked-up document, Tabular report on review status.	O	D	D	Document integration CAD Integration	5
QV10: Site Evaluation for New Construction Project	Use of GIS to support evaluation of sites for new facilities. Standard GIS interface would be used to display appropriate data layers and interactively examine key requirements for the development (size; location relative to roads, parking facilities, and buildings; slope/terrain variables). The facility could be digitally "placed" in the GIS (temporary Feature Class) and multiple scenarios could be developed and displayed for evaluation.	ArcMap tools used for some projects	New (temporary) GIS data layer, Screen Display, Graph or Chart	O	D	D	Document integration	5 to 6

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV11: Map-based Standard Maintenance/ Repair Activity Reports	Standard report generation, augmented by map displays listing infrastructure repair and maintenance action and summary statistics for area and type of maintenance. This would involve integration with asset management. Point or polygon features representing work order location would be displayed with a color or symbol denoting the work order type or status.	Not currently in place	Screen display, Hard-copy map, Hard-copy tabular report	O	D, N, T	D, W	Asset Management	4
QV12: Field-based Query and Access to Engineering Drawings	Provides a menu interface allowing a user to pick a map feature or delineate a geographic area to retrieve and display automated documents (plans or as-builts). Interface and display format would be designed for optimal display on notebook or tablet computers. The application would be customized to allow a selection of the type of document associated with an infrastructure asset (e.g., road segment, water or sewer facility, traffic signal). This involves the storage of documents with a link to a location or infrastructure map feature in the GIS database. The application would allow interactive selection on the map display or a tabular query with a drop down list allowing selection of the appropriate document(s) which may include plats, engineering plans, as-built drawings, etc.	Not currently in place	Screen display, Hard-copy document	F	N, T	W	Document integration	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV13: Desktop Query and Access to Engineering Drawings	Provides a menu interface from a desktop computer allowing a user to pick a map feature or delineate a geographic area to retrieve and display automated documents. The application would be customized to allow a selection of the type of document associated with an infrastructure asset (e.g., road segment, water or sewer facility, traffic signal). This involves the storage of documents with a link to a location or infrastructure map feature in the GIS database. The application would allow interactive selection on the map display or a tabular query with a drop down list allowing selection of the appropriate document(s) which may include plats, engineering plans, as-built drawings, etc.	Not currently in place	Screen display, Hard-copy document	O	D, N	W	Document integration	3
QV14: Field-based Query, Access, and Search of Document Books	Custom interface designed for notebook or tablet computers in the field to carry out attribute-based or map-based queries for digital documents (e.g., Operations and Maintenance Manuals, Project Specifications, other page-size documents). Application would open these documents and allow for text based searches.	Not currently in place	Screen display (searchable document)	F	F, N	W	Document integration	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV15: Desktop Query, Access, and Search of Document Books	Custom interface designed for desktop computers in the field to carry out attribute-based or map-based queries for digital documents. Application would open these documents and allow for text based searches.	Not currently in place	Screen display (searchable document)	O	D, N	W	Document integration	3
QV16: Construction Project Status Tracking and Mapping	A menu-driven query and map display application that allows users to select types of utility or road projects for map display. The application would allow users to view a campus-wide map or to zoom into a smaller area to display projects as point features or areas shaded based on selected attributes. Attributes about projects would be displayed from a map pick. Summary tabular report on project status (from design through construction) would also be an option.	Not currently in place	Screen display, Hard-copy map, Hard-copy tabular report	O, F	D, N, T	D, W	Asset management	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV17: Custom Query for Utility Locates	Provides a custom menu interface specifically for locating underground utilities in response to "before you dig" requests (which come through OUPS or other means). The application allows the user to specify an area and obtain a map display showing the location for underground utilities and any available documentation (field notes, engineering drawing) to support field location and marking. The application would also allow entry of information documenting the field locate action. Likely, this would have limited access and not be available for general public use.	Not currently in place	Screen display, Report, Hard-copy map	O, F	D, N, T	W	Document integration CAD Integration	4
QV18: 3-D Visualization for Development Planning	Use of GIS base map data and orthoimagery along with three-dimensional terrain data and three-dimensional data of physical features (buildings, etc.) to support evaluation of a proposed development site. This is a planning and decision-support tool using special visualization software to provide 3-D perspective views and the ability to add proposed development features to generate alternate renderings of the development.	Not currently in place	Screen display, Hard-copy map or 3D image	O	D, N, T	D, W	CAD integration	6
QV19: Traffic Disruption Analysis	GIS query to show status of construction activity which will cause road closures and disruptions to traffic flow or access to parking areas	Not currently in place	Screen Display	O	D, N	W	NONE	5

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV20: Tree Inventory and Tracking	Supports the capture of information on location, characteristics, and maintenance actions (treatment, trimming, removal) of individual trees and shrubs. The application allows queries and map display with specific tree/shrub information	Major work already done but ongoing updates required	Updated GIS dataset, Screen Display, Hard-copy Map, Hard-copy Tabular Report	O, F	D, N, T, S	W	NONE	4
QV21: Roof Replacement/ Maintenance Tracking and Cost Evaluation	This application is designed to support this specific maintenance area (roof repair/replacement) which is significant in terms of cost, staff time, and maintaining the integrity of buildings. Application provides a custom query to select one or more buildings and access maintenance history and cost information. The application displays characteristics and maintenance history and then provides an easy to use tool to enter characteristics (square footage, roof configuration, materials) for roof maintenance or renovation and, based on loaded parameters, estimate costs of the project and to check on bids by contractors. The application would allow the delineation of a roof area from orthoimagery and allow the user to enter an estimate of roof slope to provide a reasonable estimate of square footage...	Not currently in place	Screen display—forms and maps, Report or table	O	D	D	Asset management	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV22: Special Event Planning for Traffic Flow and Parking	Use of GIS as a basis for real-time or near real-time information on road or lane closures that could disrupt traffic flow. This would require specific information on active projects, their timing, and how traffic or access to parking areas could be disrupted,	Not currently in place.	Screen display, Hard copy maps	O	D	D	PTS parking database (batch file transfer)	4
QV23: Public Safety Incident Mapping	Use GIS to access incident data from public safety agencies to map incidents on base map—point features tied to an address or location symbolized or colored by incident type. Query options would allow access to incidents by type, date range, time of day, and other factors. This is not meant to be a real-time application but one that accesses historical incident data as a tool for planning.	Not currently in place	Screen display of incident map, Report on incidents by type and date	O	D, N	D, W	Batch file transfer from public safety dispatch or records management system	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV24: Site Photo Capture and Retrieval	Field based application—using smartphone, tablet computer, or digital camera with GPS capability allowing user to take a picture of a site, tag this with a location, and efficiently enter attributes or keywords (ideally from pick list) and have this stored in a central database for access from GIS or attribute query. This could be used to support work requests (e.g., painting request), to provide additional documentation on a completed work order, or to support field inventory work. This capability should be integrated with the work request/work order system to support maintenance activities.	Not currently in place	Digital photo with location information and attributes	F	N, T, S	W, FD	Document integration	3
QV25: Query and Map Display for Asbestos and Hazardous Materials	Custom GIS query and display of sites (building locations) where there is storage of hazardous materials or known cases of asbestos. The application would shade buildings, or centroid points for buildings, based on type of material.	Not currently in place	Screen display, Hard copy map, Tabular report	O, F	D, N, T, S	W	EH&S databases	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV26: Access to Photos of Standard Equipment and Infrastructure	This application would create a "digital catalog" of standard equipment or infrastructure types (handrail type) to support maintenance activities—to provide visual information to verify that standards are being followed when repair or replacement is required. There would be a query tool to access photos in the catalog by name, ID numbers (model, material information), and other information. This could be a feature access by the asset management system to support work order preparation.	Hard copy photo book has been used in past but no current application. New Trimble unit with photo capability-see picture of specific piece of equipment.	Screen display, Hard copy map, Tabular report	O, F	D, N, T	D, W, FD	Document integration Asset Management	4
QV27: Query and Access to Parking Sign Information	Use basic query and display capabilities to display map of parking sign locations and access information about the sign by interactive selection.	Not currently in place	Screen display, Hard copy map, Tabular report	O, F	D, N, T	D, W, FD	PTS Parking database	4
QV28: Visualization for Real-time Parking Occupancy	Use GIS as map-based tool to visualize, in near-real-time, occupancy at parking areas using data sent from sensors at the parking areas.	Not currently in place	Screen display, Hard copy map, Tabular report	O	D, N, T	W	PTS parking databases in real-time mode	6
QV29: Equipment Location Query and Display	Mainly for preventative maintenance—building location and maybe engineering drawing of O&P. Query tools allow for attribute-based or map selection for a building, floor, room and type of equipment. Application returns detailed information about equipment and photo.	Not currently in place	Screen display with detailed specifications	O	D, N, T	D, W	Document integration Asset Management	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
QV30: Map Display for Parking Meter Repairs	GIS map display with interface to meter repair data. Includes query tools to select date range and provide preventative and special maintenance history information (in window) after selecting meter.	Not currently in place	Screen display, Hard copy map, Tabular report	O	D, N, T, S	D, W, FD	Batch file transfer from meter repair history database	3
QV31: Parking Area Classification	Interactive tool for use in office and in field to designate specific parking areas for special events—and use of these designations for mapping and query	Not currently in place	Screen display, New derived map layer	O	D, N, T	D, W	Potential future integration with real-time parking occupancy monitoring system	5
CM1: Campus-wide Standard Base Map Production	Use of ArcMap map design tools to design templates and generate maps. Maps would show roads, buildings, parking areas, etc. with appropriate annotation	Currently in place	Screen display, hard copy map	O	D	D, W	NONE	5
CM2: 3-D Visualization for Development Planning	Use of GIS base map data and orthoimagery along with three-dimensional terrain data and three-dimensional data of physical features (buildings, etc.) to support evaluation of short range or long range decision making. This is a planning and decision-support tool using special visualization software to provide 3-D perspective views and with the ability to add proposed development features to generate alternate renderings of the development.	Not currently in place	Screen Display, Hard-copy Map or 3D image	O	D	D, W	CAD integration	6

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
CM3: Custom Maps or Drawings to Support Management Briefings	Use of ArcMap tools to extract data from multiple GIS feature classes for areas of interest and selection of custom symbols, colors, annotation, and map margin items. Also includes document clipping or extraction (portion of drawings or document for pasting into presentation or reports. This is an ad hoc process for quick generation of maps and images needed for presentations, reports, press releases, etc.	Not currently in place	Screen display, Custom report or presentation with map insert	O	D	D, W	Document integration	3 to 6
CM4: Project Status Map and Report	GIS template for automatic production of map display or hard copy map showing locations of development projects (major building or infrastructure construction, replacement, or renovation projects) with annotation and symbolization to identify project status. ArcMap template includes standard border, title, scale bar, legend, symbology, and annotation. Application would allow map generation at a user-selected scale and/or sheet size	GIS has been used in this way but no formal application in place.	Screen Display, Hard-copy Map, Hard-copy Tabular Report	O, F	D	D, W	Document integration Asset Management	4
CM5: Query and Map Display of Utility Infrastructure Features	GIS application allowing map display and interactive selection of single or multiple utility features with custom symbology, colors, and annotation and the ability to open a window to display selected utility feature attributes. Map products may be used by non-participating parties.	Uses ArcMap tools and default symbology.	Screen display	O, F	D, N, T	D, W	NONE	3

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
CM6: Utility Shutoff Point Mapping	A custom map product that highlights points in or outside buildings identifying where shutoff points for utility services are located. The points would be colored based on same colors used for utility marking. Annotation would be included and could provide interactive information to select points and provide more details about them	Not currently in place	Screen display	O, F	D, N, T	D, W	NONE	3
CM7: Parking Map Production	Using base map data downloaded from the GIS, produce custom maps depicting parking areas with annotation and added features to provide a guide for staff, students, visitors on parking areas and restrictions.	Not currently in place.	Screen display, Hard copy map	O	D	D	CAD integration	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA1: Facility Count and Reporting	Use of point-on-line, point-in-polygon, or line-in-polygon overlay functions to count and present statistics about facilities falling within a designated area. Included functions would be: a) Count the number of point features (e.g., manholes, that are connected to a selected Main), b) count number of point facilities (e.g., water valves) that fall within a defined area, c) count number of linear features (e.g. sewer mains) or total length that falls within a defined area. The application should give flexibility for the user to select the features to be counted AND the geographic unit for the count. In addition to a selection of a pre-existing geographic unit, the user should have the option to interactively delineate an ad hoc area or to generate a buffer around a point or line feature for the search and selection. The function should work in a global basis (counts in all instances of a selected unit e.g., all cut zones) or for individually area defined interactively by users.	Not currently in place.	Data file for export or import, Screen Display, Hard-copy Map/Hard-copy Tabular Report, Hard-copy Graph or Chart	O	D, N, T	D, W	NONE	4

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA2: Cost Estimation for Landscape Projects	Menu-based interface for delineation of landscape project areas and selection of project type (sod laying). Use custom interface to measure and perform calculations on area and other geographic factors impacting project. Application will return an estimate on labor hours and materials—a general estimate for planning purposes and comparison with bids received.	Not currently in place.	Screen display (map and summary table)	O	D, N, T	D, W	NONE	5
SA3: Network Tracing to Identify Services Impacted by Shut-offs	Allows a user to interactively select a point on the water or sewer network and to select an option for upstream or downstream trace. The application then traces all segments of the network logically connected in the upstream or downstream direction and facilities on that network. The application would highlight the traced segments in a screen map display and give the user the option to generate a report or tabular display listing trace results.	Not currently in place.	Screen Display, Hard-copy Map, Tabular Report	O, F	O, N, T	D, W	NONE	6

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA4: Preliminary Engineering Planning and Budgeting	This application evaluates specific construction project proposals as a step prior to a decision to proceed and carry out detailed engineering design. Users are guided through steps to delineate the project area and access data typically needed for preliminary project planning. The user will input information about the proposed project, and the application will perform calculations to provide the following—a) estimation of materials needed, b) project costs based on basic project specifications and calculated map areas, c) flagging of potential development restrictions, and d) property acquisition for ROW and easements.	Not currently in place.	Data file for export or import, Screen Display, Hard-copy Map, Tabular Report	O	D	D	NONE	5
SA5: Surface Drainage (runoff) Analysis	Use of analytical models to evaluate potential runoff from a defined site. This application is a candidate for interface to GIS with an accepted run-off modeling program that accepts information on slope, land cover, etc., to estimate runoff during user-defined storm events. Application would extract data from GIS for the model and would import results into the GIS for display and further analysis.	Not currently in place.	Data file for export or import, Screen Display, Hard-copy Map, Tabular Report	O	D	D	May involve transfer to/from GIS and external modeling software	6

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA6: Work Schedule Efficiency Analysis	Custom application to analyze different work scheduling scenarios for time consuming, repetitive tasks (mowing, trimming) with a goal of improving work efficiency (cutting down on lost time) moving from site to site. This application would use polygons delineated for the work areas with attributes on work tasks and labor. Using information on travel routes and location of equipment, a "routing model" would be developed with the ability to test different scenarios and calculate work time.	Not currently in place.	Screen display with map and tabular data	O	D, N, T	D, W	NONE	5
SA7: Infrastructure Evaluation to Support Insurance Analysis	Use GIS to keep inventory of infrastructure and, in conjunction with asset management system, document condition and upgrades to use in insurance claims—to fully characterize value and justification for claims.	Not currently in place.	Tabular report	O	D	D	NONE	4 to 7
SA8: Wi-Fi Coverage Analysis and Mapping	Custom application to enter proposed location of Wi-Fi transmitters outside buildings and use simple propagation model, perhaps using information on terrain and building location to calculate, and depict on a map display, areas of Wi-Fi coverage. Use this as a planning tool for Wi-Fi deployment	Not currently in place.	Screen display with map and tabular data, Hard copy map	O, F	D, N, T	D, W	NONE	5

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA9: GIS Support for Energy Efficiency Studies	Support for long-range planning to evaluate short-term and long-term actions for energy efficiency. GIS can support planning and project management for a range of "green" initiatives (e.g., LED exterior lighting).	Not currently in place.	Screen Display, Hard-copy Map, Tabular Report	O	D	D	Document integration	4 to 8
SA10: Graphic Support for Room Scheduling	Application would provide information from the GIS (including building wireframe data). The purpose is to provide a visual depiction to accompany the current tabular information. This could be used in a non-integrated manner or with actual important and integration with room scheduling software.	Not currently in place.	Enhanced graphics for ASTRA support	O	D	D	Document integration	5
SA11: Query and Retrieval of Facility Permits	State and Federal permits link to buildings and projects	Not currently in place.	, Screen Display, Tabular Report	O	D, N, T, S	D	External permit databases (batch file transfer)	4
SA12: Utility Line Extension Capacity and Cost Projection	Menu-based tools to enter and analyze capacity and cost for extension of steam heat/chilled water lines to newly facilities. Application would perform simple network analysis to determine if capacity exists for extending existing lines. Application also includes a tool for project construction costs.	Not currently in place.	Data file for export or import, Screen Display, Tabular Report, Hard-copy Graph or Chart	O	D	D	Document integration	6

Application	Description	Status	Products	Location[1]	Devices[2]	Environment[3]	External System Integration[4]	Expected Level of Customiz-ation[5]
SA13: Route Analysis for Snow and Ice Removal	Use network trace analysis capabilities, with street centerlines and possibly sidewalks too, to analyze routing options and plan most efficient routes.	Not currently in place.	New GIS data set, Screen display with map and tabular data	O	D	D	NONE	6

[1]Location: O=Office and F=Field. Field-based applications assume operations with wireless communications but may be operated in disconnected mode.

[2]Device: D=desktop computer, N=notebook computer, T= tablet computer, S=Smartphone, G=GPS collection device

[3]Environment: D=local desktop or office network, W=Web, FD=Disconnected Mode in Field (not real-time wireless connection)

[4]External system development identifies the external software, system, or database which supports or operates with the GIS application.

[5]Indication of the expected amount of work required to develop and deploy the application. This is presented as a score from 1 to 8 in which a score of "1" means that very little configuration or development is needed (application will rely mainly on "off-the-shelf" software tools), and a score of "8" implies that a high level configuration and programming is needed for customizing and deploying the application.

One further evaluation of potential RGIS applications involves an examination of their priority as a basis to decide if they should be implemented and a planned timing for implementation. Since many of the applications involve some level of customization or compilation of data that does not currently exist, their implementation timing needs to consider cost and time required for development. Table 8 presents a scoring approach to help assign a priority level to each application. Scores, from 1 to 8, are assigned to the following categories:

Importance and benefits for facilities and infrastructure management (Importance-FM): Reflects how well this application supports facilities and infrastructure management business processes and expected benefits that: a) reduce time and cost, b) deliver improved quality of services, c) enhance health and safety, and d) promote sustainability. A subjective scoring from 1 to 8 with a score of "1" meaning no or Very Low level of importance or benefits and a score of "8" meaning Very High level of importance and benefits.

Importance and benefits for other business areas (Importance-Other): Reflects how well this application supports other business processes, and expected benefits that: a) reduce time and cost, b) deliver improved quality of services, c) enhance health and safety, and d) promote sustainability.

Extent and frequency of use (Use Extent/Frequency): Identification of the size of the user community and the frequency that the application will be used. Uses a subjective score from 1 to 8 in which a score of "1" means Very Low use frequency and size of user community and a score of "8" means Very High use frequency and size of user community.

Complexity/Cost for Development (Complexity/Cost): Reflects the expected complexity of development (need for customization) and cost (staff or contracted hours). Uses a subjective scoring from 1 to 8 in which lower scores mean higher complexity and costs: a score of "1" means Very High level of complexity and cost and a score of "8" means Very Low complexity and cost (uses OTS interface with little need for configuration or customization).

Table 8 presents the scoring for each application. The Priority Score is a sum of the individual scores and results are organized into Priority Categories: Very High, High, Moderate, and Low.

Table 8: GIS/Document Management Applications-Priority Scores

Application	Importance-FM	Importance-Other	Use Extent/Frequency	Complexity/Cost	**Priority Score**	**Priority Category**
DM: GIS and Document Database Update, Maintenance, or Export						
DM1: Hard Copy Document Indexing	8	4	7	6	**25**	VERY HIGH
DM2: Document Image Enhancement	7	5	5	6	**23**	VERY HIGH

DM3: Scanned Document with OCR	7	5	5	6	**22**	VERY HIGH
DM4: Import and Reformatting of Digital Documents	8	5	6	6	**25**	VERY HIGH
DM5: Import of AutoCAD Drawings or GIS files	8	5	6	6	**25**	VERY HIGH
DM6: Quality Assurance Checking and Posting	8	7	6	4	**25**	VERY HIGH
DM7: Metadata Entry	7	6	5	5	**23**	VERY HIGH
DM8: Parcel/Real Property Import and Update	6	6	5	5	**22**	HIGH
DM9: Utility Data Update from Drawings	7	4	5	5	**21**	HIGH
DM10: Road/Parking Area Update	7	5	5	5	**22**	HIGH
DM11: Building Footprint and Wire Frame Update	7	3	4	5	**19**	HIGH
DM12: Easement Capture and Update	5	4	4	4	**17**	MODERATE
DM13: Field-based GIS Capture of Infrastructure	7	5	5	5	**22**	HIGH
DM14: AutoCAD File Output from GIS	8	5	6	6	**25**	VERY HIGH
DM15: Sign Inventory and Update	6	7	4	4	**21**	HIGH
DM16: Address Data Capture and Updates	6	6	4	4	**20**	HIGH
DM17: Street Centerline and Address Range Update	6	6	4	4	**20**	HIGH
DM18: Report on Maintenance Actions not Tracked by Work Management System	7	5	4	4	**20**	HIGH
DM19: Other GIS Data Capture and Update	6	6	5	3	**20**	HIGH
QV: GIS and Document-based Queries, Retrieval, and Visualization						
QV1: Geographic Navigation and Selection for Area of Interest	8	6	8	5	**27**	VERY HIGH
QV2: Ownership Search and Notification	5	5	4	4	**18**	HIGH
QV3 Real Property Transaction Tracking	5	5	3	4	**17**	MODERATE
QV4: Pavement Management	4	5	4	3	**16**	MODERATE
QV5: Cut/Paste/ Customize Map Display for Reports and Presentations	8	6	5	5	**24**	VERY HIGH
QV6: Interactive Web Map Selection and Display (Public Internet)	4	6	7	3	**20**	HIGH

QV7: Distance and Area Calculator	6	6	5	4	**21**	HIGH
QV8: GIS for As-built Drawing Verification	6	1	3	5	**15**	MODERATE
QV9: Digital Submittal and Review of Construction Plans and As-Built Drawings	6	2	4	3	**15**	MODERATE
QV10: Site Evaluation for New Construction Project	5	2	4	2	**13**	LOW
QV11: Map-based Standard Maintenance/ Repair Activity Reports	5	2	5	4	**16**	MODERATE
QV12: Field-based Query and Access to Engineering Drawings	7	4	7	5	**23**	VERY HIGH
QV13: Desktop Query and Access to Engineering Drawings	7	4	7	5	**23**	VERY HIGH
QV14: Field-based Query, Access, and Search of Document Books	7	4	7	5	**23**	VERY HIGH
QV15: Desktop Query, Access, and Search of Document Books	7	4	7	5	**23**	VERY HIGH
QV16: Construction Project Status Tracking and Mapping	6	4	6	4	**20**	HIGH
QV17: Custom Query for Utility Locates	5	2	5	4	**16**	MODERATE
QV18: 3-D Visualization for Development Planning	4	4	4	2	**14**	MODERATE
QV19: Traffic Disruption Analysis	4	5	3	3	**15**	MODERATE
QV20: Tree Inventory and Tracking	6	3	4	4	**17**	MODERATE
QV21: Roof Replacement/ Maintenance Tracking and Cost Evaluation	6	1	3	4	**14**	MODERATE
QV22: Special Event Planning for Traffic Flow and Parking	4	6	3	4	**17**	MODERATE
QV23: Public Safety Incident Mapping	2	5	4	4	**15**	MODERATE
QV24: Site Photo Capture and Retrieval	6	5	5	5	**21**	HIGH
QV25: Query and Map Display for Asbestos and Hazardous Materials	5	6	3	4	**18**	HIGH
QV26: Access to Photos of Standard Equipment and Infrastructure	6	4	5	4	**19**	HIGH
QV27: Query and Access to Parking Sign Information	3	5	3	4	**15**	MODERATE
QV28: Visualization for Real-time Parking Occupancy	3	6	4	2	**15**	MODERATE

QV29: Equipment Location Query and Display	7	2	4	5	**18**	HIGH
QV30: Map Display for Parking Meter Repairs	3	6	3	5	**17**	MODERATE
QV31: Parking Area Classification	3	5	3	5	**16**	MODERATE
CM: Custom Mapping or Document Production						
CM1: Campus-wide Standard Base Map Production	7	7	6	3	**23**	VERY HIGH
CM2: 3-D Visualization for Development Planning	4	4	4	2	**14**	MODERATE
CM3: Custom Maps or Drawings to Support Management Briefings	5	5	5	4	**19**	HIGH
CM4: Project Status Map and Report	6	3	5	4	**18**	HIGH
CM5: Query and Map Display of Utility Infrastructure Features	6	3	5	5	**19**	HIGH
CM6: Utility Shutoff Point Mapping	4	5	4	5	**18**	HIGH
CM7: Parking Map Production	4	5	4	4	**17**	MODERATE
Spatial Analysis (SA)						
SA1: Facility Count and Reporting	6	2	4	4	**16**	MODERATE
SA2: Cost Estimation for Landscape Projects	5	1	3	3	**12**	LOW
SA3: Network Tracing to Identify Services Impacted by Shut-offs	4	1	2	2	**9**	LOW
SA4: Preliminary Engineering Planning and Budgeting	5	3	4	3	**15**	MODERATE
SA5: Surface Drainage (runoff) Analysis	3	1	3	2	**9**	LOW
SA6: Work Schedule Efficiency Analysis	4	2	4	3	**13**	LOW
SA7: Infrastructure Evaluation to Support Insurance Analysis	4	6	3	2	**15**	MODERATE
SA8: Wi-Fi Coverage Analysis and Mapping	3	5	2	3	**13**	LOW
SA9: GIS Support for Energy Efficiency Studies	5	3	2	3	**13**	LOW
SA10: Graphic Support for Room Scheduling	4	6	3	3	**16**	MODERATE
SA11: Query and Retrieval of Facility Permits	3	3	2	4	**12**	LOW
SA12: Utility Line Extension Capacity and Cost Projection	5	2	2	2	**11**	LOW
SA13: Route Analysis for Snow and Ice Removal	8	4	4	6	**22**	HIGH

This evaluation of application priorities is the basis for planning and proceeding with application and development and deployment. It also provides information on which phasing of applications can be based. Selection of a Phase 1 applications should focus on those rated as Very High in Table 8. These applications are:

- DM1: Hard Copy Document Indexing
- DM2: Document Image Enhancement
- DM3: Scanned Document with OCR
- DM4: Import and Reformatting of Digital Documents
- DM5: Import of AutoCAD Drawings or GIS files
- DM6: Quality Assurance Checking and Posting
- DM7: Metadata Entry
- DM14: CAD File Output from GIS
- QV1: Geographic Navigation and Selection for Area of Interest
- QV5: Cut/Paste/ Customize Map Display for Reports and Presentations
- QV12: Field-based Query and Access to Engineering Drawings
- QV13: Desktop Query and Access to Engineering Drawings
- QV14: Field-based Query, Access, and Search of Document Books
- QV15: Desktop Query, Access, and Search of Document Books
- CM1: Standard Base Map Production

2.8 Summary of System Needs

2.8.1 Document Database Needs

Document Characteristics

Documents have been summarized in Section 2.6.4. Those documents are generally in hardcopy format. As they are desired to be converted to digital in support of an application for development, there are a number of characteristics to take into account to provide an estimate for scanning and indexing work and behavior within the applications. The characteristics include quantity, size, handling steps, material and quality, color / black and white, desired scan resolution, post-processing and collection of index attributes.

These characteristics will vary across sets and they can vary within a set as well. Size is usually classified into two categories: large-format (greater than 11” x 17”) and small-format (11” x 17” and smaller). These characteristics relate directly to the effort even to the point of selecting the suitable hardware / software.

Document Indexing

In addition to the automation of documents, there is a need to capture index information—attribute data fields which can be used to organize, search, and access documents. The selection of specific index fields to include is important because this determines how effectively it will be to query and find documents. However, the more index fields that are chosen, the more time consuming and expensive it will be to complete the document database. Table 9 lists initial ideas on index fields for document sets. Not all of these fields may be needed, but it is valuable to have a collection to choose from.

Table 9: Possible Index Fields for Documents

Possible Index Field	Comments
Building Code	Building code, if applicable
Building Name	Full building name. May also require fields for aliases
Building Address	Official address (Street Name, Street Type, Number, Prefix and Suffix as applicable). Buildings may have multiple addresses.
Project Type	Need to define a classification scheme for type of project (new construction, building renovation, landscaping project, etc.).
Project Name	As noted on project specifications.
ITB Number	Invitation to Bid number for formal competitive procurement
Project Classification	High-level classification for the nature of the project (e.g., New Construction, Renovation, etc.)
Project Type	Identification of main focus of project (remodeling, electrical, HVAC, fire suppression, etc.)
Project Subtype	Entries from a more detailed breakdown of drawing content to enhance capability to search
Floor Number	2-digit number corresponding to the floor of the designated building in which an asset is located.
Room Number	Code for the room location of the asset.
Equipment/Asset Name	Common name for the asset or piece of equipment (e.g., sprinkler head, A/C unit)
Asset Number	This applies to individual assets and pieces of equipment included in O&M records.

Possible Index Field	Comments
Volume #	As noted on binding and cover of bound documents
Plan/As-Built	Flag that indicates if the sheet shows design (prior to work) or a-built information after work completion
Previous/Alias Building Name	Buildings may be referred to by different names (in part, historical references). These old names or aliases need to be captured.
Sheet Number	
Project or Creation Date	
Type of Property Record	Deed, survey, or other record.
Parcel ID	Official parcel number
Coordinates (x, y)	x, y map coordinates from GPS capture in field
Key words	Standard set of key words to enable searches.
Notes	Brief text description about the document or circumstances for its capture or creation

2.8.2 GIS Database Content, Architecture, and Design

GIS Data Content Issues and Needs

Based on our survey of users, GIS data of particular importance for routine work are: Parcels, Streets/Roads, Utilities, Buildings, Walkways, and Trees. For planning purposes all data categories identified in Table 3 are assumed to be important and work should continue with development for them. Phase 1 GIS database development, to support a full range of very high priority GIS applications, will make use of the following, high-priority data:

- Addresses
- Administrative Boundaries
- Buildings/Structures-Planimetric View
- Critical Emergency Facilities
- Land Use
- Land/Infrastructure Development Project Areas
- Parcels and Legal Lots
- Parks/Recreation Facilities

- Railroad Lines and Rights of-Way
- Street/Road Rights-of-Way
- Signs
- Street/Road Centerlines and Address Ranges
- Zoning

GIS Metadata and Data Dictionary

There is also a need to capture, in a formal way, metadata for each Feature Classes in compliance with standards approved by the Federal Geographic Data Committee (FGDC) and the International Organization for Standardization (ISO). Metadata provides information about the GIS database that supports its use and maintenance. There are two broad categories of GIS metadata: a) dataset metadata which is information describing the content, format, sources, accuracy, update approach, how to access, and other information about the dataset (Feature Class) as a whole AND b) metadata about specific features in the GIS database. ArcCatalog includes templates for capture of dataset metadata using the FGDC/ISO standards with the ability to customize the fields. This metadata should be captured. Once it is captured, it can be accessed by users and will not change greatly over time. ArcGIS automatically maintains some feature-specific metadata (e.g., feature type, update dates). Such "data dictionary" information is a critical element in fully understanding and properly maintaining the data.

GIS Data Architecture and Structure

In addition to data content needs, there are a number of geodatabase design considerations to account for in long-term GIS operations. The primary database architecture recommendation is to deploy to an Enterprise Geodatabase using SQL Server database software. This will deliver higher performance, versioning, and multi-user simultaneous edits to the database. Beyond this fundamental architecture decision, there are a number of GIS database architecture elements that are recommended:

- Utilize ArcSDE Geodatabase: Long-term operations will require the use of an ArcSDE environment using SQL Server as the main database storage and management software. This will support simultaneous editing, expanded access, more flexible integration with external databases, and higher performance as the user community grows.
- Organization of Feature Classes in Feature Datasets: The ArcCatalog geodatabase management tools allow feature classes to be organized into "feature datasets"—groupings that include feature datasets that have a logical or spatial relationship. In general, the feature dataset organization is recommended.
- Unique ID (aka "primary key"): All GIS features should be captured and assigned a unique identifier. This can be populated as a sequential number. We recommend that an additional field be inserted in each Feature Class—Asset-ID or Feature ID and this should be populated with values that better support queries and integration with external databases. Where applicable, a unique

ID field should conform to existing standards (e.g., corresponding data stored in related systems, IDs used by utility organizations, etc.).

- Linear Networks: Utility networks are composed of one or more line features and point features. For instance, the sanitary sewer network includes mains, manholes and other features. ArcGIS includes the capability to structure this information as true networks (Feature Datasets which include multiple Feature Classes) and to define the spatial relationships of point and line features as a connected network. This is not necessary for all utility features but may be valuable for certain networks that require network tracing applications.
- Geometry Rules: ArcGIS has the capability to define "rules" for spatial relationships of data in Feature Classes which can be used as a quality control mechanism. These include network connectivity rules (e.g., sewer main must connect at a manhole or fitting feature) or the correspondence of boundary features (parcel boundaries should match district boundaries).
- Handling of History and Status of GIS Features: In some cases, users have stored feature history through a status attribute in a Feature Class. Features that have been removed (e.g., a sign) still remains in the Feature Class but is given a flag in an attribute to indicate its removal. This is a valid way to handle feature history but could lead to cases where features are counted incorrectly if the flagged (removed) features are not "turned off" through an attribute query. It is good practice to explore other ways to handle history through use of ArcGIS versioning tools and other third party applications that track the life-cycle of asset features.
- Use of GIS to Track Infrastructure Maintenance Activities: GIS is a great framework to track certain types of repair activities to infrastructure outside buildings which are not being documented elsewhere. This includes some repaving activities, some types of landscape work, work being done by external utility organizations. Dates of this work activity are tracked by appending a new field in the main attribute table for the date of the activity. If GIS is to be used for maintenance activity tracking, it is better to set up an additional table, linked to the main table by a primary key field (e.g., unique asset ID).
- Feature Class and Attribute Naming: There should be consistency in naming among Feature Datasets and Feature Classes
- Attribute Schemas: It is always wise to survey existing data models to find industry standards. These are available from ESRI or directly from professional organizations in the specific industry.

Data Update and Mapping Rules

For future operations, it will be important to establish a clear process for performing GIS data updates as features change. This has several parts:

- Clear organizational responsibilities for update: Role played by organizations in carrying data update operations. While there are good reasons for a centralized GIS database update model, there are opportunities for distributing some responsibilities among other groups.
- Triggers for Updates: In order for GIS updates to occur, those responsible for the update must be aware of a change (e.g., installation of new feature such as a sign, removal of a structure changes

to a feature or landscape). This involves procedural changes and new lines of communication so that those primarily involved with introducing the change provide information about it to trigger an update process. Maintenance activities or new construction or renovation projects are common instances that can trigger data update. New reporting and communication procedures need to be put in place so that change activities are reported—from multiple organizations including private utility organizations.

- Effective data update tools and applications: Improved GIS applications that streamline database update by guiding the user through the process and include some automation of current manual tasks can make GIS data update more efficient. This includes editing of map feature geometry, attributes, and metadata.
- Quality Control: Key aspects of GIS data quality include positional accuracy, completeness and currency of the data, graphic integrity (line work quality), attribute accuracy. ArcGIS software can be used to support quality control and the update process. This includes: a) establishing geometry rules (connectivity of certain features), b) greater use of attribute domains (currently there is minimal use), c) using attribute domains and relationships to support automatic entry, dropdown selection, default value entry, etc., and c) use of geometry rules to check and ensure proper connectivity for specific line and point features.

One other aspect of GIS data update, touched on earlier, involves the definition of "mapping rules" some of which may be automated in the geodatabase and others which are purely procedural and serve to guide the person carrying out an update transaction. These rules, cover such topics as: a) spatial relationship of different features, b) connectivity of line and point features in networks (e.g., utility networks), c) under what conditions and actions to take to add a new or delete an existing GIS feature, d) resolving somewhat ambiguous cases of how to classify and define polygon boundaries for new paved area covering parts of several feature classes (street, sidewalk, drive, parking area), e) when and how a GIS database change impacts the external system.

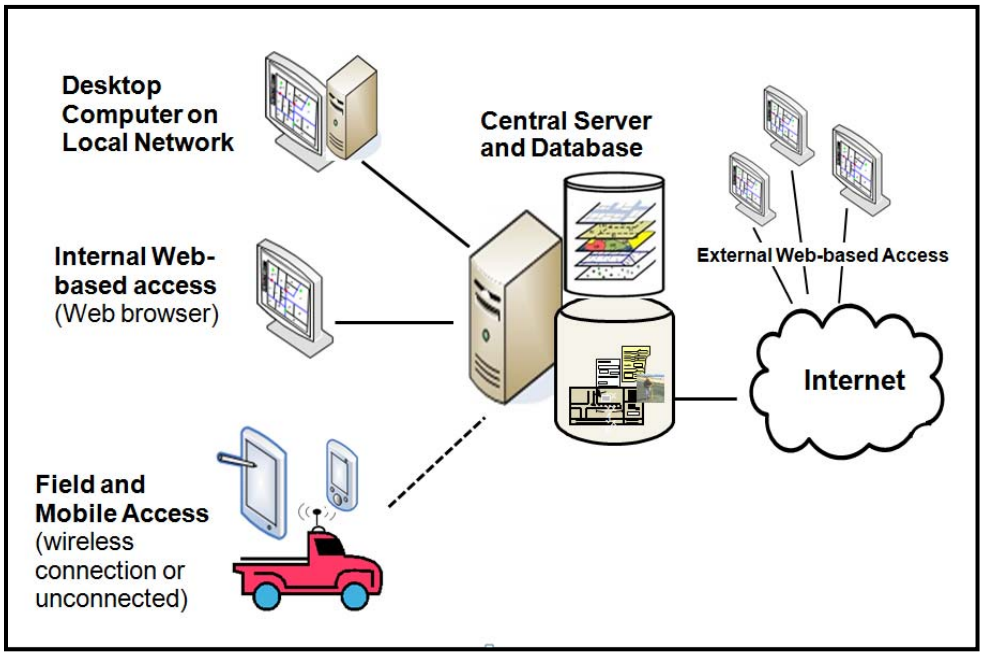
2.8.3 System Infrastructure and Software Needs

As mentioned in Section 2, NCOESC has several advantages in the development of a regional GIS and document access environment:

- Existing use and support of SQL Server software by the NCOESC
- NCOESC support for server, desktop, and mobile device hardware

The general concept of RGIS access is shown in Figure 6. This shows that the RGIS should be accessible from multiple hardware platforms and network environments—including Web access and access from the field. The component labeled "Central Server and Database" could be configured in a variety of ways: a) as a dedicated physical Windows-based server, b) a Windows-based server configured in a virtual server environment (no single, dedicated server), or c) Using an outsourced, "cloud-based" solution. A final decision on the configuration does not need to be made at this time. The virtual server approach will be lower cost and will deliver greater performance and growth potential for the future. The cloud-based approach is a possibility and there are such servers offered by a number of companies—including the ArcGIS Online service from Esri.

Figure 6: RGIS and Document Management Access Environments



Field access to GIS data and documents will require use of handheld devices with wireless connections—primarily notebook or tablet computers configured for Wi-Fi and 3G/4G service. New offerings of Windows-based tablet computers as well as the iOS support present multiple options for field deployment. One other decision has to do with whether or not to pay a premium cost for ruggedized equipment which is about 3 to 5 times the cost of comparable consumer grade devices. One possible approach is to save costs by using consumer grade devices but buying extended warrantees and using protective covers that will reduce the potential for damage.

2.8.4 Organizational, Management, and Staffing Needs

The success of the RGIS program is dependent on a number of organizational and staffing factors. These are important not only for GIS operations serving GIS Partner users, but take on a greater importance if the program is to expand and serve organizations throughout the region:

- Continued close collaboration, coordination, and sharing of resources between all organizations.
- Maintaining senior management support from Partner Agencies.
- Technical coordination and support from the NCOESC.
- Keeping skilled GIS staff in the GIS Office, and over time, increasing staff with the technical skills to support GIS and document management system operations for an expanding user base.
- Ongoing orientation and training for users to ensure their efficient access to GIS data and applications and support to an expanding user base for in the design and development of new applications.

- Setting up a more well-defined written set of standards and policies for GIS and document database maintenance. This includes assigning responsibility for database update to key organizations and individuals. Some update roles may be assigned to individuals who are mainly responsible for work activities and source documents from which updates will be made.

- Encourage professional development in IT and GIS fields including participation in professional associations and events, pursuing professional certifications, and ongoing training.

- Active reporting and promotion on the progress and operations of the RGIS program in meetings as a way to generate interest and ideas for how the technology may be used to deliver expanded benefits to a wider user community.

To support implementation, the following recommendations are provided:

1. Form a technical committee that serves as an oversight and coordination body. This committee can be formed from the existing project team and should be put in place in before Phase 3. It should include key staff from the Partner Agencies as well as selected individuals from other organizations. This group would: a) oversee development and deployment in Phase 3 and beyond, b) coordinate work of contractors and consultants, c) look for and put in place improved inter-agency coordination, d) be the main body that prepares plans and standards, and e) communicates with senior management about progress and resource needs.
2. Prepare formal database maintenance standards which address technical requirements (data content and accuracy) and which assigns specific update roles to organizations and individuals.
3. Put in place a process and format for GIS program reporting and promotion. This includes summary reports on progress for senior management (from the technical committee), regular communications with users, and promotional communication (NCORcog web pages, meeting presentations, and mentions in newsletters).
4. Recruit student interns (with GIS skills) which have recently been approved. Consider the need for additional GIS staff as the GIS program expands.
5. A training program for staff and interns—to address the needs of users and technical staff. One of the goals is that applications will be designed with easy-to-use, intuitive interfaces so that extensive user training will not be required but GIS orientation and training for casual users will be required.

Also, with likely expansion of the GIS program—to address the needs of a larger community of GIS Partner users, there will be the need for additional staff for GIS technical development and support.

2.9 Other Recommendations Considered

One important recommendation of this study is to keep the needs of school districts in front of the team and involved in the implementation process. To-date, school districts have been very poorly served when shared-services programs have been created. The need is clearly there, but they will need some advocates in order to play a part in the definition of the system.

School districts could potentially use GIS on academic, operational, and planning fronts. They have lands, buildings and infrastructure assets that they must construct and maintain. GIS has proven itself an excellent tool to manage the life-cycle history of such assets in a way that allows organizations to be more pro-active thereby extending the useful life.

GIS can support the academic mission of schools in two ways. First, having a rich GIS available covering the entire region makes it possible for GIS lesson plans within the classroom or using GIS as part of other classroom activities. It would give educators a chance to observe how GIS may help students engage in studies that promote critical thinking, integrated learning, and multiple intelligences at any grade. Secondly, as students gain classroom experience with GIS, they become part of a pool of qualified candidates for the intern program which keeps the RGIS thriving.

GIS also has the potential to help administrators in demographics and planning, safety and preparedness, and transportation and logistics – provided those business processes and applications are given the appropriate attention. As school districts are incorporated, this is an excellent opportunity to create a shared services model that could have the most benefit state-wide.

2.10 Use of State Resources

The government of the State of Ohio provides a number of resources and services that are available and should be used to the greatest extent possible for this planned GIS. Ohio Geographically Referenced Information Program (OGRIP), serves as the authorized Geographic Information System (GIS) coordinating entity for the State of Ohio. The program has accomplished some very good work in relation to statewide ortho imagery and 911 roads and addressing. Some basic details are as follows:

http://ogrip.oit.ohio.gov/Coordination/OGRIPAdvantages.aspx - Referenced 8/10/2015

OGRIP was created in response to the critical need for coordination in the development and use of digital spatial data. OGRIP has broad representation and serves to facilitate information gathering regarding spatial data, spatial data initiatives and issues impacting the GIS community in Ohio.

OGRIP encourages GIS activities that enhance the development and use of reliable digital spatial data through communication, coordination and collaboration. This is accomplished by educating organizations, communicating benefits, raising GIS awareness, identifying points of contact and data sources, developing community resources and providing direction regarding GIS and spatial technologies.

GIS Communication & Coordination: OGRIP offers communication and coordination with the GIS community across the Ohio. Through communication and coordination, OGRIP provides information on GIS activities and initiatives focused on the development of digital spatial data. OGRIP coordinates state initiatives with federal and local government efforts where it makes sense encouraging collaboration and coordination. Some of the activities associated with these services are:

- *GIS Directory – maintain a directory of GIS contacts throughout the state at all levels of government, academia and the private sector.*

- *Ohio GIS Listservers – manage electronic communications with the Ohio GIS professionals.*
- *County GIS Profiles – development of a summary of GIS activities, their status and spatial data holding by county.*
- *Monthly Meetings – OGRIP holds a forum meeting the last Monday of every month to discuss issues impacting GIS in Ohio.*

GIS Clearinghouse & Data Distribution: OGRIP through the GIS Support Center (GISSC) manages the distribution of spatial data. This data currently includes USGS and state enhanced USGS data sources.

GIS Education and Awareness: OGRIP sponsors and hosts numerous educational workshops and seminars throughout the year. OGRIP provides notification of educational venues and training opportunities in Ohio. A few of the repeating opportunities OGRIP is involved in are below:

- *Monthly Educational Presentations – OGRIP Forum Meeting*
- *Annual Ohio GIS Conference (Fall)*
- *Annual Land Records Modernization Conference (Spring)*

2.11 Software Licensing

ESRI software and tools are used by all partners with GIS capabilities and are integral to the daily operations and maintenance of their GIS programs. As part of this plan, the project team has deliberated on the likelihood of pursuing some kind of "group licensing" structure and/or using collective bargaining to negotiate a group rate for ESRI software maintenance.

Historically and in general, ESRI enters license agreements with single organizations, and collective bargaining or a shared licensing pool spanning multiple agencies is very uncommon. In all likelihood, ESRI would suggest an ELA (Enterprise License Agreement) for the region. This would potentially be complex since ELAs are generally aimed at one organization rather than a consortium. Further, ELAs aren't typically structured to save money, but instead are aimed at streamlining purchasing within an organization and providing additional regional advantage services. Thus, cost savings of a region-wide ELA might be negligible or nonexistent.

There are few desktop GIS options outside of the ESRI suite of software/tools that are viable compliments and alternatives for certain GIS activities. Given the current extent of GIS software utilization among the partners, it is not recommended to embrace these options in the early stage of the implementation. These alternatives are not likely to eliminate the need for ESRI software (particularly for GIS “power-users”) but something like them could be very beneficial for an occasional GIS user who needs to access data every so often on the desktop, but can’t justify the cost of additional ESRI licensing. Most of these occasional access scenarios will be addressed by the web viewer tool.

3. DATABASE AND APPLICATION DESIGN

3.1 Database Design

GIS is an amazing enabling technology for related applications. One major application area is the integration of document management and GIS. The key to integration among applications is the practice of database design.

The database design must take into account the functional elements needed for the specific application while also considering the relationships needing supported through key / foreign key links. An example would be the case of a particular manhole within the wastewater collection system. In the GIS world, there are both graphic and non-graphic information items that describe that feature. In the document world, there are a number of documents that relate to that feature – from design documents to current condition inspection details. A typical use-case scenario would want to allow the user to search for that feature by graphic or non-graphic criteria and ultimately retrieve any of the associated documents by reference. This is only accomplished with careful database design.

The overall database design will be initiated with the first application in Phase 1 and will continue to evolve as each application is completed within each phase. Extreme care and attention must be paid to documenting the database design to allow future enhancement / modification as well as supporting application interfaces and integration. Without complete and correct documentation, enhancing the system becomes a very difficult task.

One pointer, specific to implementation, is that necessary database constructs can be stored on the same database server as described in Section 3.2, below. This allows the developer ready access to necessary objects.

3.2 GIS Database Architecture and Design

This section details a range of GIS database architecture and recommended design elements to configure a system that is highly performing, usable, easy to maintain, supports integrations with external systems, and provides application opportunities. Table 10 summarizes the GIS data architecture and design elements and shows recommended actions during each phase of implementation. Some of these were also detailed in Section 2.8.2. The database design must be designed for both current operations and long-term use.

Table 10: GIS Database Architecture and Design Elements

Recommended Element	Comments
ArcSDE Geodatabase	ArcSDE environment to be set-up early on to prepare for full implementation.
Feature Class/Feature Dataset Organization	Feature Classes should be grouped logically into Feature Datasets when possible.

Recommended Element	Comments
Unique ID (primary key) Population	Guidelines for assignment of unique IDs will be developed, as appropriate, during each phase to support the data layers and applications being configured and created.
Attribute Naming Standards	Standards for attribute naming provided in Phase 1 and applied during full implementation
Attribute Schema	Identification and implementation of attribute schema for each Feature Classes will be developed phase-by-phase. Industry standard data models will be referenced during development.
Linear Networks	Lineal Networks should be utilized, when applicable, for network structuring for utility networks in each phase.
Geometry Rules	Geometry rules described and put in place for applicable Feature Datasets during each phase.
Managing Revision History	Recommendations will be developed during Phase 1 and applied.
Populating Feature Class Metadata	Must be completed by the end of each development effort. Important to keep this current and complete. Extremely important as applications are being developed and maintained.
Creating Attribute Data Dictionary	Must be completed by the end of each phase. Important to keep this current and complete. Extremely important as applications are being developed and maintained.
Establishing Attribute Domains and Default Values	Complete for each Feature Classes configured in each Phase. Should be carried out as part of data dictionary preparation.
Defining Update Triggers and Responsibilities	Recommendations provided and implemented phase by phase.
Defining Mapping Rules	Implemented initially in Phase 1, may change during future phases.
Implementing Tools and Procedures for Data Update and Maintenance	GIS update application and process for scenarios and Feature Classes completed in each phase.
Addition of new GIS content	Includes addition of new Feature Classes—map features and attributes not in the current database. These features will be added, as needed, within each phase.

Recommended Element	Comments
GIS-Document Management	Architecture designed and set-up by phase with the implementation of each document set.
GIS-Maintenance Management	Must consider necessary constructs to integrate with existing systems or systems selected to provide this functionality.
Document Management-Maintenance Management	Must consider necessary constructs to integrate with existing systems or systems selected to provide this functionality.

3.3 Application Design

Phase 1 is the beginning of the custom application development. Elements of Phase 1 should be designed and built as a foundation for full system development. The phase would include design and development of a database and applications that encompass the very high-priority components of the RGIS. Phase 1 will deliver a working environment that supports key GIS Partner business areas—focusing on asset and infrastructure management needs of the Partner Agencies. Some important outcomes of Phase 1 include the following:

- ✓ to demonstrate key functionality of the integrated RGIS and use as a tool for explaining the purpose of the system
- ✓ to test design decisions and identify adjustments to the design
- ✓ to generate interest and support for future development

The Phase 1 database would include the following main components:

- Document Database: A document database that captures key documents with attribute indexing and geographic indexes.
- GIS Database: All current Feature Classes for the study area migrated from the current sources to an ArcSDE Geodatabase using SQL Server. This will be implemented in an ArcGIS for Server environment accessible to project participants.

It is recommended to include the following applications to be developed and tested in Phase 1:

1. Document Database Update: Set of processes for adding and indexing documents to the regional document database. Upload and indexing of scanned documents or document files already in digital format (assumed PDF). The document indexing application will provide a menu-based interface for accessing a document and an intelligent data entry form for populating index attributes.

2. GIS Database Update: Application for GIS database update for developed Feature Classes using new established rules and database schema changes. This application will begin with the high priority Feature Classes as a basis for future phased development of GIS update for the entire GIS

database. When possible and suitable, feature services will be made available to allow remote update as long as credentials are provided.

3. Query and Access to Documents—Office User: With access to the document database, this web-based application will provide a menu-based user interface allowing the query, access, and viewing of selected documents using attribute query and GIS-based selection. This application will be designed for desktop computers with the assumption that the user will have a large monitor or dual monitor. This will support two typical scenarios: a) query and access for documents inside a building (GIS access to buildings and selection of documents relating to a particular floor, room, or pieces of equipment) and b) query and access to external infrastructure—a document associated with a location or map feature (e.g., utility line segment) outside of buildings.

4. Query and Access to Documents—Field/Mobile User: Similar to application #3, but designed for a notebook or tablet computer (10" and greater). With access to the document database, this application will provide a menu-based user interface allowing the query, access, and viewing of selected documents using attribute query and GIS-based selection. This will support the two typical scenarios: a) query and access for documents inside a building (GIS access to buildings and selection of documents relating to a particular floor, room, or pieces of equipment) and b) query and access to external infrastructure—document associated with a location or map feature (e.g., utility line segment) outside of buildings.

5. Custom GIS Application-Network Trace: Use ArcGIS capabilities and restructured data in the Water and Sanitary Sewer Feature Classes to support network tracing. The scenario will perform tracing and show part of the network effected by a break or valve shutoff.

6. Site Photo Capture and Access: This application is aimed at the field/mobile user and supports capturing a digital photo, from a smartphone or tablet computer, of an infrastructure asset, location or piece of equipment inside a building, or a condition that needs attention (pothole in street, sign knocked down, and maintenance problem inside building). The photo would be automatically tagged with its date and location (from the device GNSS positioning capability) and the application would give the user a menu to capture basic information about the photo. Photos would be stored and linked to point features in a new geodatabase feature class for query and retrieval. In the future, the photos could be part of integration with the future work/maintenance management system and used with asset inventory and work request submittals.

Details for Selected Very High Priority Applications

Application Name:	**1A. Document Database Update**
Purpose:	To provide an easy to use, menu-driven interface to support the import of new large format documents into the document database.
Device/OS	Windows-based desktop computer workstation with large, dual-monitor configuration with locally connected large-format scanner.

Server Environment:	MS Windows Server OS (2008 R2 Standard). Server location for early part of Phase 1 will be at Contractor headquarters.
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	Not essential for application.
Documents:	a) Selected large-format Plans and As-Builts. b) Selected large format drawings inside Operations and Maintenance manuals. Use a small but representative set of documents to test update procedures. Base mainly on Van Meter Hall documents.

Application Name:	**1B. Document Database Update-Indexing**
Purpose:	To provide an easy to use, menu-driven interface to support the import of new page-size format documents into the document database.
Device/OS	Windows-based desktop computer workstation with large, dual-monitor configuration with locally connected small-format page scanner.
Server Environment:	MS Windows Server OS (2008R2 Standard). Server location for Phase 1 will be at Contractor headquarters.
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	Not essential for application. Selected feature classes will be used to support geoindexing.
Documents:	a) Selected Specification Book materials, b) selected Operation & Maintenance records, c) selected large-format plans and As-Builts. Use a small but representative set of documents to test update procedures. Base mainly on Van Meter Hall documents.

Application Name:	**2. GIS Database Update**
Purpose:	To provide an easy to use, menu-driven interface, appropriate for office users of desktop computers with large monitors, to query and access documents (page-size and large-format) using attribute and map-based selection
Device/OS	Windows-based desktop computer workstation with large, dual-monitor configuration.
Server Environment:	ArcGIS Server SW with SQL Server operating on MS Windows Server OS (2008R2 Standard). Server location for Phase 1 will be at Contractor headquarters.

Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: ArcGIS for Desktop 10.3.1
GIS Data:	a) Water and wastewater utilities (for update), b) selected BaseData and orthoimagery as reference for update
Documents:	Sample documents used as examples of typical sources for GIS database update: a) digital redline mark-up, b) CAD file.
Other Data Source:	
Key Fields:	

Application Name:	**3. Query and Access to Documents—Office User**
Purpose:	To provide an easy to use, menu-driven interface, appropriate for office users of desktop computers with large monitors, to query and access documents (page-size and large-format) using attribute and map-based selection
Device/OS	Windows-based desktop computer workstation (preferably with large monitor).
Server Environment:	ArcGIS Server SW with SQL Server operating on MS Windows Server OS (2008R2 Standard).
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	a) Orthoimagery, b) selected Base Features feature classes, c) selected Building Rooms feature classes. Used for map references to support queries.
Documents:	a) Selected Specification Book materials, b) selected Operation & Maintenance records, c) selected large-format plans and As-Builts. Use a small but representative set of documents to test update procedures. Base mainly on Van Meter Hall documents.
Other Data Source:	
Key Fields:	

Application Name:	**4. Query and Access to Documents—Field/Mobile User**
Purpose:	To provide an easy to use, menu-driven interface, appropriate for office users of desktop computers with large monitors, to query and access documents (page-size and large-format) using attribute and map-based selection
Device/OS	Windows-based (v7 or v8) notebook or tablet computer.
Server Environment:	ArcGIS Server SW with SQL Server operating on MS Windows Server OS (2008R2 Standard).
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	a) Orthoimagery, b) selected Base Features feature classes, c) selected Building Rooms feature classes. Used for map references to support queries.
Documents:	a) Selected Specification Book materials, b) selected Operation & Maintenance records, c) selected large-format plans and As-Builts.

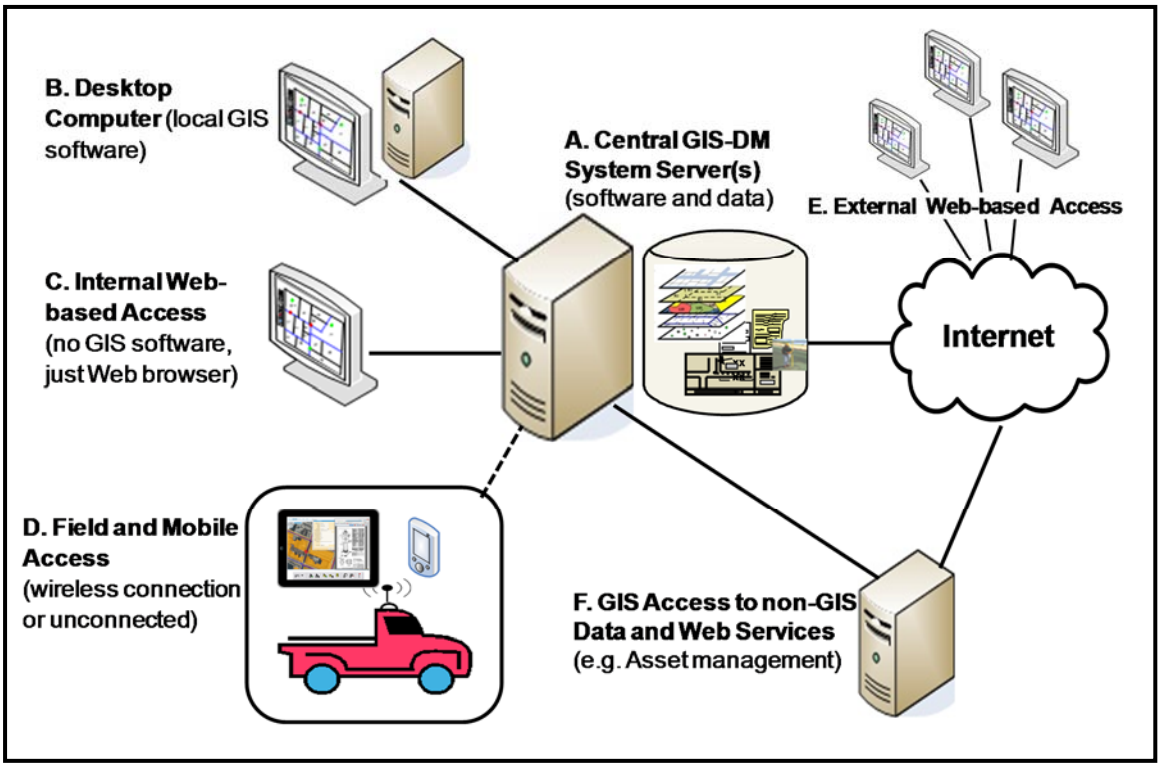
Application Name:	**5. Custom GIS Application-Network Trace**
Purpose:	To provide an easy to use, menu-driven interface for a custom GIS network tracing for the water and sanitary sewer networks.
Description:	Menu interface to ArcGIS tools that allows user to identify interruption point on the network (break or valve shutoff). The application will perform upstream or downstream tracing to identify utility line segment and services impacted by the interruption
Device/OS	Windows-based desktop computer workstation.
Server Environment:	ArcGIS Server SW with SQL Server operating on MS Windows Server OS (2008R2 Standard).
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	a) Water and Wastewater utilities (for trace application), b) selected BaseData as spatial reference for update
Documents:	Sample digital photos to be captured and stored in application.

Application Name:	**6. Site Photo Capture and Access**
Purpose:	To provide an easy to use, menu-driven interface, appropriate for mobile computer devices, to query and access documents (page-size and large-format) using attribute and map-based selection.
Device/OS	Windows-based (v7 or v8) notebook or tablet computer.
Server Environment:	ArcGIS Server SW with SQL Server operating on MS Windows Server OS (2008R2 Standard). Server location for Phase 1 will be at Contractor headquarters.
Main Software Packages:	• Server Software: ArcGIS Server v10.3.1, SQL Server v2008R2 • Client Software: Web Browser
GIS Data:	a) Orthoimagery, b) selected Base Features feature classes, c) selected Building Rooms feature classes. Used for map references to support queries.
Documents:	Sample digital photos tagged with date, location, and entered index data.

3.4 System/Network Configuration

The recommended system configuration for the RGIS is a centralized GIS server environment with central storage and management of GIS software and the main GIS and document databases as shown in Figure 7. Most users will access the RGIS in web-based mode via the local area network or through a wireless connection. The configuration will also support external access through publicly-accessible web applications.

Figure 7: RGIS Configuration



This configuration has the following main components:

A. Central GIS-DEM System Server: The central server will be managed as part of the RGIS configuration managed by the NCOESC. It will operate in a Windows server operating system environment in a virtual server configuration. Esri ArcGIS for Server software will be deployed and the GIS database will be managed as and SQL Server-based Enterprise Geodatabase. The server environment includes a configured Web server (using virtual server resources and existing Web server software). Appropriate network and security controls will be in place to allow and control access. The server is configured in a way that allows Web and non-Web access from users (B, C, D, E).

B. Desktop Computer: A small number of GIS staff (users who perform data update, management, and compute-intensive applications) will access the GIS on the NCOESC network and use its resources with a Windows-based desktop computer with ArcGIS GIS software that allows for local processing and full access to central server data and services (A).

C. Internal Web-based Access: Office-based users with desktop computer users connected to the NCOESC network will have full access (subject to security controls) to the RGIS server. Access will be through a Web browser with most processing done at the server.

D. Field/Mobile GIS Access: Users in the field (any location away from their office) will use Windows-based notebook or tablet computers to access applications and data on the RGIS server. The notebook and tablet computers use wireless communications (Wi-Fi or 3G/4G cell coverage) although certain applications will also operate in disconnected mode (without direct wireless

connection to the server). In the future, the system will likely support non-Windows tablet computers and smart phones (different vendor mobile operating systems).

E. External Web-based Access: The server configuration will allow public Web access (subject to security controls) for any external user with Internet access and an approved Web browser.

F. GIS Access to non-GIS Data and Web Services: The system will allow access to other non-GIS applications and databases and as they are configured and set-up, direct integration with external systems.

3.5 User Interface Considerations

The user interface defines the "look-and-feel" of a menu-based graphical interface with which a user interacts (Web-based or non-Web environment). For non-Web-based application environments, the Microsoft Windows interface has become a de-facto standard to the point where many software vendors closely follow the arrangement of menu choices and icons in their software interface design. All of the applications to be developed and deployed will be deployed with a custom user interface—created using tools of the ArcGIS software, SQL Server, standard Web design tools, and Windows-based tools. The goal is to create an intuitive and well-designed interface that allows users to efficiently access application functionality and present results in a readable and easily understood way. The applications will be sensitive to the following design factors:

- Minimum number of mouse clicks (or touches) to invoke a designed function
- Simplicity with a minimum number of graphic and text objectives and content displayed
- Easy navigation allowing users to move from screen to screen (forwards and backward) in a flexible and clear manner
- Minimum amount of text entry needed to run the application
- Tooltips and context-sensitive help to guide the user and explain errors and how to resolve them

User Interface Elements and Controls

The applications will give users an intuitive interface for accessing data and services. The application interfaces will include the following general elements:

- Map Interface – A map window will display data within the browser window.
- Toolbar – A toolbar will display the available functions of the application. This includes standard browser toolbars as well as toolbars with tool choices that are standard for ArcGIS for Server and custom programmed.
- Buttons – Buttons will provide the user with the ability for map navigation, searching, identifying features, measuring distances, buffering features, and printing reports and maps. In addition, buttons will provide the user with the ability to update incidents and street conditions.
- Navigation Aids – Any standard browser tools or programmed tools that assist the user in moving through the Web-based pages presented by ArcGIS for Server. This may include other

custom navigation features that may be provided for users through the application (e.g., breadcrumb paths, tabbed pages, explicit XREF links to other pages, "next" buttons).

- Text Entry – An input method that will allow the user to enter textual information into search boxes, attribute fields, geocode options, and buffer options.
- Drop-down Boxes – An input method that will allow the user to select one or more entries from a pick-list of items to associate with a feature or to perform a search by.
- Radio Buttons – An input method that will allow the user to select one choice option from a list of options.
- Check Boxes – An input method that will allow the user to select one or multiple choices from a list of options.
- Dialog Forms – New windows will open that provide information or prompts to users and which may require user entry or interaction, such as login.
- Text Description – A text information area will display results from searches, identifying features, and other functions of the application.
- Links – HTML links will access external Web sites and on-line user documentation.
- "Tooltip" Help – Small text messages associated with programmed buttons, icons, and tool choices which, upon mouse hover actions, provide a description of the action that will occur if selected.
- Browser Address Bar – the Browser address bar will be used to enter the URL.

Basic Look-and-Feel and Design Principles

Application design and development should adhere to the following basic design principles and best practices:

- Employ consistent look-and-feel standards and use mandatory elements (map navigation, map query, results, contact information, logo, on-line help, and tool tips). The Web site should use elements that are considered standard for web page design:
  - Title/Heading Region: Sometimes called the banner region and containing appropriate name, logo, and other main identification information
  - Legend: Contains a listing of the map content (identifying the meaning of symbols and colors) on the right side menu panel of the page
  - Map Content: Data display located in the center panel of the page
  - Map Interaction: Located on the left side menu panel of the page containing buttons, text boxes, and drop-downs that allow the user to interact with the map and perform navigation, searching, printing, reporting, and other functionality
  - Results: Information that is returned as part of a search or query on the map located below the map content

  - Links: Important links to external Web services and on-line help
  - Contact, Feedback, and Privacy Region: Sometimes called the footer region, contains links to obtain contact names, addresses, telephone numbers, and email addresses; display a user feedback form; and access a privacy statement located at the bottom of the page.

- Most Web-based GIS applications providing map displays should comply with cartographic standards. In addition to including the basic web page elements mentioned above, the application should generally include the following types of features that add to usability and understanding for users:
  - A small-scale reference map that shows the location of any large-scale map displays
  - A dynamic label of the scale for the current map display
  - Scale bar
  - North arrow
  - Disclaimer statement
- Web-based GIS services, in addition to providing a central source of data and services should provide links to other Web services.
- Web-based GIS systems must be intuitively designed for ease of use. Anyone must be able to use the Web-based GIS system to obtain information. Users should only have to click their mouse two or three times to reach useful information. Consideration should be given to the possible need to support access by the physically disabled.
- Web-based GIS systems must be designed for flexibility and expansion for the implementation of new technologies and data capacities. The system must be scalable to meet the rapidly changing information technology realm and the multitude of data requirements of the system's user base.

The design should follow existing web site standards of the managing organization, including labeling and data display thresholds.

4. IMPLEMENTATION PLAN

4.1 Strategic Foundation and Implementation Phases

The fundamental purpose of the RGIS is to provide a tool to support the GIS Partner agency programs and their long-term missions. The initial goals for the RGIS address support for infrastructure and facilities planning, tracking, project management, and ongoing operations and maintenance. But the system will also be a resource for use by all organizations and programs. Given that, the following broad goals have been established for the RGIS:

- ✓ Promote GIS use and GIS end-users within the region.
- ✓ Provide easy access to geospatial data for users without extensive training with GIS software.
- ✓ Promote inter-organization (region-wide) participation in the sharing of standardized GIS data and GIS resources to reduce costs.
- ✓ Secure geospatial data in one place—with appropriate security so that only authorized staff can make changes.
- ✓ Provide real-time capability for data verification and location with GPS.
- ✓ Promote GIS technology training and education opportunities in order to develop and maintain appropriate skills levels for operation and use of GIS.
- ✓ Facilitate coordination and communication
- ✓ Promote the value of GIS in decision-making

While RGIS operations and implementation focuses initially on work of the key partners, the long-term intent, with a regional view, is to support all agency programs and users. The mission statement below gives a concise, long-term focus for the RGIS Program.

Mission statement and guiding principles for the regional GIS Program

The RGIS will be the primary source of geographic information and user applications for query, access, and analysis of location-based information for all users in support of their respective service, research, and educational mission.

Guiding principles in support of this mission are:

Focus on support for the mission, business, and programs of participating organizations

Routine use of the RGIS to support land and infrastructure planning, project design, and maintenance of all facilities

Focus on maintaining and providing access to a comprehensive, high-quality, and up-to-date geographic database

Great attention to high-quality service and a proactive approach to enable users to realize maximum benefits from RGIS data and applications

Positioning of the RGIS as a core, regional information technology that coordinates and integrates with other systems and helps deliver maximum benefits from all information technology systems and applications

Ongoing and proactive exploration and implementation of new RGIS services and applications that meet the needs of the user community

Optimization of efficiency and cost-effectiveness in all aspects of GIS development and operations.

Maintenance and improvement of staff and management competencies and support for professional development.

Effective coordination with and support for academic programs, research activities, and students' learning and practical experience

4.2 Implementation Phases

RGIS implementation is broadly organized into the following three phases after the completion of this study which marks the end of the study/planning phase:

Phase 1: Development and Early Operational Implementation: All high-priority GIS design and architecture elements are implemented. The majority of in-process document management tasks are completed for the key document sets. Procedures are in place to efficiently maintain the GIS and document database. All "Very High" priority applications are in place and improved procedures and policies are established for efficient operations for use of RGIS applications.

Phase 2: High Priority Implementation and Deployment: The RGIS will continue to expand and thrive serving a broader user community. Any High-priority application development and document database quality assurance, testing, and deployment work will be completed in this Phase. All identified Very High and High priority applications are in place.

Phase 3: Full Implementation and Deployment: The RGIS will continue to expand and thrive serving a broader user community. Any application development and document database quality assurance, testing, and deployment work not finished in Phase 2 will be completed in this Phase. All intended applications are in place and additional applications are developed as desired.

This provides a logical approach to complete the high, medium and low priority applications and associated resources in a fashion that presents the best value-proposition, which ultimately garners the most support from all project participants. Detailed tasks and timing are described in Section 4.5.

4.3 RGIS Organizational Structure, Program Governance and Staffing

This Section contains recommendations for RGIS Program organizational structure, management practices, and staffing.

4.3.1 Organizational and Management Challenges and Requirements

From and organizational and management perspective, the RGIS Program must address the following requirements and challenges:

- Building an effective implementation project structure and management practices for phased development work
- Deciding on a short-term and long-term system hosting environment (e.g., on-site server(s), Cloud-based, or hybrid environment) and putting in place sound management and technical practices that supports security and high-performance.
- Keeping senior management aware of RGIS progress and benefits and sustaining their support from the development period into ongoing operations.
- Identifying and maintaining funding sources for development and operations.
- Managing a smooth transition from manual document management environment to automated operations—with a move to a largely "paperless" environment in the future.
- Working GIS and document management applications and data into a wide range of business processes with a goal of streamlining the processes and realizing benefits in efficiency, cost savings, and higher-quality.
- Putting in place effective organizational relationships and data sharing procedures to support efficient GIS and document management update.
- Engaging the broad user community and proactively identifying new opportunities for RGIS applications and benefits—and working with users to define and implement these applications.
- Keeping track of technology changes and industry products and standards impacting RGIS operations, upgrades, and expansion and using this information to make decisions and effectively manage software and hardware upgrades, new product installation, and software license management.
- Keeping involvement with outside groups (e.g., other consortiums, counties, other users of GIS and document management technology, professional associations) to become aware of practices and tools that can benefit the RGIS and support professional development.
- Enhancement and expansion of technical education and training opportunities for technical staff and users of the RGIS using on premise and outside training sources.

4.3.2 RGIS Program Organizational and Management Structure

The recommended organizational structure for the RGIS and Program is depicted in Figures 8(a) and 8(b). Figure 8(a) shows the structure for the project environment during system development. This transitions into an ongoing program environment (Figure 8(b)) after completion. The organizational structure shown is designed to encourage and enable broad participation and collaboration among stakeholders and effective oversight by senior management. Two critical organizational components, established before Phase 3 development work begins should be noted. This includes a recommended RGIS office, a new, formal organizational unit in Seneca Regional Planning, and an ongoing Technical Committee with broad representation from stakeholder organizations. The organizational components shown in Figures 8(a) and 8(b) are explained in Table 11.

Figure 8(a): Organizational Structure for RGIS Development

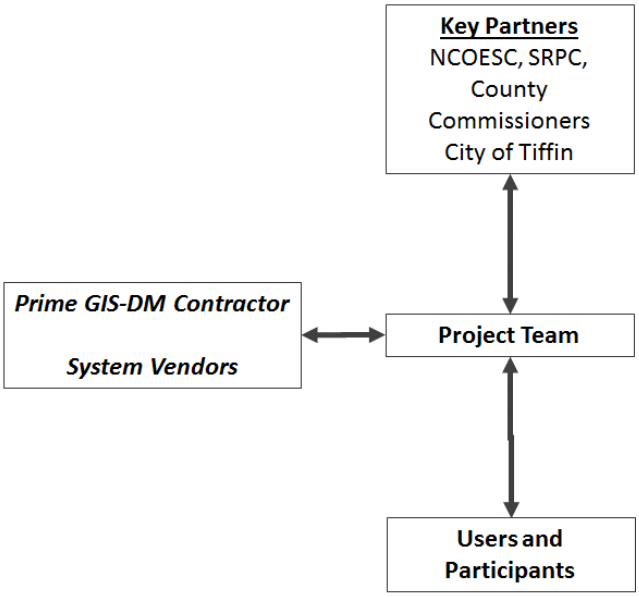


Figure 8(b): Organizational Structure for Ongoing RGIS Operations

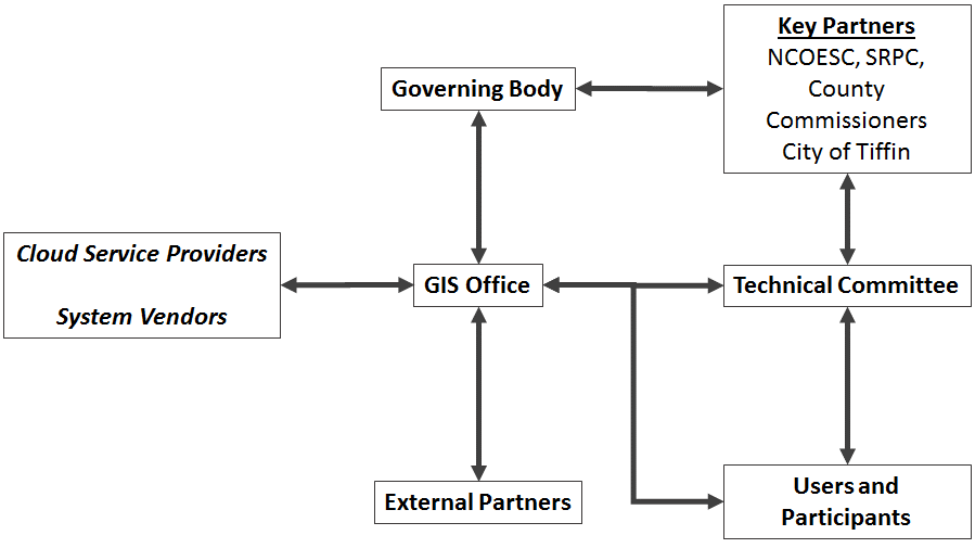


Table 11 provides more detailed information about the organizational structure depicted in Figures 9(a) and 9(b) above.

Table 11: Explanation of the Recommended RGIS Program Organizational Structure

RGIS Organizational Entity	Description
Governing Body	This Body is composed of senior leaders from each of the Key Partners. This group oversees RGIS development and provides direction on planning and development work and its use in supporting the mission. This Body approves expenditures, contracts, and the assignment of personnel for RGIS System development and operation.
IT Division (NCOESC)	NCOESC acts as the IT Division, an administrative unit that provides computing system and network support for users and applications. The IT Division plays a key role in RGIS System technical design and development (ensuring that proper standards and operational integrity is maintained) and provides IT infrastructure support for RGIS operations.
GIS Office	This is the new organization is to be established in the Seneca Regional Planning Commission at the end of the Phase 2 development work. It has the main responsibility for ongoing operations of the RGIS System, maintaining the RGIS System database (with support from users), coordinating activities with other organizations, executing special projects, and providing support to users. This Office includes a manager and a small technical staff (including student interns).
Project Team	The Project Team has responsibility for overseeing and managing the phased RGIS development work. It includes personnel from the Key Partners and other key stakeholders. This is the main group that reviews contracted deliverables and the work of contract personnel—providing quality assurance checks and approval. This group works with management and staff in their organizations to gather information necessary for development, organize review activities, and coordinate other work necessary for RGIS development.
Technical Committee	The Technical Committee is formed at the end of the Phase 1 development period or soon after completion of this development. It includes mid-level managers and technical or operations staff from the Key Partners and representatives from other organizations that are making use of the RGIS System. This is a standing committee whose membership may be rotated or added to as necessary. It is led by the RGIS GIS office. The primary purpose of this group to encourage and enable involvement from and coordination among RGIS staff and users throughout region. The Committee may take on roles in RGIS System projects, develop standards, explore new system uses and applications, help organize training activities, provide assistance to new users, and a range of other support and coordination functions. Decisions are reached through a collaborative consensus process. The Project Team can be used as the basis for this Technical Committee.
Contracted Companies	This group includes all entities contracted to provide RGIS System products and services. In Phase 1, this includes a Prime Contractor with a lead role (with possible subcontractors) for RGIS development (applications, database development, training, etc.). This group also includes other vendors and contractors that provide RGIS System products and services (e.g., Esri for GIS software).
System Users and Participants	This group includes all organizations other than the Key Partners which participate in the design and development of the RGIS system (providing ideas and input for requests from the Project Team).
External Partners	External organizations may include, potentially, any non-affiliated organizations with which the team may share GIS data and related document, be involved in some type of RGIS-related project collaboration, or establish some other type of RGIS coordination. This type of relationship should be strengthened to ensure that infrastructure changes are reflected in GIS update. Relationships with external organizations may involve formal agreements or informal coordination. Depending on the specific external organization and nature of the relationship, agreements may be established at any level but work and information exchange is handled by the RGIS Project Team, the Technical Committee, of the GIS Office. The GIS Manager has primary responsibility for managing these external organizations but the Technical Committee plays a role as well. Certain types of formal relationships and agreements with external organizations will require the approval of the Governing Body.

4.4 Resourcing and Staffing

Staffing requirements are impacted by the demands for RGIS development and ongoing work for system operations after this intense period of development and deployment. It is assumed that the majority of work on development (e.g., document conversion, GIS database design/configuration

changes, application development, etc.) will be the responsibility of a selected contractor (or team of contractors). EMH&T recommends that current staffing levels allocated to the RGIS effort be maintained for Phase 1. Key RGIS related activities for personnel during Phase 1 include:

- Continuing ongoing work with GIS data capture and update.
- Work on special GIS projects (as requested by management and users).
- Organizing documents in preparation for scanning/indexing work.
- Quality assurance review and acceptance for scanned/indexed documents.
- Support design and review/comment of custom RGIS applications (also will require limited time from users).

Table 12 provides recommendations on contributions of existing personnel and new recommended positions to support development operations.

Table 12: Staff Resource and Time Requirements for RGIS Development and Operations

		Estimated Full-time Equivalent Positions (FTE)		
		Phase 1	Phase 2	Phase 3
Position/Project Role	**Description**	FY2015-2016	FY2016-2017	Future FYs
A. GIS Specialist	Existing GIS specialist (Engineering) with key role in RGIS Project.	0.50	0.25	0.25
B. GIS Specialist	Existing GIS manager (Auditor) with key role in RGIS Project.	0.50	0.25	0.25
C. Data Infrastructure Specialist	Full-time position with approximate 70% of time devoted to GIS-related data collection, update, and management.	0.50	0.75	0.75
D. Project Manager	Management of RGIS Project in all phases	0.25	0.25	0.10
E. Staff	Participation in RGIS project by providing input for design and development and comments from deliverable review. This includes contributions of time from existing personnel who are members of the Project Team or Technical Committee or provide input during development (not including positions A, B, C, and D above). FTEs shown are estimated totals for all personnel.	0.75	0.50	0.50
F. GIS Analyst	New recommended position to support expanded user base	0	0.50	1.0

		Estimated Full-time Equivalent Positions (FTE)		
		Phase 1	Phase 2	Phase 3
Position/Project Role	**Description**	FY2015-2016	FY2016-2017	Future FYs
	and demand for EIS-DM services			
G. GIS Interns	New recommended position to support expanded user base and demand for EIS-DM services.	0	0.50	1.0

Legend: Existing Position | New Recommended Position

4.5 Implementation Tasks and Timing

This Section contains the detailed tasks and timing for RGIS development and operational deployment in Phases 1, 2 and 3 which culminate in a fully operational system and ongoing RGIS Program. The projected timing for the phased completion is approximately 3 years (to the end of 2018). Implementation tasks described in this Section are organized into the following high-level work areas:

1. Project Organization and Preparation
2. Management Structure and Staffing
3. Project Management and Communications
4. Document Database Development
5. GIS Database Design and Restructuring
6. Server and Network Set-Up and Software Configuration
7. Office Equipment Specifications and Implementation
8. System, Software, and Network Administration
9. Custom Application Development
10. User and Technical Training / Professional Development
11. Ongoing Database Update
12. User Support and Helpdesk Services
13. Outreach and Promotion
14. External Relations and Agreements

4.5.1 RGIS Implementation Tasks and Timing

The high-level work areas in the Implementation Plan are summarized in Table 13 below.

Table 13: Summary of Implementation Plan—High-Level Work Areas

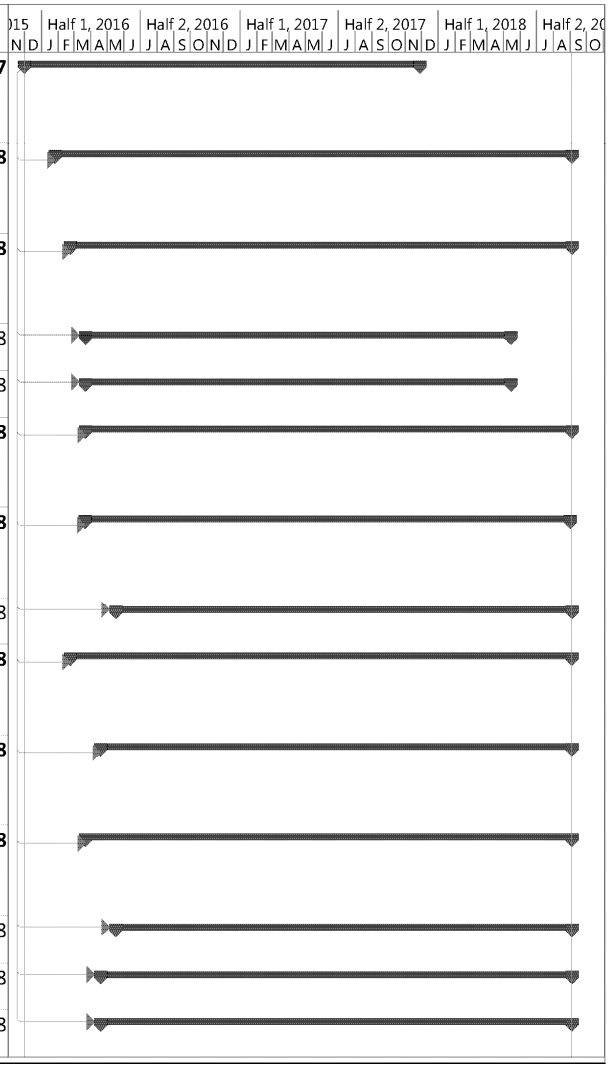
High-Level Work Area	Planned Start	Planned Finish	Phases
1. PROJECT ORGANIZATION AND PREPARATION	**12/1/15**	**11/27/17**	**1, 2**
This work area covers key activities necessary for a proper initiation of Phase 1. This is includes: a) completion and approval of the Implementation Plan (multi-year plan for full RGIS development and deployment), b) Budgeting and funding, and c) selection and procurement of vendors and consultant services for future phases.			
2. MANAGEMENT STRUCTURE AND STAFFING	**1/25/16**	**9/3/18**	**1, 2, 3**
This Work Area addresses all areas of RGIS System organizational development, program governance, and staffing. This includes assignment of a Project Team for Phase 1, 2 and 3 work, creation of a technical committee, and the creation of formal policies addressing technical and non-technical topics. Also included is the establishment of a clear support environment (server, software, network administration) with the NCOESC IT Division.			
3. PROJECT MANAGEMENT AND COMMUNICATIONS	**2/22/16**	**9/3/18**	**1, 2, 3**
This Work Area covers all ongoing project administration activities required to keep the project on track and efficiently executed. Key areas include periodic adjustments to the Implementation Plan (scope and schedule adjustments as needed), set-up and maintenance of a project Web portal, formal project status reporting, and all ongoing communications among the project team, consultants and vendors, management personnel, and users.			
4. DOCUMENT DATABASE DEVELOPMENT	**3/22/16**	**5/14/18**	**1, 2, 3**
This Work Area is an outcome of the document inventory, document database design, and Phase 1 data conversion carried out for the Phase 1. Design decisions and cited changes will be identified and scanning/indexing procedures will be revised as necessary. Hardware and software for full document scanning and indexing will be set-up and tested and a detailed work plan will be prepared to guide full document database development. based on these design and setup activities, all documents will be scanned and indexed, QA checks will occur, and documents will be added to the RGIS System data repository and made available for users.			
5. GIS DATABASE DESIGN AND RESTRUCTURING	**3/22/16**	**5/14/18**	**1, 2, 3**
This Work Area addresses all RGIS database design and development activities necessary to support RGIS System applications identified in Phase 1--focusing on migrating the current File geodatabase data into a server-based ArcSDE geodatabase. Accompanying this geodatabase migration, this Work Area covers all modification and entry of GIS database design parameters for geodatabase Feature Classes and datasets including: spatial reference parameters, attribute schemas, logical and spatial rules, annotation controls, default symbology, and display rules. In addition, this Work Area includes set-up of metadata forms (ArcCatalog) and population of metadata for each Feature Class.			
6. SERVER AND NETWORK SET-UP AND SOFTWARE CONFIGURATION	**3/22/16**	**9/3/18**	**1, 2, 3**
This Work Area covers setup of the server, network, and software environment to support development work and ongoing system use in Phases 2 and 3. This includes allocation and setup of server resources, installation and configuration of server-based software (primarily ArcGIS for Server, SQL Server), ArcSDE database software. Also included is the setup of wired and wireless networks for user access.			
7. OFFICE FACILITIES PERIPHERAL HARDWARE AND EQUIPMENT SPECIFICATIONS AND IMPLEMENTATION	**3/22/16**	**9/3/18**	**1, 2, 3**
This Work Area addresses office, system, and equipment needs for RGIS System operations. It covers design and set-up of a facility for document scanning and database update and the acquisition of new or upgraded computer hardware and software (including mobile devices).			
8. SYSTEM, SOFTWARE, AND NETWORK ADMINISTRATION	**5/17/16**	**9/3/18**	**1, 2, 3**
This Work Area addresses all ongoing technical system administration and monitoring--user accounts and access security, network services, routine performance and security monitoring of the server and network, addressing problems with access, performance, and security, managing server software licenses, and all other routine system administration activities.			
9. CUSTOM APPLICATION DEVELOPMENT	**2/22/16**	**9/3/18**	**1, 2, 3**

High-Level Work Area	Planned Start	Planned Finish	Phases
This Work Area covers activities for full development and deployment of user applications. This includes application design and development work addressing user interface, workflow, coding work, database connections, and other activities for full deployment of the applications. The application development will follow a systematic process that includes user review and feedback. This Work Area also includes design and development of integration with external systems and databases that support user needs. Also part of this Work Area is the completion of technical and user documentation.			
10. USER AND TECHNICAL TRAINING, AND PROFESSIONAL DEVELOPMENT	**4/19/16**	**9/3/18**	**1, 2, 3**
This Work Area covers all training and professional development associated with the RGIS System. This covers general system orientations, specific training for software and applications and the establishment and operation of a "GIS Library" (primarily digital resources and links).			
11. ONGOING DATABASE UPDATE	**3/22/16**	**9/3/18**	**1, 2, 3**
This Work Area covers work associated with ongoing update and maintenance of the GIS and document database--capturing updates that result from major projects, minor repair/maintenance activities, or database errors uncovered in the course of routine work. Maintenance work is carried out using specific tools and applications geared to the specific update activity and includes document scanning and indexing; capture and update of map features, attribute data, and metadata; and associated QC checks. An important part of this Work Area is the assignment of responsibilities for update of specific GIS Feature Classes.			
12. USER SUPPORT AND HELPDESK SERVICES	**5/17/16**	**9/3/18**	**1, 2, 3**
This Work Area includes organizing and setting up procedures and tools for user support services--that promotes effective use and ongoing expansion of use of the RGIS System. This will involve a number of different sources including the NCOESC IT Division (for infrastructure related issues) for user support, and appropriate use of Esri technical support services.			
13. OUTREACH AND PROMOTION	**4/19/16**	**9/3/18**	**1, 2, 3**
This Work Area covers all activities that involve outreach for the RGIS program--focusing on topics that will support effective system use and expansion of the broad user community and support GIS and document database maintenance and applications.			
14. EXTERNAL RELATIONS AND AGREEMENTS	**4/19/16**	**9/3/18**	**1, 2, 3**
This Work Area concerns formal and informal communications, collaboration, and agreements with external organizations addressing topics that support the RGIS Program.			

Figure 9 shows the planned schedule for RGIS implementation (planned start and finish dates) for the major Task Series.

Figure 9: High-Level View of RGIS Implementation Schedule

Task #	Task Name	Start	Finish
1	**PROJECT ORGANIZATION AND PREPARATION**	**Tue 12/1/15**	**Mon 11/27/17**
2	**MANAGEMENT STRUCTURE AND STAFFING**	**Mon 1/25/16**	**Mon 9/3/18**
3	**PROJECT MANAGEMENT AND COMMUNICATIONS**	**Mon 2/22/16**	**Mon 9/3/18**
4	**DOCUMENT DATABASE DEVELOPMENT**	Tue 3/22/16	Mon 5/14/18
5	**GIS DATABASE DESIGN AND RESTRUCTURING**	Tue 3/22/16	Mon 5/14/18
6	**SERVER AND NETWORK SETUP AND SOFTWARE CONFIGURATION**	**Mon 3/21/16**	**Mon 9/3/18**
7	**OFFICE EQUIPMENT SPECS AND IMPLEMENTATION**	**Mon 3/21/16**	**Fri 8/31/18**
8	**SYSTEM, SOFTWARE, AND NETWORK ADMIN**	Tue 5/17/16	Mon 9/3/18
9	**CUSTOM APPLICATION DEVELOPMENT**	**Mon 2/22/16**	**Mon 9/3/18**
10	**USER AND TECHNICAL TRAINING / PROFESSIONAL DEVELOPMENT**	**Mon 4/18/16**	**Mon 9/3/18**
11	**ONGOING DATABASE UPDATE**	**Mon 3/21/16**	**Mon 9/3/18**
12	**USER SUPPORT AND HELPDESK SERVICES**	Tue 5/17/16	Mon 9/3/18
13	**OUTREACH AND PROMOTION**	Tue 4/19/16	Mon 9/3/18
14	**EXTERNAL RELATIONS AND AGREEMENTS**	Tue 4/19/16	Mon 9/3/18



4.5.2 GIS Database Maintenance

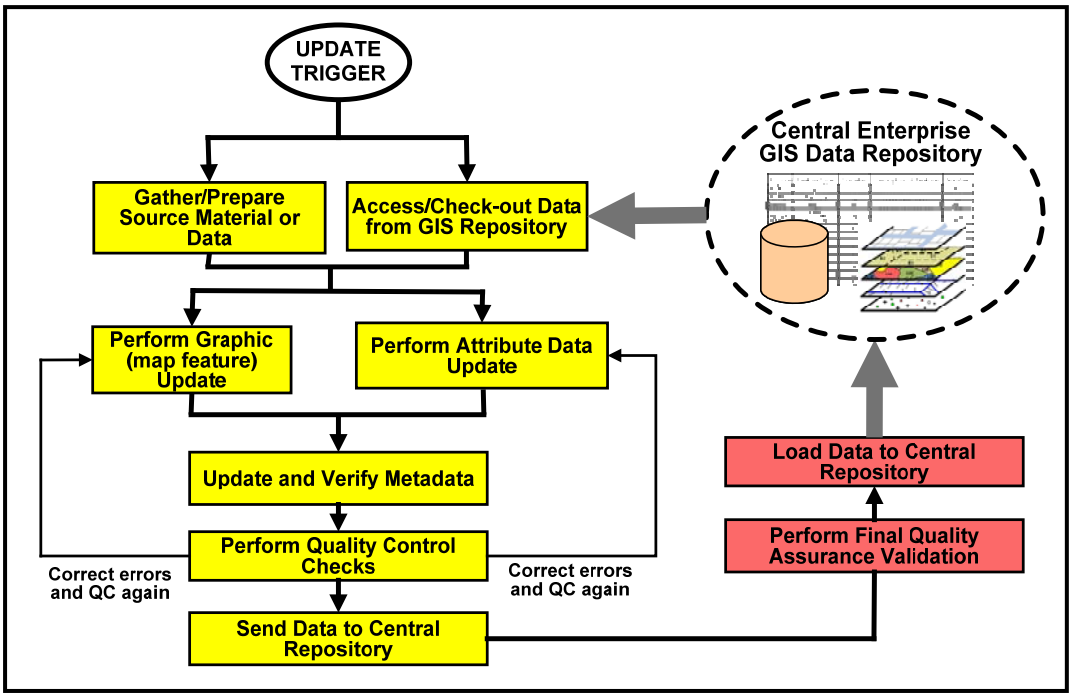
Maintenance of the GIS database is a critical function of database administration, and the GIS manager should exercise strong oversight. The goal of database maintenance is to keep the GIS data accurate, current, and accessible by users as changes occur.

GIS database update procedures should reflect careful planning and the characteristics of different data sets. The following are key factors to take into account when planning and managing data updates:

- Frequency of changes to field conditions and source materials that influence the timing of database update
- Format and availability of sources to be used in the update
- Update triggers that procedurally notify GIS of physical changes that require data updates (e.g., building permit or field inspection showing changes)
- Workflow, technical tools, and applications for performing the update
- Formally assigned responsibility (e.g., person or organizational entity) for performing update
- Approaches to quality assurance and posting updates to a central GIS database
- Metadata update
- Tracking update transactions and informing users of database revisions.

Figure 10 illustrates a generalized workflow for GIS database maintenance which includes update to GIS features and attributes with appropriate quality control measures applied during the update. This is followed by delivery of updated data to the central GIS database repository where final quality assurance checks are run, and when data passes these quality checks, it is posted to the central repository for user access.

Figure 10: General Workflow for GIS Database Update



As a general rule, the expected timing and events that trigger and update (e.g., completion of a work order) should be identified. Then, specific responsibilities for update activities need to be assigned. Off-the-shelf GIS software tools may be available to support database update work, but these tools may require customization to reflect nuances of the data sets and to improve the efficiency of the process. Metadata should be updated along with the database. The primary responsibility for GIS database update should be the GIS group (recommended to become a formal GIS Office in Phase 3). Workflows will be put in place that ensure that triggers are monitored and that source data is provided to the GIS Office. In some cases, other users will have GIS database update responsibilities.

Ongoing GIS database maintenance should be carried out in a fairly centralized manner by the GIS Office and by GIS trained staff (and interns) in close coordination with the GIS Office. However, other groups will play a role in providing source data for GIS update work. Phase 1 implementation calls for an improvement in processes and tools used to support a streamlined database update process with a focus on the following:

- Integration between GIS and asset/work management system and processes to make sure that completed workflows trigger GIS update transactions. This can be supported in a future technical GIS integration between the future asset management software platform that provides information on a work action and a “work print” with the location of the action. This product will be used by GIS staff to make the update. Prior to full deployment, a field-based application to mark a work action (e.g., replacement of a sign) and a photo if needed can suffice.
- Incorporation of GIS-related format specifications on “front-end” project specifications—focusing on major construction or renovation projects. Revisions of

project specifications (for contractors) defining standards for plan and as-built drawing creation and submittal are already. These standards call for georeferencing and data content and format that facilitates import and update in the GIS database. Future requirements for plan and as-built drawings to be in digital form, following the stated standards, will improve the efficiency of GIS update.

- Coordinate work with public and private utility organizations. This includes getting notifications when work is being done in the area that will drive a GIS database change. Ideally, establish a process and standards for providing information about changes to underground utilities (gas, water, wastewater) in a format (e.g., mark-up on orthoimagery) that will facilitate GIS update.
- Assume that there will be a need, at least in some cases, for the GIS staff to visit the field to verify or collect data for GIS update. Staff should be prepared to visit the field with the proper GPS/GNSS equipment, sometimes on short notice, to collect data for GIS update.

4.6 Initial Cost Projections

Table 14 explains the major cost categories for development work and provides initial cost ranges (for contracted services) for the purpose of budget planning. Ranges reflect decisions to be made regarding specific approach and, in some cases, trade-offs in work responsibility between contracted services and personnel.

Table 14: Cost Estimates for RGIS Implementation

Cost Item	Low	High	Average	Notes
GIS Database Design	$ 15,000	$ 25,000	$ 20,000	Set-up of ArcSDE geodatabase design, including features class organization, attribute schemas, rules, defaults, and metadata and migration of data into this design.
GIS Data Development	$ 20,000	$ 30,000	$ 25,000	Creation of data layers for Very High Priority applications with required attributes for all features.
Document Automation	$ 30,000	$ 50,000	$ 40,000	Scanning and indexing of documents with associated QA and loading of document data required for Phase 1. Range reflects a great deal of uncertainty of total numbers and final decisions about contractor vs GIS Partners roles in document handling and on-site scanning.
RGIS Application Development and Deployment	$ 100,000	$ 150,000	$ 125,000	Design, development, testing, deployment, and documentation for RGIS applications with a "Very High" priority category. See Table 8.
Training and Orientation	$ 6,000	$ 10,000	$ 8,000	Preparation of training materials and training of technical staff and users on RGIS System operations and applications.
Project Management and Coordination	$ 55,000	$ 75,000	$ 65,000	Consulting assistance supporting all Phase 1 development and implementation work. Range reflects decisions to be made on contractor vs GIS Partners responsibilities in project oversight, reporting, coordination, etc.
Hardware and Software	$ 32,000	$ 40,000	$ 36,000	Expected costs for software licenses, contractor server costs, and hardware/software for document scanning (large-format scanning).
Travel Expenses and Other Direct Costs	$ 1,000	$ 1,400	$ 1,200	Range reflects decisions to be made on expected number of trips and on-site time
Total:	**$ 259,000**	**$ 381,400**	**$ 320,200**	

4.7 Implementation Roles, Relationships, and Management

This Section provides information and recommendations on the RGIS implementation project management approach, roles and responsibilities for specific tasks, relationships with other projects and initiatives, and key practices for project management and reporting.

4.7.1 Other Projects or Initiatives Relating to the RGIS

There are a number of other programs and initiatives, currently ongoing, recently completed, or being considered for the near future that support or impact RGIS development and operations. These are briefly summarized in Table 16.

Table 15: Other Programs and Initiatives Related to RGIS

Program, Project or Initiative	Description	Relationship to RGIS
Special Regulatory or Program Requirements	Includes a variety of programs and procedures mandated by law, regulation, or policy that involves infrastructure or locational information (e.g., Tree Removal Policy, Environmental Permitting and Inspection)	The RGIS should be used as a tool to automate data capture and presentation.
GIS Hire in the Auditor's Office	Auditor, Engineer and Commissioners have pursued an additional GIS hire.	Could affect the overall staffing levels to provide work on specific tasks as well as general redundancy in duties to keep operations running smoothly
Educational Programs	SWCD conducts periodic educational sessions.	GIS is used to created slides and presentations. New tools will streamline that process.
Board of Revision Hearing Support	Auditor must defend valuation of properties with as much available information as possible.	This will make the process much easier in that the data will all be in one location.
Ditch Maintenance Expectations Program	Existing software used by SWCD to manage history of activities and other information.	Would be good to integrate at low level in the future to gain the benefit of updated base and infrastructure information over time.

4.7.2 Roles and Responsibilities

Table 16 is a resource matrix that shows the roles and responsibilities for key organizations and groups with involvement in RGIS development and operation. The following role/responsibility codes are used in this table:

- L = Lead responsibility. In charge of planning, project tracking, delegation of work, coordination of participants, and completion of work.
- O = Oversight or Approval. Includes formal responsibility for approving plans, policies, budgets, and deliverables.
- R = Review and Comment. Participation through a review of deliverables or specifications and submittal of comments, recommendations, or suggested changes to deliverables.
- P = Participation/Support. General involvement or support, or other assistance in project tasks that may or may not include formal review and comment as in “R” above.

Table 16: Roles and Responsibilities for RGIS Development and Operation

Task Number	Work Area/Task Name	Phase(s)	Senior Management	NCOESC IT Division	RGIS Project Team	GIS-DM Office (new after Phase 2)	RGIS Technical Committee	RGIS System Users and Stakeholders	RGIS Contractor	HW/SW Vendor
1	**PROJECT ORGANIZATION AND PREPARATION**	1, 2								
1.1	Document Count and Characterization	1, 2			L				P	
1.2	Approve Implementation Plan	1, 2	O	O	L				P	P
1.3	Budgeting and Funding	1, 2	O	O	L				P	P
1.4	Procurement of Products and Services	1, 2	O	L, P	L				P	P
2	**MANAGEMENT STRUCTURE AND STAFFING**	1, 2, 3								
2.1	Establish Oversight Function	1, 2, 3	R	P	L				P	
2.2	Establish Technical Committee	1, 2, 3	O	P	L				P	
2.3	Formalize IT Role of NCOESC	1, 2, 3	O	P, R	L					
2.4	Recruit and Hire New Technical Staff	2, 3	L		P	P	P			
2.5	Establish GIS Office	3	O		L					
3	**PROJECT MANAGEMENT AND COMMUNICATIONS**	1, 2, 3								
3.1	Implementation Plan Update	1, 2, 3	O	R	L	L	P	R		
3.2	Project Reporting and Formal Communications	1, 2, 3	O	R	L	L	R			
3.2.1	Prepare Monthly Status Reports	1, 2, 3	O	R	L	L	R			
3.2.2	Prepare Quarterly Management Reports	1, 2, 3	O	R	L	L	R			
4	**DOCUMENT DATABASE DEVELOPMENT**	1, 2, 3	O		R				L	
5	**GIS DATABASE DESIGN AND RESTRUCTURING**	1, 2, 3	O		R				L	
6	**SERVER AND NETWORK SETUP AND SOFTWARE CONFIGURATION**	1, 2								
6.1	Allocate Server Resources	1, 2		P	P				L	
6.2	Install and Configure ArcGIS for Server License	1, 2		P	P				L	
6.3	Install and Configure SQL Server	1, 2		P	P				L	
7	**OFFICE EQUIPMENT SPECS AND IMPLEMENTATION**	1, 2, 3								
7.1	In-House Document Automation Facilities	1	O		L					

Task Number	Work Area/Task Name	Phase(s)	Senior Management	NCOESC IT Division	RGIS Project Team	GIS-DM Office (new after Phase 2)	RGIS Technical Committee	RGIS System Users and Stakeholders	RGIS Contractor	HW/SW Vendor
7.2	GIS Office and Facility Upgrade	1, 2	O		L	L	R			
7.3	Specifications, Acquisition, Configuration of Field Devices	1, 2, 3	O		L	L	R	R		
8	**SYSTEM, SOFTWARE, AND NETWORK ADMIN**	1, 2, 3		R	P				L	
9	**CUSTOM APPLICATION DEVELOPMENT**	1, 2, 3								
9.1	Design and Development - Very High Priority	1	O		O, P			R	L	
9.2	Design and Development - High Priority	2	O		R	O, P	O, P	R	L	
9.3	Design and Development - Moderate Priority	3	O		R	O, P	O, P	R	L	
9.4	GIS-External System Integration	3	O	R					L	
9.5	GIS-Work/Asset Management Integration	3	O	R	O, P	O, P	R	R	L	
10	**USER AND TECHNICAL TRAINING / PROFESSIONAL DEVELOPMENT**	1, 2, 3								
10.1	Online Information and Training Sources	1, 2, 3			L	L				P
10.2	Instructor Led GIS Training	1, 2, 3			L	L	R			P
10.3	GIS Professional Development and Certification	1, 2, 3	O, R		L	L	P	R		R
11	**ONGOING DATABASE UPDATE**	3								
11.1	GIS Database Maintenance	3	O		L	L	R	R		
11.2	Document Database Update	3	O		L	L	R	R		
12	**USER SUPPORT AND HELPDESK SERVICES**	1, 2, 3	O	R	L	L				
13	**OUTREACH AND PROMOTION**	1, 2, 3	O	R	L	L	P	R	R	
14	**EXTERNAL RELATIONS AND AGREEMENTS**	1, 2, 3	O		L	L	R		R	

L=Lead Responsibility, O=Oversight or Approval, R=Review and Comment, P=Participation/Support

4.7.3 Quality Control and Quality Assurance

During Phase 1, a conversion procedure manual should be created which contains detailed information on procedures to be followed for automation of key document sets in the archives. This is a crucial part of system development and calls for a coordination of personnel and contractor staff in key parts of the process:

- Selection of documents for scanning
- Pre-scan document preparation (as necessary)
- Hard copy document handling and management
- Scanning and indexing
- Quality control (part of the document scanning and indexing)
- Delivery of data and quality assurance checks and acceptance
- Post-automation hard copy document handling, and loading data into document repository

The quality assurance/acceptance step is an important part of this process and will require the establishment of clear and efficient procedures and criteria to support decisions on the acceptance or rejection of documents. This step will use automated tools with manual inspection of a defined sample to ensure quality prior to acceptance and loading of documents.

4.7.4 Monitoring and Reporting on Progress

RGIS development should be accompanied by regular tracking and reporting of development status. This includes tracking progress against all project tasks and reporting at different levels of detail for different stakeholders (management reporting vs. detailed project reporting) Procedures for status monitoring and reporting are discussed in this section.

High-Level Monitoring and Reporting

It is recommended that a “Quarterly Progress Report” be prepared for senior management. The report summarizes activities and progress at a high level (major Task Series).The report will follow a format like that shown in Exhibit A.

Exhibit A: Suggested Format for Quarterly Status Reports

(Summary reports on progress against goals)

EGIS-DM SYSTEM IMPLEMENTATION QUARTERLY PROGRESS REPORT

Submitted by: xxxxx

Submitted to: xxxxxx

Submittal date: xx/xx/20xx

Report period: xx/xx/20xx to xx/xx/20xx

Summary of Overall Progress:
Xxxxxx xxxx x xx xxxxx x xxx xx xxxxxxx xxx xxxxxxxxx x xxx xxxx x xxx xx xxxx x xxx xx. Xxxxxx xxxx xxxxxx x xx xxx xxxxxxx xxx xxxxx xxx xxxxx xxxxx xxx x xxx xxx xxxxxxx xxxxxx xx xxxx xxxxxxxxxx x xxx.

Summary of Progress for Task Series:

Work Area 1: Prototype Completion
- Xxx
- xxx

Work Area 2: Organization and Preparation for Future Phases
- Xxx
- Xxx
- xxx

[Work Area 3 to 15]

Work Area 16: External Relations and Agreements
- Xxx
- xxx

Important Issues:
Xxx xxxxx xxxx xxxxx xx x xxxxx xxxxxxxxxx xx xxxxxxxxxxx xxx xxx xxxx xxxxxxxxxxx xx xxx x xxx xxxxx xxx. Xxx xxxxxxx xxx xxx xxxxxxx xxxxx xx xxxx xxxxxxxx x xxx xxxxx xxxxxxx xx xxxxxx xxx xxx

These Quarterly Progress Reports are completed by the RGIS Project Management with input from the Project Team and they are submitted to management personnel and other stakeholders requiring a summary of progress. The Implementation Status Report, discussed below, provides information for completion of these quarterly reports.

Detailed Monitoring and Reporting of Status

This is a more detailed reporting, referred to as the "RGIS Project Implementation Status Report" that captures summary status information about work being carried out for implementation tasks in this RGIS Implementation Plan. The intended audience for these reports is management personnel and team members directly involved in the development work and other stakeholders who are actively engaged in implementation work. These reports should be prepared on a monthly or bi-monthly basis the by the Project Manager with input from the RGIS contractor and Project Team. The format shown in Exhibit B is suggested.

Exhibit B: Suggested Format for Detailed RGIS Implementation Status Report

EGIS-DM SYSTEM IMPLEMENTATION STATUS REPORT

Submitted by: xxxxx

Submitted to: xxxxxx

Submittal date: xx/xx/20xx

Report period: xx/xx/20xx to xx/xx/20xx

Summary of Progress on Tasks: Xxxxx xx xxxxxxxx xx x xxx xxxxxxxxxxx xxxxx xxxxx xxxx x xxxx xxxxx xxxx xxxxxxxxxxxx xxx. Xxxxxxx xx xxxxxx xxxxxxxxxxxxxx xxx xxxxx xxxxx xxxxxx x xx xxxxx xxxx xx xxx x xx xxx xxxxx xxx xx xx x xxx

IMPLEMENTATION TASKS	Plan Start	Plan Finish	Actual Start	Actual Finish	Percent Complete	Comments
Work Area 1: Prototype Completion						
1.1: xxxxxxxxx						
1.x: xxxxxxx						
Work Area 2: Organization and Preparation for Future Phases						
2.1: xxxxxxxx						
2.x: xxxxx						
I I I						
Work Area *n*: Xxxxx						
n.1: xxxxxxxx						
n.x: xxxxx						
Major Accomplishments this Reporting Period:						
1. xxxxx						
2. xxxxx						
3. xxxxx						
Major Upcoming Milestones and Activities:						
1. xxxxx						
2. xxxxx						
3. xxxxx						

APPENDIX A: RGIS GIS ANALYST POSITION DESCRIPTION

The GIS Analyst system description information provided here is intended to be used as a basis for formal creation of new staff position and for recruiting and selecting job candidates.

GEOGRAPHIC INFORMATION SYSTEMS (GIS) System/Database Administrator

Summary:

Under the direction of the GIS Manager, this position: a) supports GIS and document database maintenance, b) design and deployment of DM and GIS software and applications, c) ongoing monitoring, support, and management of the RGIS configuration to ensure high performance, d) technical support for users, and e) integration of non-GIS databases and applications.

Duties and Responsibilities:

- Participation in GIS database design and configuration as part of the RGIS implementation and deployment.
- Installation and configuration of RGIS software. This includes ArcGIS desktop and ArcGIS Server software, AutoCAD, SQL Server, and other software packages used to support RGIS applications.
- Support in the design and configuration ArcSDE geodatabase(s) to support users and GIS applications.
- Support creation, set-up, and use of GIS and document database maintenance operations.
- Monitor system use and performance, perform trouble shooting, make adjustments, and perform system and database tuning to ensure efficient and secure operations.
- Set-up and perform system back-ups and restore operations.
- Provide technical support in establishing GIS database quality assurance and in the installation of new or updated GIS data.
- Configure user interfaces that meet the needs of specific groups of users.
- Support other staff and consultants in the design and development of GIS applications.
- Provide support in training and technical support to users.
- Attend and provide information for required meetings.
- Perform other miscellaneous job-related duties as may be assigned.

Minimum Job Requirements:

- Must meet all personal and legal requirements for full-time positions.
- 2-year associate or technical in a GIS or IT field or full completion of an in-depth GIS Certificate program from an accredited educational institution. A 4-year degree in Geography, GIS, engineering, or related field with specialization in GIS is preferred.

- 2 years of job experience with direct involvement in Windows system administration and/or ArcGIS software and database administration.

Knowledge, Skills, and Abilities Required:

- Understanding of facilities / infrastructure planning and management business processes
- Familiarity with GIS software specifically ArcGIS 10 Desktop and ArcGIS for Server and procedures for software installation and configuration.
- Familiarity with SQL Server and procedures for installation and configuration.
- In-depth understanding of ArcSDE geodatabase architecture and SQL Server and experience in using ArcGIS and SQL Server tools for database definition, ArcSDE configuration, and performance tuning.
- Experience in the use of Windows Server for setting up and administering user and computer accounts, security, user and database access, troubleshooting, and resolving system and network problems.
- Solid technical writing skills (for preparation of user and technical documentation)
- Ability to work well with users to understand needs and communicate results.
- Must be able to work independently with provided direction.
- Must be able to take initiative and be creative.

Technical certifications (e.g., Microsoft Windows or SQL Server administration, ESRI GIS administration, GISP) are not a requirement but candidates with applicable certifications will be given preference.