

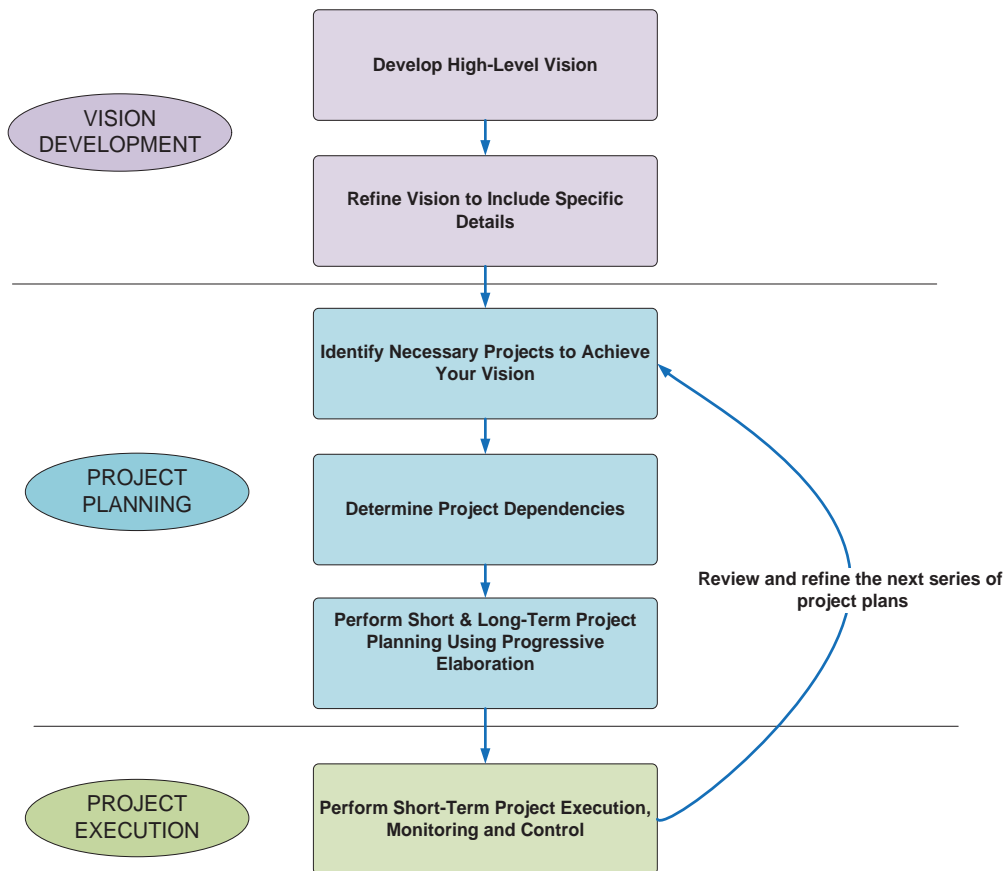
EGIS Implementation Planning for Utilities: A Dynamic Planning Model

Brandon Pfleckl, GIS Program Manager

Summary

Enterprise-wide GIS (EGIS) Program Planning can be a daunting task full of questions and, frankly, fear of where and how to start. Then, once you start, how do you stay on track? Rarely does a project, let alone a program full of dozens of related projects, proceed as originally planned without encountering obstacles that change your path of advance. Understanding the concepts of proper program management can save significant time and energy over the life-cycle of building your EGIS program. You will find that it is simpler than you think and you likely already possess some of the most important skills to plan and execute your EGIS program vision with success. Through use of *progressive elaboration* you will be armed with the ability to steer your program, despite course changing obstacles, towards successful achievement of your EGIS vision.

This paper shall explore three major processes involved in program planning; establishment of a program vision, development of a program of projects that seek to achieve your vision, and the process of project planning and project execution on the *program* scale.



There are some big differences between programs and projects. A project represents a single level of effort and usually has a well-defined scope of work including detailed requirements, executables and schedule. With projects you generally know what needs to be accomplished and have a clear path forward. Programs tend to have a much greater level of uncertainty. Generally speaking, a program is a set of related projects organized to accomplish a common vision. Programs span much longer time-frames and represent numerous levels of efforts (numerous projects). Each project in a program should represent a building block used to construct your program vision. Considering the fundamental difference between project and programs, they must be managed in different ways. One of the biggest challenge to managing a program is the duration of time a program can exist and the level of uncertainty which grows from the short-term to the long-term.

A critical element of any program is understanding your goals and objectives – put simply, you must answer the question; what are you trying to accomplish? Then determine how you are going to accomplish those goals and objectives with available resources. Ideally you would create a complete set of business and functional requirements early in the program life, develop a detailed plan moving forward, and finally execute projects that satisfy your goals. However, developing an EGIS program is not that simple. EGIS programs can span a significant portion of your organization if not your entire organization. Determining every requirement up-front and developing a single plan of execution is an impossibility for a variety of reasons. Primarily, EGIS program development can easily run into the long-term (Short-term, mid-term, and long-term will be regarded as 0.0-1.5 years, 1.5-3.0 years, and 3.0-5.0 years respectively.). A lot can change over five years that will impact your path moving forward. For example, you need to be able to take advantage of technology changes, positive or negative budget changes, operational workflow changes, political shifts, schedule delays and other factors that bump and shift your program path. Any of the preceding factors can change priorities and project approaches throughout the life of your program. Additionally, the complex web of inter-related project dependencies will undoubtedly prevent you from planning ‘the next step’ in detail until the ‘first step’ is accomplished.

Use of progressive elaboration allows you to take advantage of those changes. Progressive elaboration allows projects in the short-term to be planned in detail, but mid to long-term projects will have only generally defined scopes. As short-term projects are completed more information will become available concerning available resources and organizational priorities. Detailed planning efforts will then “progress” to the next projects in line. You should purposefully provide time throughout the life of your program to re-evaluate and adjust your program plan at regular intervals. Regardless of path shifts, progressive elaboration allows you to keep your direction heading towards your vision.

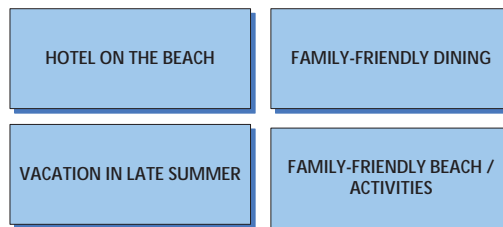
First, an analogy of program planning will be used to convey the key concepts within progressive elaboration and program planning. Secondly, a case study review of EGIS program planning will be explored; specifically, the Prince William County Service Authority’s use of EGIS in water/wastewater utility management.

Progressive Elaboration in Program Planning – Conceptual Analogy:

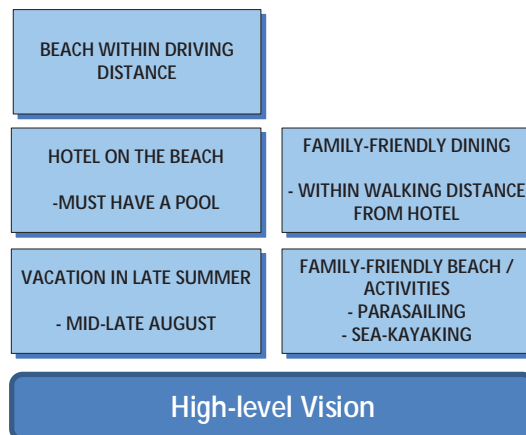
Let’s look a look at the process of planning a family vacation to the beach as a good analogy of the process involved within program planning and progressive elaboration. You will be able to apply the concepts directly to your EGIS program to help reach success.

Develop high-level vision

First, you will need to develop a high level vision. Within the context of a business, a high-level vision is a statement that declares an organization's, a program's or even a project's general goals. It is an aspirational statement of what you are striving to accomplish. Development of a high-level vision should be done early in any process you undertake so you have an understanding of what you are trying to achieve and all actions moving forward are aimed at achieving your vision. Within the context of planning a family vacation, you need to have an understanding of what your family wants to experience. Using careful thought and discussion with your family (your stakeholders), you determine that you want to go to a family-friendly beach with a variety of activities for children as well as family-friendly restaurants, you want to stay on the beach preferably in a hotel, and you need to go in late summer.



Use your very general understanding of what you want to accomplish as a discussion framework moving forward and add a greater level of detail to your vision. You determine that the beach should be within driving distance (airfare would be too costly and cumbersome with a large family), the activities you want to enjoy include parasailing and sea kayaking, restaurants should be within walking distance to your hotel, the hotel should have a pool, and the best date range is mid-late August.

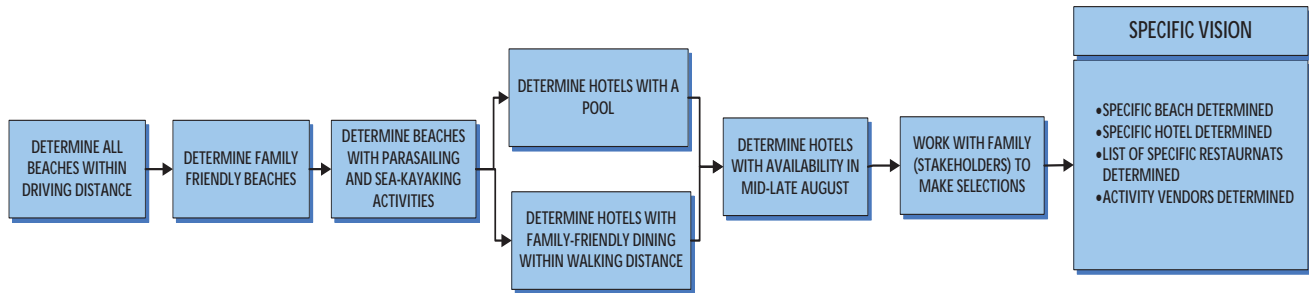


Refine high-level vision to include specific details

Defining your high-level vision is an enormously important step which lays the foundation for more detailed planning efforts moving forward. There is a lot to plan and coordinate. You want to execute your tasks in the most efficient way and with clear direction or you will waste time. Therefore, specific details must be added to your vision before you can begin. Your high-level view of what you want to accomplish should be used as a discussion tool to add specific details to your vision statement.

For example; you don't want to pick a hotel before you have decided upon the beach you want to go to nor would you want to research restaurants before you have decided upon your hotel (unless the quality of

restaurants is what drives your hotel selection). Using your high-level vision, determine dependencies and a sequence of decisions that must be answered that will refine your vision into something much more specific that can be planned against.



Identify necessary projects to achieve your vision and their dependencies

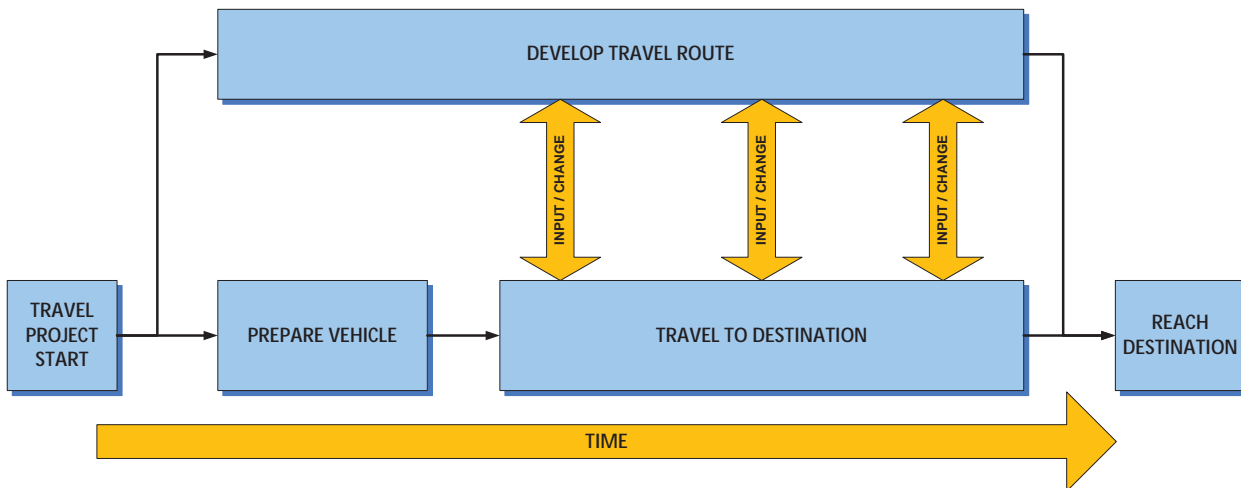
What will allow for you to accomplish your specific vision? What decisions must be made? The answers to these questions will identify the projects you need to execute to achieve your vision. In our analogy we will need to answer and plan for the following;

- *How are you going to get to the beach?*
- *What items will you need to pack?*
- *What restaurants do you want to eat at?*

Let’s look at one of those questions, travel. You’ve decided to drive to the beach but there are several dependencies to making sure you get to where you want to go on-time, safely, and reliably. Your *travel project* is comprised of several tasks:

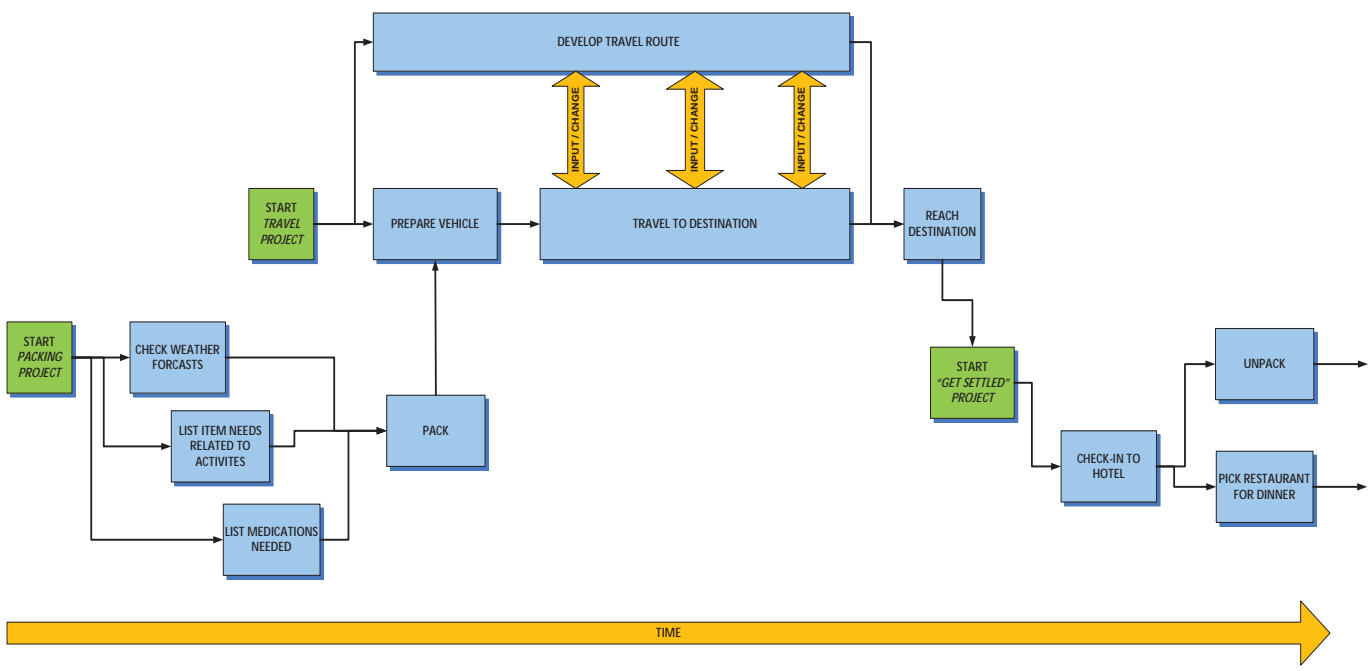
- Develop travel route
- Prepare vehicle for travel
- Travel to destination

Next, link your tasks in terms of dependency – determine which tasks needs to be done first, second, third, etc. and which tasks will occur over the life of your project. For example, your travel route will need to be adjusted throughout the life of your *travel project*. You may be able to determine the mostly likely route you will take but traffic accidents and the need for rest stops will change that plan. You will need to continually evaluate and adjust your *travel route* task throughout the life of your *travel project* as illustrated below:



Complete a similar process for all other projects. Add all your related projects together into one dependency diagram. A dependency diagram, also known as a sequence of activities, is used to create a map or diagram that illustrates the relationship between one project with other related projects. Dependency diagrams are used to identify the order in which things need to be accomplished. They do not involve the development of a specific schedule of time; however, it can help to layout your diagram in a chronological fashion (layout projects and tasks from left to right in order of completion).

For example, before you begin traveling to your destination you will need to pack all your belongings. Additionally, once you reach your destination you will need to start the check-in process, unpack and get dinner.



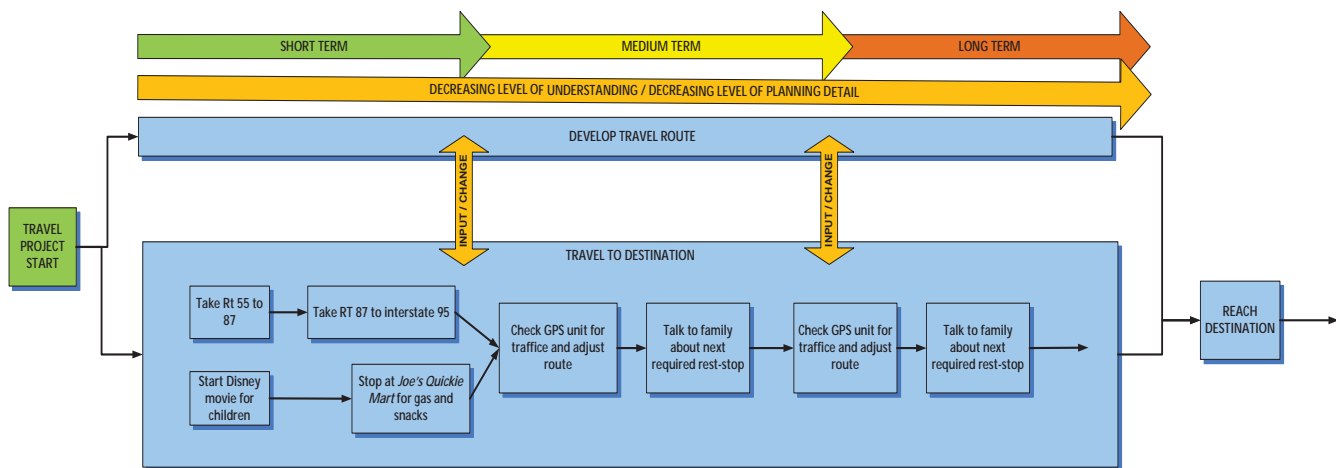
Completion of your initial dependency diagram will give you a useful look at the projects and their dependence to other related projects that must be planned for and accomplished to reach your vision.

Perform short and long-term planning using progressive elaboration

Once you have prepared your dependency diagram you can begin the process of detailed project planning. However, detailed planning can only be done well in the short-term. Over the mid and long-term you will encounter a wide variety of obstacles and garner previously unknown information that makes detailed long-term planning very difficult and, frankly, poor use of time and energy. While you need to have a good idea of the projects that are necessary to reach your vision, you can only plan projects in detail where detailed information exists. As mentioned earlier, over time your priorities, resources and the environment in which you are working will change. This is where *progressive elaboration* becomes such a useful tool.

Let's take another look at the *travel project* to elaborate on the concept of *progressive elaboration*. Instead of looking at short medium and long-term on a scale of years, we'll look at them on a scale of hours. In the first 0.0 – 1.5 hours of travel you can develop a very detailed plan of what you want to do and how you will do it. You should be well aware of the geography of the area that is closest to your home so any necessary pit-stops can be planned in detail. However, as time moves on and you enter the medium term, it becomes much more difficult to plan - family members may get hungry or have to go to the bathroom at varying intervals, you may hit a traffic jam and have to re-plan your route, or your car may need fuel earlier than expected.

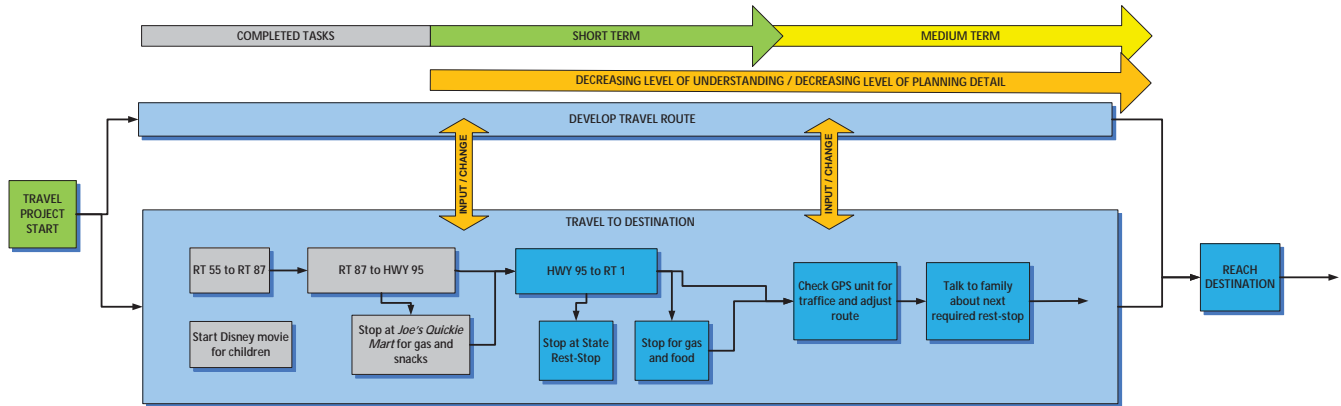
Look at the projects that occur early in your program that you know precisely how they need to be completed. You will only know how something needs to be precisely completed if you have a wealth of information at your disposal (specific stakeholder needs, available resources, etc.) You are creating your work breakdown structure at this point for the projects you know enough about to do so. Other mid and long-term projects will simply remain as broadly defined until you get to the point of the program life-cycle that you have enough information to start planning those projects in detail. For example, the illustration below depicts the *travel project* in the short, medium and long-term. The short-term travel plan has much more detail than the medium or long-term plan; however, tasks have been identified in the medium and long-term to address the need for additional decision making and planning.



Perform short-term project execution

Relying upon the detail in your short-term plan, you are able to hit-the-road and begin executing your project. Execute, monitor and control each task carefully to make sure you are staying on track. Changes to your plan

are inevitable – when changes occur alter your plan accordingly and make note of why the change was necessary. Understanding why changes in your project happened can provide useful knowledge for future planning efforts. The illustration below depicts the completion of your first set of tasks in your *travel project* and the addition of new detailed planning efforts for subsequent tasks. Over time, like a conveyor belt, what was once a mid-term task with high-level detail will roll into the short-term and you must plan for it accordingly.



Progressive Elaboration in EGIS Program Planning – Case Study Review of the Prince William County Service Authority’s EGIS Program Development Process:

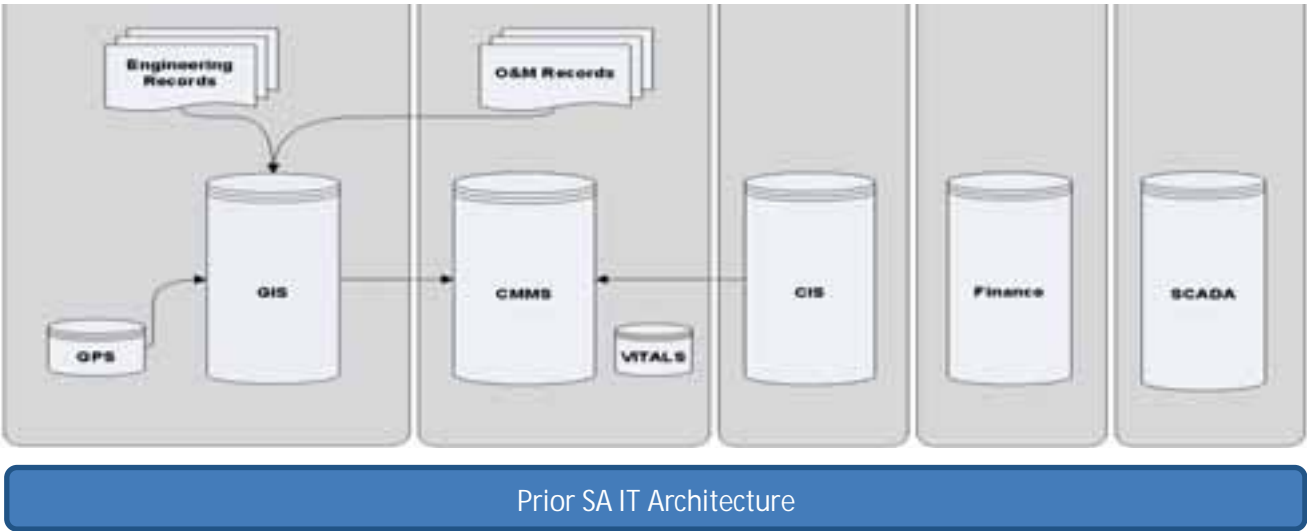
Background

The Prince William County Service Authority (SA) is a forward-thinking water utility in the Washington DC area, providing water and wastewater services to a population of approximately 375,000 people. The SA has been in the process of upgrading its technological infrastructure since early 2009 as part of a large-scale *Information Technology Master Plan* (ITMP). One of the cornerstones of the ITMP includes the development of an Enterprise Geographic Information System (EGIS) to deliver a robust versioned data production environment, a sophisticated geodatabase design capable of integration with other SA systems, an advanced ArcGIS Server-based GIS web portal, and upgrade of all other ancillary geospatial systems under the ESRI umbrella (GPS and routing applications).

The SA’s prior GIS environment was constructed around an Autodesk Computer Aided Design (CAD)-based application known as *MapGuide* Enterprise (version 6.5). *MapGuide* included functionality to edit GIS data in a CAD based environment and write that data to an Oracle Spatial database, then provide that data via the SA’s intranet to users throughout the company. *MapGuide* provided stable service of GIS data to the users within the SA; however, it lacked modern GIS capabilities, preventing the SA from meeting its GIS vision for the future.



Prior to the implementation of an EGIS, the SA's overall IT architecture was heavily fragmented. Each major IT system operated relatively independently with little integration of information across systems and little integration of business workflows. As a result, several workflows were duplicated across divisions resulting in redundant data entry (and data discrepancies), redundant and incomplete data analysis, and confusion over which personnel and what IT systems "owned" specific information.



Develop high-level vision

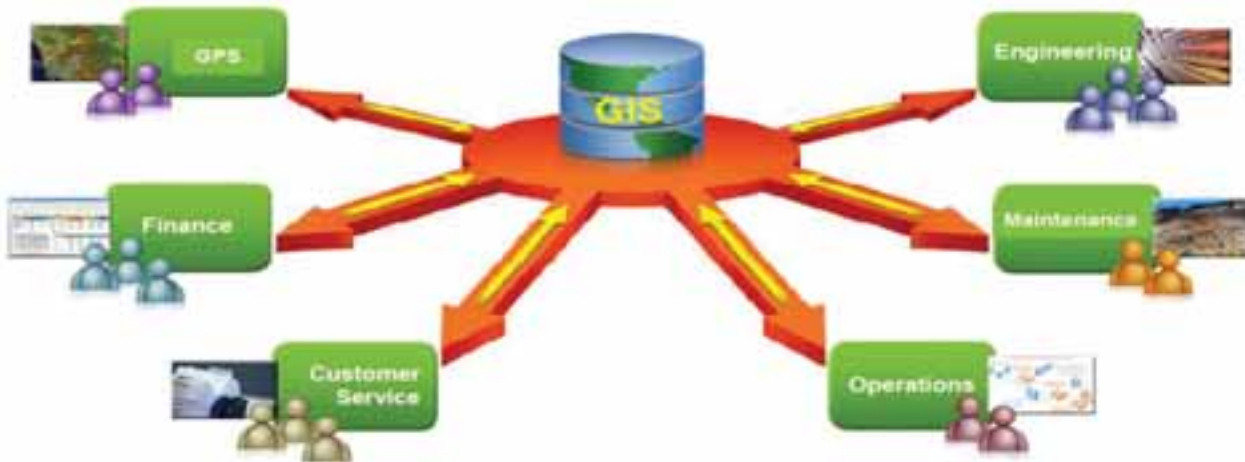
The SA relied on an outside contractor, MWH Global, to develop the ITMP and specify the high-level vision for the organization in relation to all major IT systems. Expertise was sought outside of the SA to reduce internal bias and garner the skills and experience of well-established industry experts. The report culminated a nine-month effort to review the SA's information technology and related business processes. The lengthy report provided findings, conclusions and recommendation for the SA to move forward with the accomplishment of the overall organizational goal of becoming "nationally recognized as a steward of the environment and a premier

provider of clean water and superior service by achieving excellence in our partnerships, our work culture, and our business practices.”

Driven by the statement above, a high-level vision statement was developed, within the ITMP, related to the Information Technology infrastructure and related business processes. See below for the high-level SA GIS Vision:

The GIS is envisioned as the cornerstone of the SA integrated information technology environment and the enabler for advanced asset analysis and service delivery. By coupling GIS geospatial data along with non-spatial data of other SA systems, the SA will have the ability to provide faster, more accurate and efficient services to its external customers. At the same time, the SA will enhance the ability of its employees to be more efficient through use of a common data source of spatial and non-spatial data. Utilizing GIS as the central point between the various systems will allow the SA’s full technology suite to be utilized in every aspect of its operations after the ITMP is implemented. This will change GIS from another SA system into an operational requirement and a key component in the way the SA conducts business.

In summary, the high-level vision was established to develop an EGIS where GIS was transformed from a standalone system to one that linked all other major IT systems together in a spatial context. In essence, to become a GIS-Centric organization where GIS acts as an information-hub through which all other major database systems and their data are linked. This would provide the SA with new and powerful tools to analyze information in a way that was not possible at that time. The GIS-Centric structure was envisioned to allow the SA to layer information from varying systems together to reveal spatial patterns, free data analysis tasks from the constraints of table-based queries to spatial-based queries, disseminate SA-wide information much more readily to those who need it and provide that information in much more useful ways. The illustration below depicts the initial high-level vision of the GIS-Centric structure:



Refine vision to include specific details

The ITMP took the high-level vision a step further and determined specific vision items that needed to be accomplished in order to consider the high-level vision achieved. The GIS-Centric organizational approach was further defined to accomplish the following (partial list):

- Optimize design engineer's time
- Provide access by all SA personnel to common data across IT systems in a spatial context
- Reduce clerical costs associated with maintaining current data in multiple systems
- Increase O&M field crew efficiency due to integration of mobile, GIS, and work management
- Optimize scheduling of work
- Provide ability to better recognize and set priorities
- Identify critical assets
- Reduce crew windshield time/travel distance minimized
- Provide ability to provide customers information in seconds when they call in and improve the customer's experience

The SA's high-level vision to develop a GIS-Centric IT architecture required changes to systems, data and workflows throughout the entire organization, as well as a suite of geospatial applications to support user needs. Refinement of the vision to site more specific requirements, as shown above, provided a path forward to begin program planning. The next question to ask; *how are we going to achieve the visions items listed above?*

Identify necessary projects to achieve your vision and their dependencies

The ITMP was again used to help guide the process moving forward by providing a summary review of issues that prevented the EGIS vision from being realized. For example, the ITMP reported that;

The present [GIS] system is limited in the amount of analysis that can be accomplished. The SA can gain operational efficiencies by performing GIS analysis including calculating accumulated travel cost, predicting future construction needs, and predicting areas of highest failure rate....[however,] there are no integrations between GIS and other core business systems that can benefit from such integrations.

The ITMP pointed the SA in the right direction; however, a clear understanding of where the SA stood in terms of GIS data quality and completeness, data quality and completeness of other IT systems, as well as effective and ineffective workflows was not known. Understanding this information was critical to the planning phase and beginning the transition from the old GIS system to an EGIS.

To properly determine the projects needed to reach the SA's GIS vision, the SA had to: (1) evaluate in detail its existing workflows and data quality across all major IT systems; (2) determine user needs related to the specific GIS vision items, and (3) determine improvements in the way data was collected, stored, and integrated with GIS.

Led by SA personnel, a series of internal workshops were held to discuss the existing GIS system and potentially related data and workflows from other IT systems including the SA's Computerized Maintenance Management System (CMMS), Customer Information System (CIS), Supervisory Control and Data Acquisition System (SCADA), and the SA Financial system. While tedious and time-consuming, these workshops provided an invaluable opportunity to discuss four key questions necessary to the development of a proper GIS-Centric IT architecture and related workflows:

- *What existing data does the SA maintain that is useful?*
- *What existing data does the SA maintain that is redundant and/or not useful?*
- *What data does the SA not have that is needed or could be needed in the future?*
- *What specific functionality would help SA personnel perform their job better?*

Additionally, workshops were geared around the discussion of existing workflows within each department and how those workflows are related to one another. Some database procedures were in use to move data between GIS, CMMS and CIS; however, much of the SA's existing workflows were within silos relegated to each department. The existence of information silos is common when enterprise systems are absent. However, as the SA planned to move to an EGIS environment it was crucial to discuss how data originated within the organization and passed from one department (or one system) to another. Four primary questions were asked of all major SA user groups, including:

- *Where does the data you maintain originate?*
- *How is the data transformed in any particular workflow?*
- *Is the data ever transferred to another system, and if so, how does that data change over time?*
- *How many copies of a particular piece of data exist and in which systems?*

Detailed discussions of these topics shed light on how processes and workflows were related, how they could be improved and integrated with one another (assuming a GIS-Centric architecture existed). Additionally, new data needs as well as data quality issues were identified. For example, it was discovered that some similar asset attribute information was being stored in GIS and CMMS and, at times, the attributes for a particular asset differed from one system to another. For example, a water main pipe diameter attribute may exist in GIS as 8" but the same asset had a recorded pipe diameter of 6" in CMMS.

The process of guiding these workshops into constructive dialogue, recording the information gathered, and piecing workflow and data puzzle pieces together into a clear understanding of the SA's existing baseline proved invaluable for proceeding with project planning exercises. The result was a long list of projects that had to be accomplished to achieve the SA's EGIS vision.

Let's take a look at one of the specific vision items that contains a large number of project dependencies; *provide access by all SA personnel to common data across IT systems in a spatial context.*

The vision item listed above ultimately involves the development of a web-based GIS dashboard. However, long before the process of dashboard development could begin a series of related projects had to be tackled:

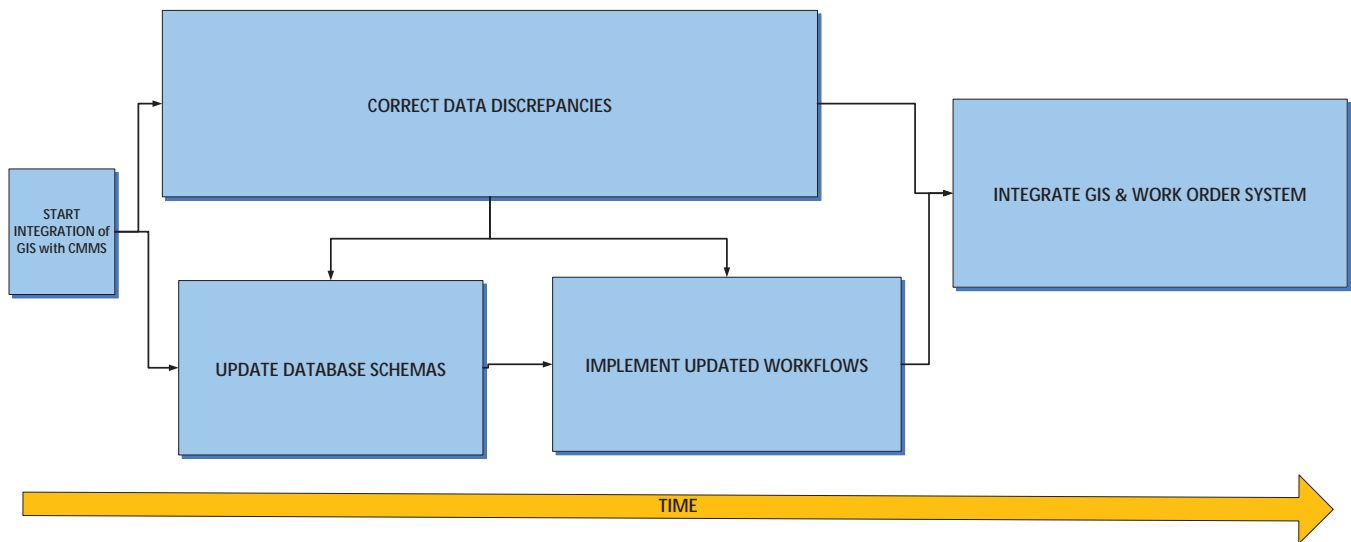
- Integrate GIS with customer service system
- Integrate GIS with work order management system
- Integrate GIS with SCADA system
- Integrate GIS with financial system

Each project listed above also includes a number of dependent tasks that had to be identified and accomplished. To simplify the example we'll look at one of the four projects listed above; *Integrate GIS with the work order management system*.

In order for GIS to integrate with the work order management system the following tasks had to be accomplished:

- Integrate GIS with work order management system
 - Identify, refine, document and implement updated workflows related to data collection and storage
 - Identify data discrepancies between the two systems and make corrections
 - Determine database linking features between the two systems and make adjustments to one or both database schemas

Now let's take a look at the tasks above from the perspective of dependency (see illustration below). The *Correct Data Discrepancies* and *Update Database Schemas* tasks can start at the same time but the *Update Database Schemas* task could not be completed until certain aspects of the *Correct Data Discrepancies* task were complete. Likewise, the *Correct Data Discrepancies* task is related to the development and implementation of new workflows (we will investigate the relationships more in the next section). Understanding how projects and their tasks are related is an important step in the development of the dependency diagram.

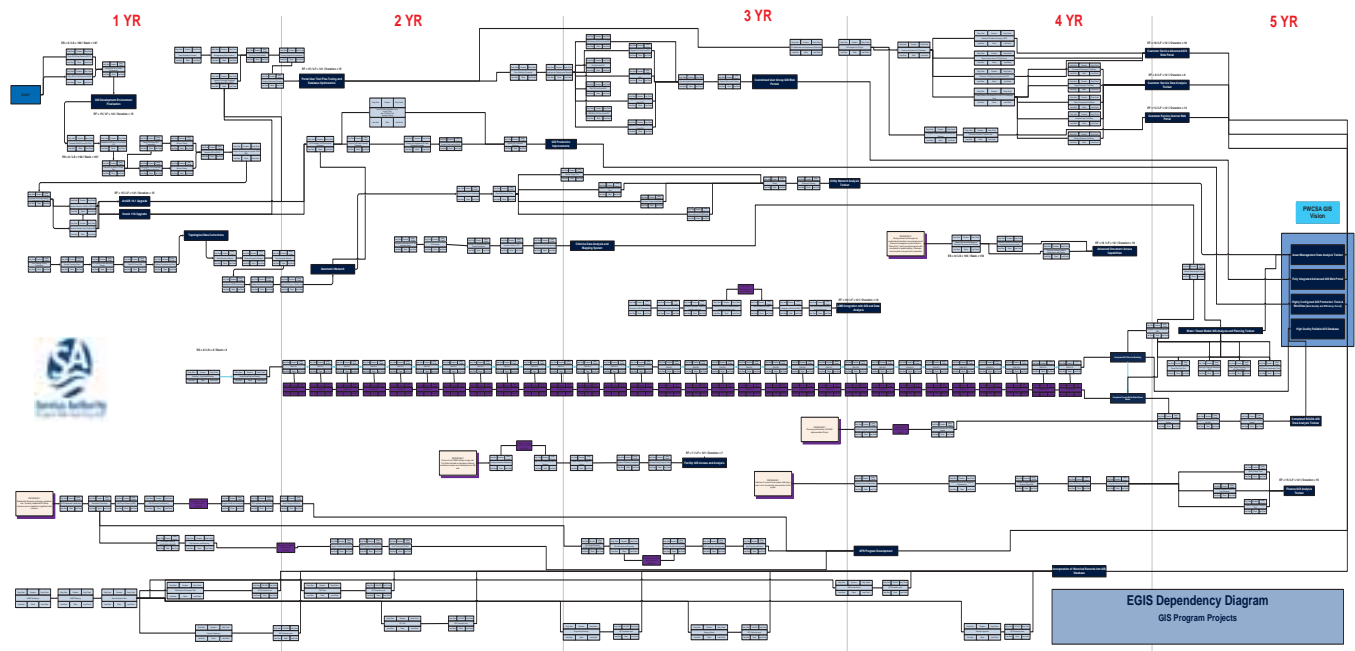


The SA has now identified the tasks necessary to integrate GIS with CMMS but has not yet planned the activities involved with each task nor linked the tasks with related projects to our vision item. There are three other large projects needing completion for the single vision item, *provide access by all SA personnel to common data across IT systems in a spatial context*, to be considered complete:

- Integrate GIS with customer service system
- Integrate GIS with SCADA system

- Integrate GIS with financial system

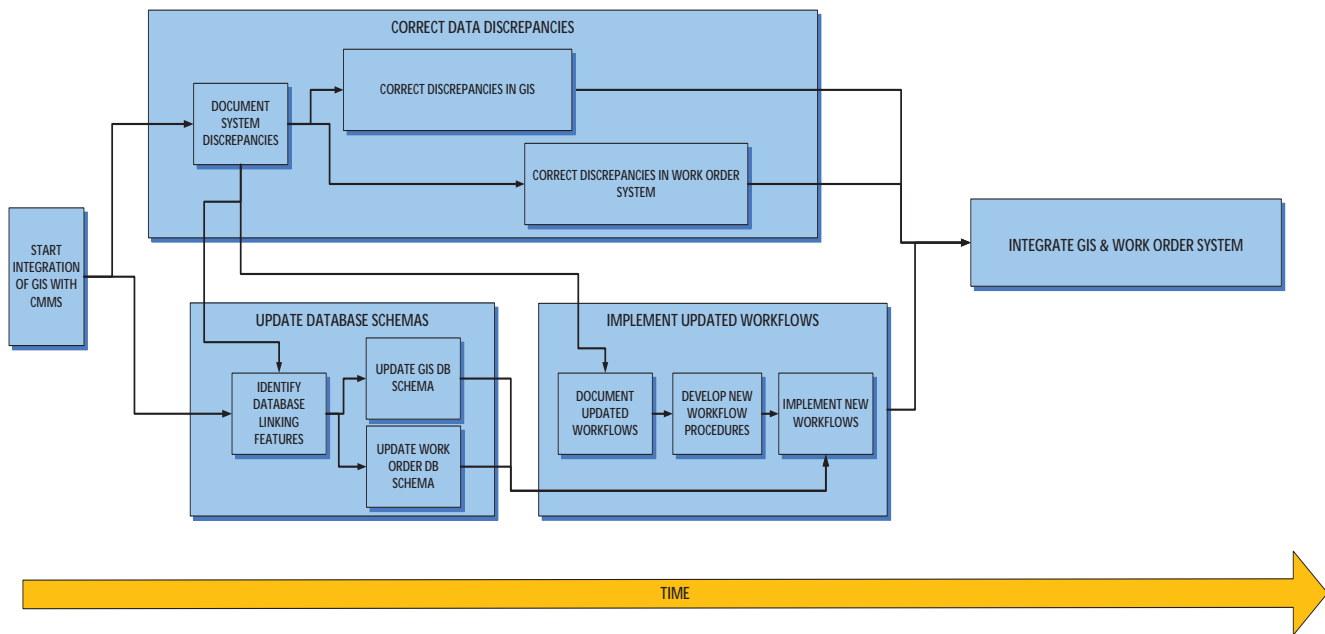
The SA incrementally investigated each project listed above and identified the tasks necessary for completion then added them to the dependency diagram. Each specific vision item was approached in a similar manner until the SA had a holistic view of all the major projects and their dependencies that had to be completed for the SA to consider their EGIS vision complete. The graphic below depicts the SA's initial dependency diagram (It is meant to convey the complexity of the planning effort involved in developing an EGIS program, it is not meant for detailed information):



Perform short and long-term planning using progressive elaboration

With the initial data dependency diagram complete the SA began moving forward with short-term project planning. Through use of *progressive elaboration*, only those projects needing completion in the early phase of the EGIS program (the short-term) were planned in detail.

Let's refocus on our single example project, *Integrate GIS with work order management system*, and its related tasks. The SA took each task within the project and developed a list of activities necessary for completion of the task and ultimately the project (think of the concept of a work breakdown structure).



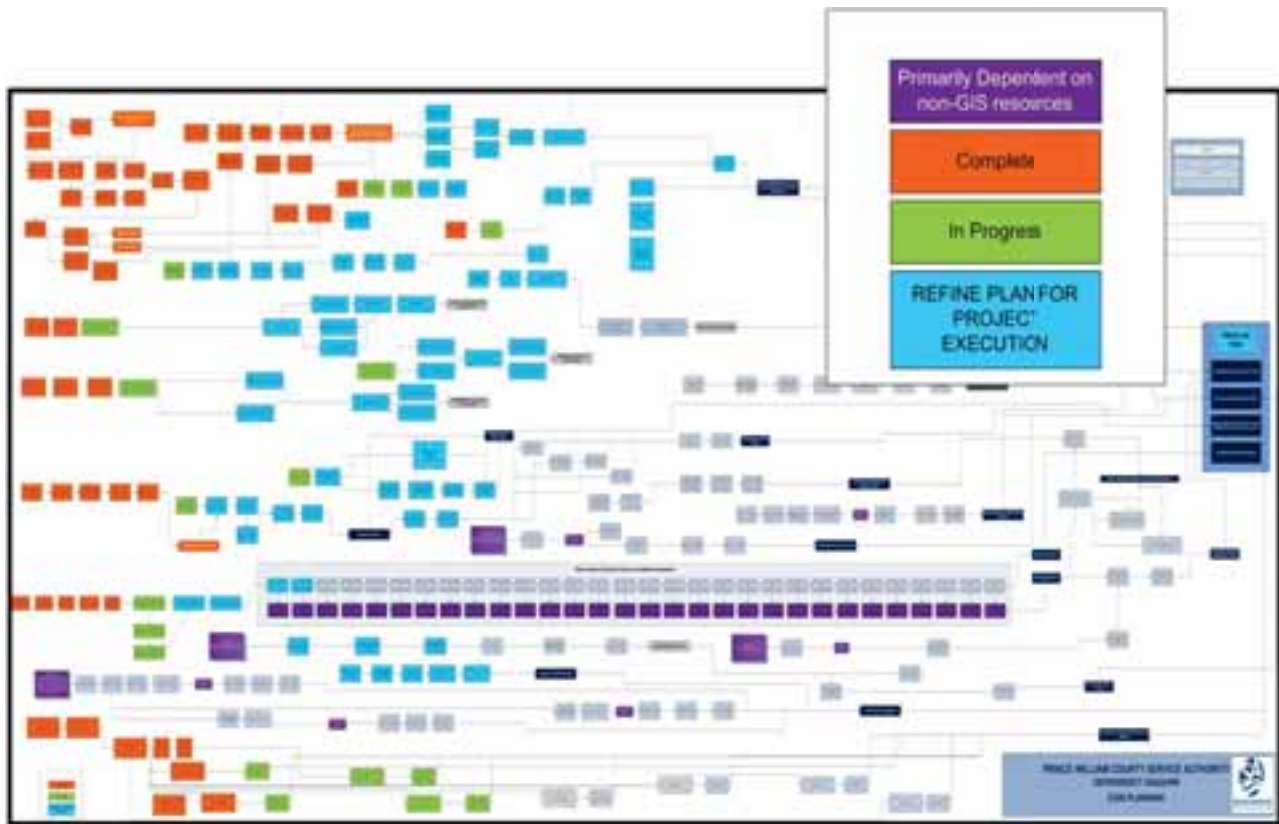
The *Correct Data Discrepancies* task required an in-depth review of all data discrepancies between the CMMS and GIS systems. Through this investigation the SA was able to develop a wealth of information necessary to achieve the integration task. Specifically; which system should “own” what data, specific database schema updates necessary, the method for system integration, and necessary adjustments to workflows.

The SA made the decision to run the *Update Database Schemas* task and the *Correct Data Discrepancies* task in parallel for one primary reason – time. The data correction process would take well over 18 months and could progress while the database schemas and new workflows were being completed, allowing the SA to progress more quickly through the *Integrate GIS with work order management system* project.

Each project in the short-term was approach in a similar fashion until a complete plan for each short-term project was developed setting the stage to begin executing the SA’s EGIS vision.

Perform short-term project execution

The dependency diagram has served the SA as a “living” document used to continually update project and activity dependencies and track progress. As projects near completion detailed planning effort ensues for the next related project in the program. The illustration below depicts the SA’s full dependency diagram which is color-coded to represent which projects and tasks are complete, in progress, ready to be planned in detail, or dependent on some project not directly tied to the EGIS Program. EGIS projects dependent on other projects outside of the EGIS program are essentially put on-hold until they are ready to be tackled. (the illustration below is meant to convey the concept of *progressive elaboration*, it is not meant for detailed information):



Make changes as needed to stay on track

Program planning starts at the high-level and progressively adds detail (top-down approach). Large projects to accomplish your program vision can be fairly easy to define but those large projects are often related to a number of smaller projects and tasks that must be planned for and accomplished. Each project is like a brick used to construct your program. Like building a house, you must pay careful attention to where each brick is placed (when it is completed) to ensure you progress as efficiently as possible.

Throughout the life of the SA EGIS program information is continually gathered related to the changing needs, priorities and resources of the SA. Some originally identified projects have been expanded and have grown in priority, others have been pushed to later stages in the program, while some have been completed canceled. When developing your EGIS program be ready to make those types of changes. The only factor that should never change, or only change pending major shifts in the organization, is the program vision.

The vision is the guiding light that must be continually kept in mind or you can easily get off track. While there should be only one complete vision for your EGIS program the path to get there should bend and shift to accommodate change. Be flexible in your approach and plan for change – build opportunities to plan for change into your EGIS program planning approach through use of progressive elaboration and steadily watch as your EGIS vision becomes a reality.

Contact Information:

Brandon Pfleckl

GIS Program Manager

Prince William County Service Authority

703-335-8996

bpfleckl@pwcsa.org

LinkedIn