County Name: **Montgomery County, Maryland**
Program Title: **Implementing Configuration Management Practices in a Geographic Information Systems (GIS) Environment**

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Program Title: **Implementing Configuration Management Practices in a Geographic Information Systems (GIS) Environment**

1. Why was this program or practice implemented?

The Montgomery County, Maryland, Department of Technology Services (DTS) has successfully launched a Configuration Management (CM) program for its Geographic Information Systems (DTS-GIS) team. CM is a field originating in the Software Engineering industry. CM provides necessary processes and tools to control change and manage data impacted by change, thus reducing the risk of errors and bad data. In the attempt to apply CM concepts in an operational GIS environment, DTS continues to work through the challenges of implementing formalized processes taken from a technically-based Information Technology (IT) industry and folding them into the fast growing data-based GIS industry, where CM practices are currently in the preliminary stages of implementation. GIS has a great need for formalized procedures to assure data and business integrity, quality control, workflow definition and tracking, development/maintenance tools tracking and change management. This project has provided best practices for the geo data management lifecycle using CM practices as a guideline, and demonstrated how change control and automated CM can effectively improve the success rate of geo-based data deliveries. By applying CM in various areas of the GIS infrastructure, DTS-GIS has increased user satisfaction and attained improved geo data deliveries to the County's public safety 911 center and its supporting agencies.

The Montgomery County DTS-GIS data environment is growing at an exponential rate. County geo data has dramatically increased in recent years, requiring more formal data development, management and delivery procedures. The DTS-GIS Team has responsibility to maintain Public Safety geo data for the County's Public Safety Data System. As such, the GIS data needed for supporting public safety requires continuous updates and modification in an effort to produce a more robust data set for Montgomery County's Law Enforcement and Fire and Rescue Services.

DTS-GIS has experienced problems related to:

- Version control
    - problems due to lack of knowing what version of a file should be used for what purpose and tracking the various versions of the file as updates are made to it
- Change control
    - problems due to lack of knowing when and where to make changes and what procedures to follow when making the change, as well as having the proper authorizations to proceed with the change
- Quality assurance/control
    - problems due to limited or lack of verification and review upon completion of a change, limited or lack of peer review, as well as limited or lack of techniques used to ensure data validation and data integrity

These problems lead to:

- team members not knowing where the official work-product baseline is located
- team members not knowing if the version of the work-product baseline they have available to them contains all approved changes to date
- work product baselines get released to the client with approved corrections made, but missing approved corrections from the previous baseline
- unapproved changes made to the official work-product baseline
- work products are unable to be built "from scratch" because all configuration items have not been documented or saved in the correct location.

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Prior to this CM project implementation, DTS-GIS did not support configuration and change management mechanisms that ensure data integrity in the geo work products. The main problems occurring within DTS-GIS are related to the data development and management processes, operational procedures, specifically including configuration management procedures in a) version control, b) change control and c) quality assurance/control. In the area of Public Safety geospatial base data, a formal data delivery process is also required in support of ensuring better services to the customer.

After several problems with internal deliveries between DTS-GIS and DTS-Public Safety Support, and problematic deliveries to the Public Safety customer, it became evident that more formal processes were required to ensure the integrity of the GIS work products by addressing configuration management practices that could be deployed in the GIS environment.

2. How was this program or practice implemented?

The objective of DTS-GIS configuration management program is to establish and maintain integrity of the geo databases within the GIS environment, specifically, the Public Safety geo data, while at the same time improving and formalizing the data management and quality assurance / control processes.

DTS-GIS CM initially established the following processes:

- Identification Process to identify all geo databases, data sets, scripts and existing tools and documentation
- Data Change Control Process for the geo data changes, updates, modifications using three new CM libraries (where data is stored for during a specific phase of the data development process)
- GIS Change Advisory Board (CAB) Process for Public Safety
- Requirements Management Process
- Requirements Change Control Process for requirements changes
- Quality Assurance/Control Process (automated)
- Release and Delivery Process consisting of a repeatable process that allows for parallel development and release at the same time.

Data Provisioning and Release Process

Internal GIS procedures were established to identify all Public Safety configuration items, including data sets, scripts and tools. With identification, all types of items can be classified as data and non-data items. All geo data items are baselined and put into a CM library (repository) where the data can be managed throughout the database development and quality assurance and control (QA/QC) process all the way through the release of the data sets.

Due to the limitations of existing CM tools in the market, the ArcInfo geo data files could not be included into a CM Repository tool for version control and tracking purposes. Instead, GIS CM has established formal business procedures to handle the version control aspect of the data development process. The manual procedures include 1) establishing CM Libraries and 2) establishing rules, policy and ownership over the libraries and subdirectories in the libraries.

CM libraries were created on the GIS development servers to maintain data sets for the workspace, source and release data. Three separate directories with the same subdirectory structure were used to house all data files for these libraries (Figure 1). This structure allows the entire team to know exactly where to find the latest copy of a particular data set that is ready for editing (source), the latest released copy of the data set which has been approved for delivery to the customer (release) while at the same time, providing a workspace directory for the GIS specialist to make updates and perform QA/ QC on an "in-work" version of the data set (workspace). The workspace directories are distributed among the various GIS development servers, according to the assigned owner. By establishing the CM libraries and defining the directory structure, a formal process was then created that all GIS team members could easily follow.

Category	# Layers	Owner	Category	# Layers	Owner
Basemap	22	Lian	Orthophotos	6	Apollo
Census	7	Lian	Permitting	3	Lian
DEM	3	Lian	Planning	5	Yanli
DHCA	1	Lian	Police	4	Vicky
DHHS	1	Dan	Political_mc	4	Celina
Elections	7	Vicky	Political_other	1	Celina
Environmental	7	Lian	Property	3	Lian
Finance	3	Lian	DPW&T	9	Barb
Fire	14	Vicky	Recreation	4	Dan
Grids	6	Barb	Regional	2	Celina
Historic	2	Barb	Schools	10	Tim
Landuse	5	Barb	Sheriff	2	Celina
Locations	19	Tim	Utilities	15	Carol
Metadata	177	Lian	USPS	2	Celina
OCE	10	Carol			

Figure 1: Data Set Categories for each CM Library with Corresponding Owner

A manual "check-in" and "check-out" procedure was established to ensure that the correct files were being modified and published. The latest copy of any data set is available in the RELEASE library. The authorized owner of the data set can "check-out" the data file(s) to the corresponding WORKSPACE directory for edits and local QA/QC. Upon completion of the editing process, the owner must "check-in", or copy a new version of the data file(s) back to the SOURCE directories.

When the geo data is ready for release, the data sets are copied from the SOURCE directories to the RELEASE directories only by authorization from the GIS Manager. In the case of Public Safety data (only), the data sets must undergo an additional step prior to release to the Public Safety customer. Due to the proprietary structure of the map files in the Public Safety Data System, the ArcInfo / ArcGIS data files must further be converted and put through another QA/QC process prior to final delivery to Public Safety, as depicted in Figure 2 below.

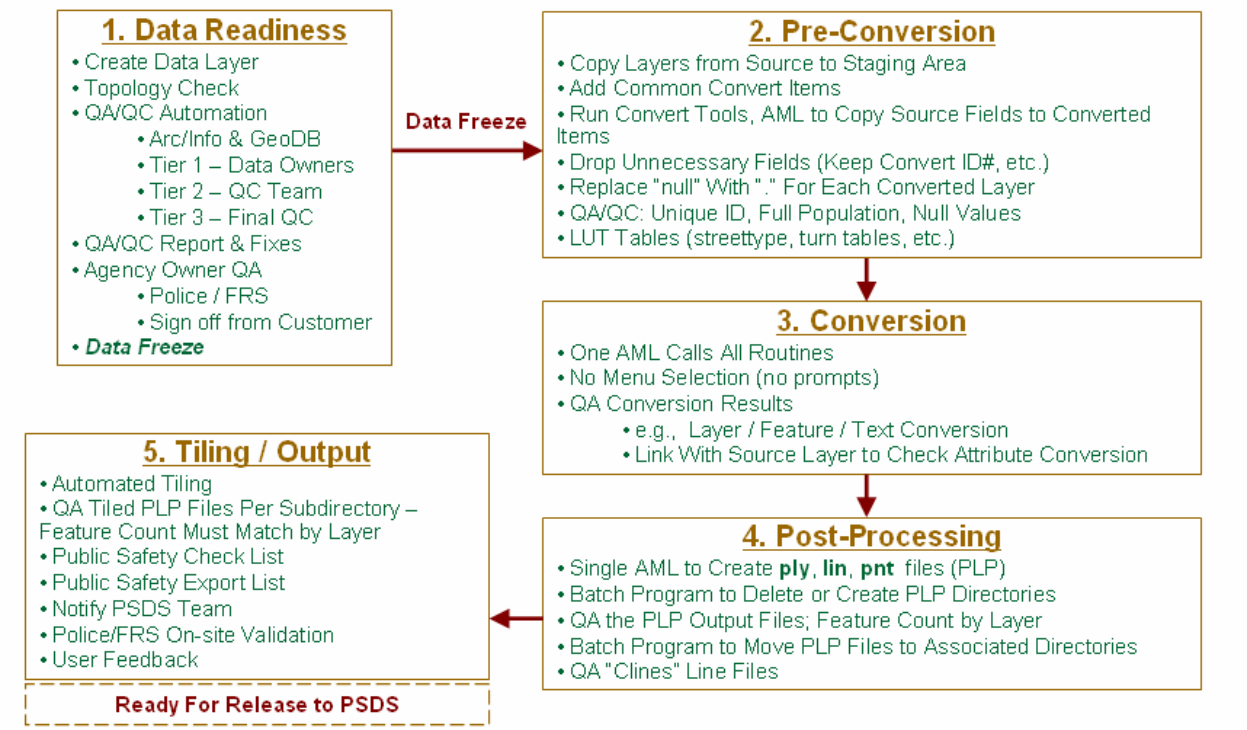


Figure 2: GIS Public Safety Data Delivery Process

Upon completion of a the Public Safety data conversion process with its own QA/QC process, all data artifacts for the geo delivery are moved to the release directory for Public Safety. By establishing various directories for different purposes, the GIS team has been able to manually address the version and change control process for geo data while maintaining the ability to continue data development in parallel while preparing for a Public Safety delivery. The process is repeatable and allows for parallel development (Figure 3).

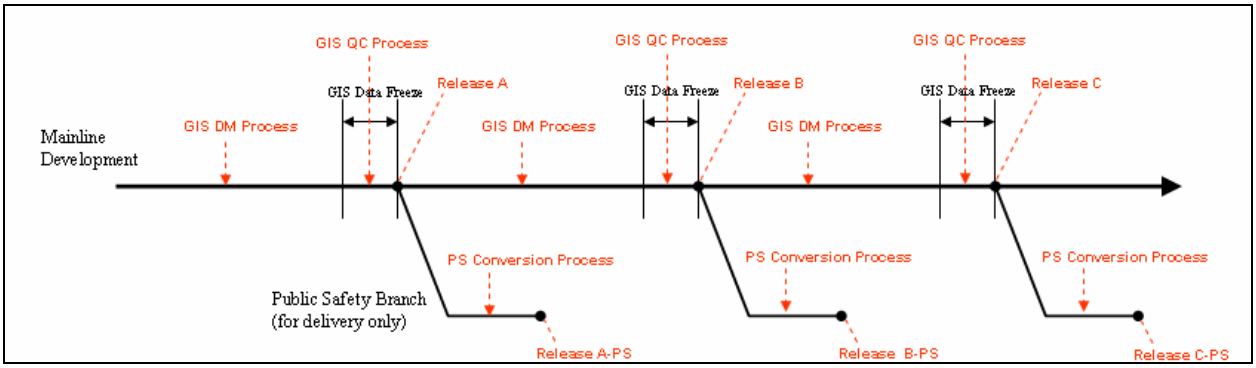


Figure 3: Repeatable, Parallel Data Development Process

Baselines are created at each point of the data development process and at the conclusion of a delivery to Public Safety. In Figure 3, a baseline is established at the beginning and the end of the "GIS QC Process." Another baseline is created "Release A" upon completion of the "GIS QC Process", while in parallel, a snapshot is created in a Public Safety directory where the "PS Conversion Process" takes place. At the completion of the conversion process, the "Release A-PS" baseline is created. "Release A" and "Release A-PS" are always copied to the release libraries as per authorization from the GIS Manager.

Requirements Management Process

A change management process, specifically designed to obtain data requirements from the Public Safety customer, allows the DTS-GIS team time to evaluate and perform an "impact analysis" for each change made in the upcoming release. Changes based on user requirements are treated separate from the standard GIS day-to-day operations, including updates to the map data. For each release, new requirements are collected from the customer during a Change Advisory Board (CAB) meeting which included representation from key County agencies (Figure 4). Again, applying the concept of a repeatable process, the CAB meetings are established at quarterly intervals, and the requirements and changes to the requirements are captured on standard forms (Figure 5).

Upon agreement of the requirements for an upcoming geo data delivery to Public Safety, the forms are baselined. Upon delivery of the final geo data to Public Safety, the released data sets are also baselined, thus, creating a configuration management baseline for a specific delivery.

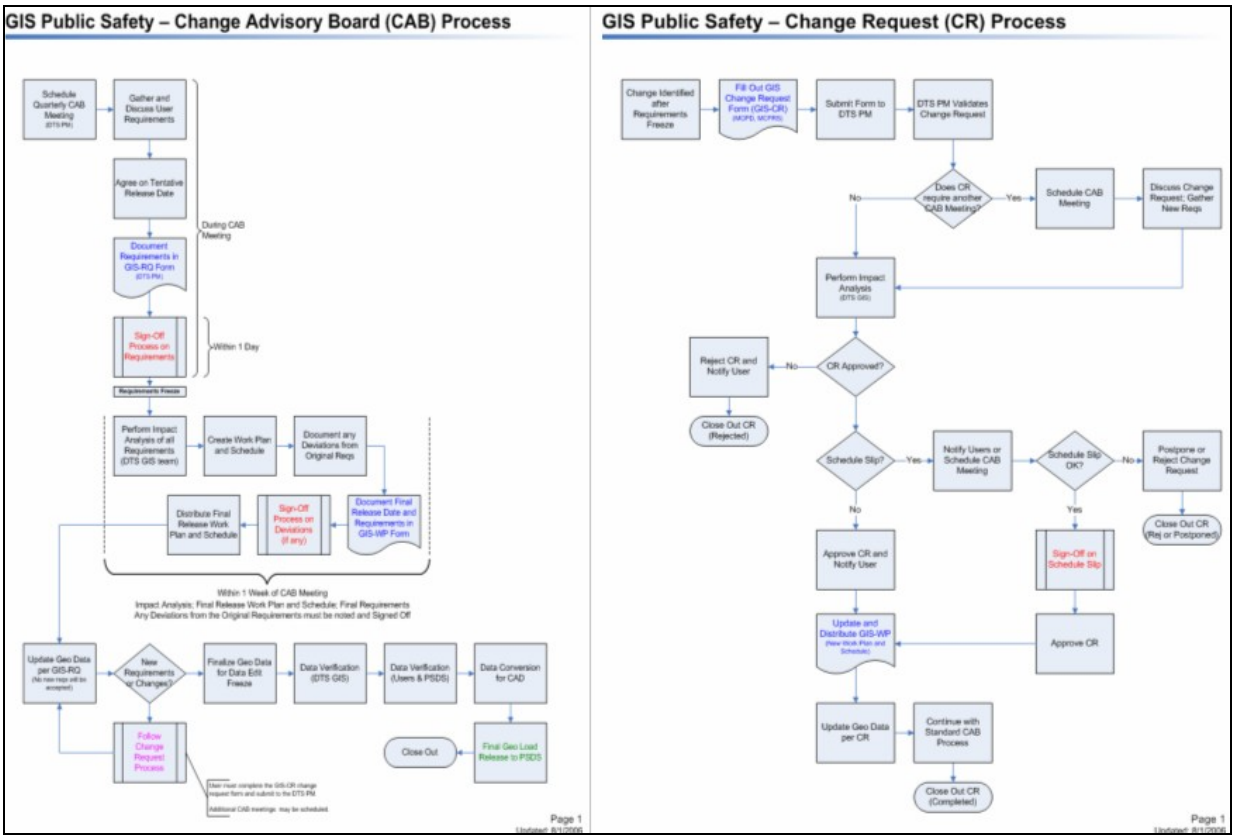
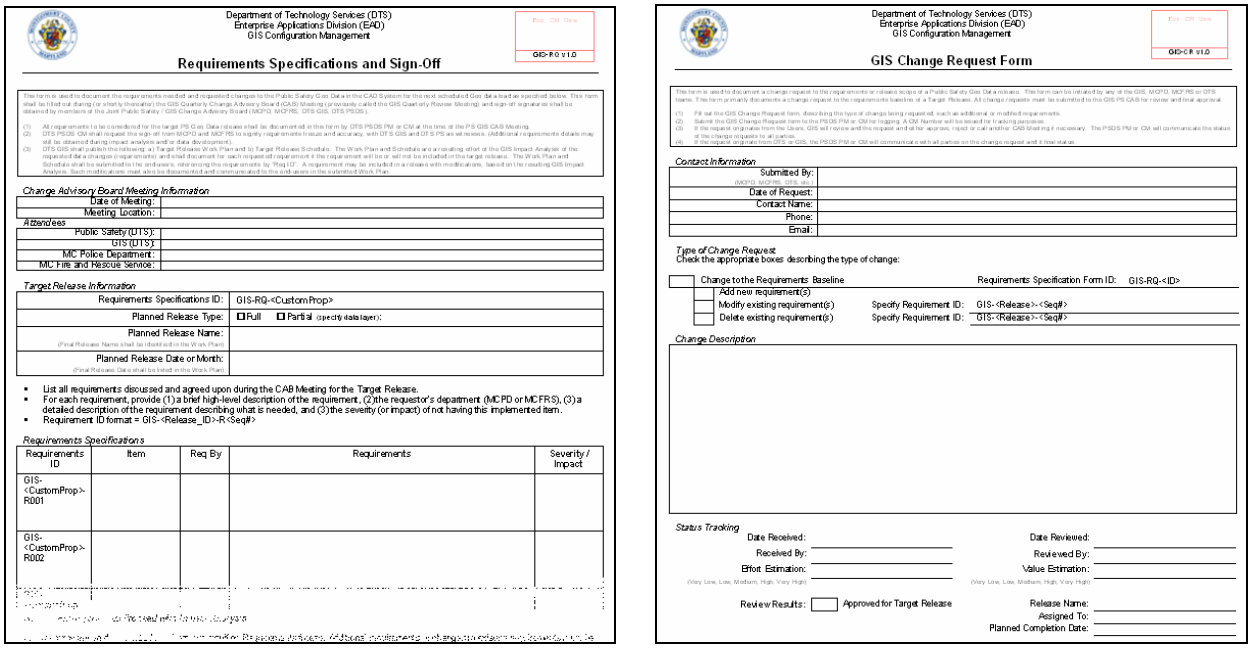


Figure 4: Public Safety Change Advisory Board Process

By establishing a regular Change Advisory Board (CAB) with the customer, DTS-GIS, DTS-Public Safety Support and the Public Safety customer are able to meet quarterly to discuss data requirements for upcoming geo data deliveries. The increased communication between the agencies ensured that the requirements were gathered and agreed upon in a timely fashion and that the DTS-GIS team could properly assess and perform an impact analysis to the data and delivery schedule. This has helped the GIS team to meet the customer's expectations by delivering high quality geo data in a consistent and timely manner.

Program Title: **Implementing Configuration Management Practices in a Geographic Information Systems (GIS) Environment**



Department of Technology Services (DTS)
Enterprise Applications Division (EAD)
GIS Configuration Management

Requirements Specifications and Sign-Off

GIS-RQ v1.0

Change Advisory Board Meeting Information

Date of Meeting:	
Meeting Location:	

Attendees

Public Safety (DTS):	
GIS (DTS):	
MC Police Department:	
MC Fire and Rescue Service:	

Target Release Information

Requirements Specifications ID:	GIS-RQ-<CustomProp>
Planned Release Type:	☐ Full ☐ Partial (specify data layer):
Planned Release Name:	
Planned Release Date or Month:	

- List all requirements discussed and agreed upon during the CAB Meeting for the Target Release.
- For each requirement, provide (1) a brief high-level description of the requirement, (2) the requestor's department (MCPD or MCFRS), (3) a detailed description of the requirement describing what is needed, and (3) the severity (or impact) of not having this implemented item.
- Requirement ID format = GIS-<Release_ID>-R<Seq#>

Requirements Specifications

Requirements ID	Item	Req By	Requirements	Severity / Impact
GIS-<CustomProp>-R001				
GIS-<CustomProp>-R002				

Department of Technology Services (DTS)
Enterprise Applications Division (EAD)
GIS Configuration Management

GIS Change Request Form

GID-CR v1.0

Contact Information

Submitted By: (MCPD, MCFRS, DTS, etc.)	
Date of Request:	
Contact Name:	
Phone:	
Email:	

Type of Change Request
Check the appropriate boxes describing the type of change:

☐ Change to the Requirements Baseline — Requirements Specification Form ID: GIS-RQ-<ID>
- ☐ Add new requirement(s)
- ☐ Modify existing requirement(s) — Specify Requirement ID: GIS-<Release>-<Seq#>
- ☐ Delete existing requirement(s) — Specify Requirement ID: GIS-<Release>-<Seq#>

Change Description

Status Tracking

Date Received: _____ Date Reviewed: _____
Received By: _____ Reviewed By: _____
Effort Estimation: _____ Value Estimation: _____
(Very Low, Low, Medium, High, Very High) (Very Low, Low, Medium, High, Very High)
Review Results: ☐ Approved for Target Release
Release Name: _____
Assigned To: _____
Planned Completion Date: _____

Figure 5: CAB Forms - Requirements Specifications / Sign-Off and Change Request

Use of Technology

The methodology used to establish configuration management in GIS, a data development project, was to map CM concepts and practices to the GIS processes, where applicable. The resulting use of the following technologies took place:

- Geo Data is stored in three different repositories (directory structures) on the GIS servers
- Non Geo Data items are stored in a CM Tool (CM Repository).

In applying CM tools where applicable, GIS CM is able to improve processes for the following:

- Problem Management: Currently, the DTS standard Help Desk tool is used to track data problems reported by the customer or DTS-Public Safety Support team. The application is the Remedy Magic help desk tool;
- Version Control: Efforts are currently in progress to establish a CM repository for all non-data items, such as scripts, programs, SQL stored procedures, documents, and other configuration items identified;
- Automated QC Tools and Programs: Currently, numerous scripts exist to aid in verification and validation of geo data at the workspace level as well as the release level. The QC tools are considered to be configuration items to be checked in to the CM tool.

3. <u>What Return-on-Investment benefits or measures have you recovered so far, or expect to recover?</u>

The 'tangible' cost for developing and implementing the CM process for maintaining and supplying GIS data (converted to the 911 CAD format) to the County public safety users are:

- CM expert – 50 hours (est. $3,000)
- Senior GIS analysts – 60 hours (est. $3,000)

- New Geo Data Source Server - $12,000
- Systems Administrator – 40 hours (est. $2,000)

Total cost is estimated at $20,000[1]

By applying configuration management in various areas of the GIS infrastructure and geo data environments, DTS-GIS has increased user satisfaction and understanding of the geo database model and attained several highly successful geo data deliveries to public safety 911 center and agencies. Quality Geo Data supports the critical functions of 911 call taking, unit assignment, dispatching and route recommendation. It enhances the public safety agencies' ability to protect lives and properties.

Most importantly, DTS-GIS has improved the quality of the data, which has shortened end-user QA/QC cycles, which in turn has allowed DTS-GIS to deliver more frequent updates to the Public Safety data system. Frequent geo data updates are critical for the public safety community, who use the geo data to dispatch first responders and for first responders who use the data to respond to these E911 calls. Prior to the implementation of the CM program, DTS-GIS delivered, at most, 2 data deliveries for public safety each year. These deliveries were plagued with data errors, and schedules were often missed. Subsequent to the implementation of the formal CM program, DTS-GIS has adopted a quarterly delivery schedule and has thus far achieved 11 consecutive on-time, high quality data deliveries.

4. Why will other local governments benefit from learning more about your program or practice?

Application of configuration management principles in the GIS field has greatly decreased mean time between deliveries by DTS-GIS related to the County's public safety system. This program provides better QA/QC and management of changes; the error fixes are manageable per delivery. The CM process has formalized GIS data management process so that GIS has control over its processes with repeatable formal procedures.

This program is an example of out-of-the-box thinking and in applying industry standard best practices in an environment where such practices were previously non-existent. This experience should be of interest to other GIS groups that supply significant GIS data to their end users.

[1] The staff time from other team members and the data users are considered part of their regular job functions; no cost is allocated.