Geospatial Systems That Support Emergency and Disaster Operations

A Case Study Guide for Local Government and Utility First Responders

PUBLISHED BY

Public Technology Institute and the Geospatial Information & Technology Association

Table of Contents

Acknowledgments

Geospatial Systems That Support Emergency and Disaster Operations: A Case Study Guide for Local Government and Utility First Responders was produced by Public Technology Institute (PTI) and Geospatial Information & Technology Association (GITA).

It contains local government best practices for providing first responders with support systems that make critical information easily available.

PTI and GITA would like to thank those individuals and agencies that shared their experiences and insight through the contribution of case studies.

GITA staff that contributed to the development of this publication include Robert M. Samborski, Executive Director and Kathryn Hail, Marketing & Communications Manager.

PTI staff that contributed to the development of this publication include Ronda Mosley, Senior Director for Research and Government Services; Dale Bowen, Assistant Executive Director for Program Development and Alan Leidner, Senior Associate, Booz Allen Hamilton and facilitator of PTI's GIS Forum.

About GITA

The Geospatial Information & Technology Association is a nonprofit educational association serving the global geospatial community. GITA's vision statement is to be the leading information resource and community for anyone who has a vested interest in the use of geospatial information. For more information visit www.gita.org.

About PTI

Public Technology Institute is a national, non-profit technology research organization. Created by and for cities and counties, PTI promotes innovation and collaboration for thought-leaders in government, and advances the use of technology to improve the management and delivery of services to the citizen. For more information visit www.pti.org.

Introduction

Insightful, accurate and timely information, while essential for the support of all human endeavors, is particularly critical for emergency and disaster operations when lives are at stake. Such support is even more effective when information is collected, visualized, analyzed, and operationalized geospatially, taking advantage of the location elements to be found in almost all data. Because large scale emergencies and disasters can move rapidly, affect huge areas, and threaten large numbers of people, they present enormous challenges to the first responders who must deal with them.

This publication demonstrates the continuing progress being made in applying geospatial systems to these highly complex events. It is dedicated to first responders across our nation for their past sacrifices, heroic efforts and continuing dedication.

First responders are traditionally understood to be the fire, police, and emergency services personnel who are dispatched into our neighborhoods to deal with emergency situations. These men and women put their lives on the line every single day to protect people at risk from injury and death, and are responsible for saving thousands of lives annually.

The work of first responders is inherently geographic in nature and has always involved knowing precisely where the emergency is, understanding the surrounding terrain and locating assets and threats important to effective action.

Speed is of the essence in emergency response because many types of severe injury and illness require immediate attention or they could result in disability or death. Consequently, there have been persistent efforts on the part of first responder organizations to utilize technology – particularly geospatially enabled technology - to improve response operations.

For example, over the past thirty years public safety and GIS professionals have experienced the computerization of dispatch operations including the use of address databases and geocoding applications; the growing ability of dispatch software and automated vehicle location (AVL) technology to identify the response units closest to an incident and design the fastest possible route to the scene; and the use of mobile computers, GPS, and wireless communications to provide first responders with access to critical geo-enabled data while improving the accuracy of information sent back to headquarters from the field.

Effective use of such geospatial capabilities has resulted in reduced response times and increased situational awareness that can be translated into lives saved, injuries minimized and property damage avoided.

Large scale emergencies and disasters such as the 9/11 terrorist attack on the Pentagon and New York City, Hurricanes Ike and Katrina, Mississippi flooding, Midwest tornados and extensive power blackouts, are considerably different than routine emergency calls. They are likely to occur across a far larger area involving multiple jurisdictions, put enormous numbers of people at risk, and seriously damage multiple critical infrastructure systems with the danger of even more far reaching cascading effects.

First responders within a municipality will often need to coordinate their activities with responders from adjoining jurisdictions and with state and federal operations centers. Government responders will also be joined by first responders from electric, water, and gas utilities and from transportation agencies, among others, to deal with outages of essential utility services and infrastructure systems. In such large scale events it is essential that this enlarged field force of responders, extending across an area that could stretch for hundreds of square miles, achieve a sufficient level of shared situational awareness to enable effective collaboration and coordination. This is a daunting task but fortunately, advances in geospatially enabled technologies and information put us in position to successfully meet these challenges.

The following are some key concepts that guide the design of geospatial systems that provide disaster operations with critical information support:

- Essential Information in-Hand: First responders from all organizations must have the geospatially organized, locational specific information, in their hands – or easily and reliably accessible – at the moment of dispatch that pertains to the area where they are being sent. This information can include the location and nature of a particular threat, the presence of at-risk individuals, key characteristics of the terrain and structures present, the placement of useful assets such as fire hydrants and standpipes, and the presence of potential threats such as gas mains, vulnerable structures and hazardous or flammable materials.
- Dynamic Information Gathering, Analysis and Distribution: For large scale and rapidly evolving events in complex environments it is important that incident managers have the

ability to continuously interact with first responders across the entire geography of the disaster event to obtain, aggregate and analyze information about what is happening. Incident commanders must also be able to tap into the wide variety of remote sensing technologies, such as aerial photography and biological and chemical sensors, to enhance their understanding of an event as it unfolds over time. Capabilities should also exist that make it possible to disaggregate the overall event picture into useful local snapshots that can be sent to the teams working within their assigned sectors.

- Sharing the Common Operational Picture (COP): Because many organizations at all levels of government and the private sector play vital roles in disaster response, and because of the existence of critical interdependencies between infrastructure and utility systems they support, it is important that they find effective ways to share information with each other – often most effectively shared in the form of critical information visualized against the backdrop of a common map.

For example: municipal authorities need to know the boundaries of and the number of people affected by power outages, and the geographic strategy for restoring services to water supply systems, mass transit, hospitals, and other facilities. Power utilities need to know the status of roads, bridges, and tunnels to most efficiently route their crews, and to bring in reinforcements from the outside. All need to know the location of at-risk and special needs individuals who are likely to require assistance. Information flows between organizations must be "choreographed" in advance (geospatial CONOPS) and must have the appropriate personnel, information, technology, agreements and procedures in place in advance.

Local and state governments including the National Guard and local utility companies will be largely responsible for responding to large scale disasters during the critical hours prior to the onset of an event, and during the first 72 hours following impact. It is during this time when the most lives are lost and the most destruction experienced. During these "golden hours" when first responders will be most at risk and their assistance most needed, they must have the best possible information and technology and the knowledge about how to use them most effectively.

This publication seeks to identify the best practices employed by local organizations and utilities to meet critical responsibilities. Our hope is that it will lead to a productive dialogue across the disaster response community, inspiring serious consideration of how to improve operations.

Both Public Technology Institute (PTI) and the Geospatial Information Technology Association (GITA) want to know whether you find this publication useful and if you think we should continue to identify best practices in this area. We would also appreciate any ideas you might have about how best to advance the state of the art in geospatial systems support for disaster operations.

A good place for us to come together to further explore this subject will be the annual conference of GITA to be held April 19 – 22, 2009 in Tampa, Florida. Bob Samborski, GITA Executive Director, and Talbot Brooks, Director of the GITA Emergency Response Symposium (ERS) are organizing a series of sessions focused on how first responders deal with large scale emergencies and disasters.

The GITA ERS Symposium will feature a keynote panel made up of managers from the Department of Homeland Security, the Department of Defense and the United States Geological Survey (USGS) who at the Federal level are leading the way in advancing the use of geospatial data, technologies and methods in support of disaster operations.

This topic will also be visited during PTI's annual conference to be held May 12-14, 2009, in San Diego, California. The focus of the conference will be on innovations and best practice solutions that enable local governments to provide more effective services to their constituents.

Utility Mobile Data Projects: Getting it Right When Disaster Strikes

Osmose Utilities Services, Inc.

Overview

In disaster-recovery mode, a utility's first objective is to restore power to its customers. Once that objective is reached, however, the problems are not over. While distribution may be restored, the distribution system model used by the utility's GIS, outage management, and other systems is still in disarray. Accurate field data needs to be gathered as soon as possible. The right mobile data-collection strategy can make a big difference.

For one thing, the data collection device must be designed for mobile use. The data taken to the field for updates should be a slimmed-down, fast-to-the-field version of GIS data, and it should include only the landbase information needed to orient field crews and the asset information that those crews need to update or reference.

The data-collection software is critical as well. In a massive audit like the one required after Hurricane Katrina, a major workforce needs to be deployed to the field to validate assets, customer connections, phasing, and more. Finally, workflows need to be optimized to allow good training, effective supervision, accurate collection, and rigorous quality assurance in a compressed timeframe.

Disasters, both natural and man-made, are more frequent realities than we would care for them to be. It is during these disasters that people need access to infrastructure and support services the most. Unfortunately these same infrastructure and support entities, especially utility services, usually incur physical damage that requires enormous coordination of resources and material to get back online quickly.

The mad dash to return operational capacity accomplishes the most important goal – serving the needs of the distressed public. For this reason it may be necessary to operate in "scramble mode", welcoming outside help and deviating from normally stringent construction and material standards in the short term.

Once the immediate disaster has passed, the organization needs to consider how those quick fixes will affect long-term safety and efficiency. Many of the changes will need to be corrected. Other changes can remain. All changes, however, need to be documented in the spatial model used for monitoring and decision support. The long-term negative impacts of an inaccurate spatial system model range from poor-performing outage and engineering models to inaccurate accounting records.

Although the examples in this paper refer to an electric utility, the message is the same for anyone. If your organization maintains physical assets, you probably have a documented disaster recovery plan. If you maintain a spatial model of those same assets, do you have a plan to ensure that any short term changes made outside of your normal workflows are documented?

The following are strategies and technologies for effectively updating field asset data in a post-disaster setting.

Objective Number One – Restoring the Physical System

The first objective after a disaster has passed is the restoration of electrical power to every customer who can safely take it. To do this, utilities can call in any number of repair personnel from within their ranks, from other utilities with whom they have mutual aid agreements, and from contractors. These crews will be deployed over the stricken areas and will work to restore service.

Contract crews and mutual aid crews will oftentimes not be equipped with the materials needed for exact replacement, nor will they be aware of special construction standards. In many situations, the crew is left to make a judgment based on their available materials and system knowledge. For instance, a crew replacing a destroyed 37.5 kVa transformer may only be able to get a 50 kVa transformer. In order to restore service, they may need to install the larger transformer at least as a temporary replacement.

In the example of the transformer, this by itself is not significant if properly documented. In a disaster however, repair crews (even internal ones) will often depart from the normal workflow by not properly documenting changes to post to the spatial model.

Given the situation, this is understandable. But, when the undocumented replacement of a transformer is multiplied by hundreds or thousands across a system, the bad effects on the spatial model accumulate quickly.

Objective Number Two – Restoring the Spatial Model

In an ideal situation, every repair or change made on the system would be immediately posted to the spatial model. This almost never happens because repair crews do not have the data tools or skill set to make that happen. If data collection crews can be deployed with repair crews then changes could be captured quickly. The obstacles here are:

a) Finding the right number of trained data collectors quickly (typically even a large utility will have 20-30 qualified collectors – repair crews may number in the hundreds); and,

b) Developing a workflow that can quickly verify and reconcile the collected changes.

A "Data Restoration" solution that has proven itself successful is one that involves a concentrated inventory across the system to document changes. This approach allows a utility to first get through the physical restoration quickly and safely.

By deploying a trained team of inventory technicians across the system, the utility can ensure that the entire system is covered by qualified resources in a manageable way.

An approach like this can produce surprisingly quick resolution to the changes in the spatial model. It is reasonable to expect a well-executed inventory to cover a medium-sized distribution system (300,000 combined poles, service points, and lights) in as little as three months.

A large system inventory is complex and difficult under ideal circumstances and with no time constraints. To be successful under disaster conditions, utilities need to consider some essential facts. These facts apply for utilities using either internal collection crews or contract crews.

Data Recovery Essentials

Restoring the Spatial Model – Basic Elements

Data Collection Equipment

Data collection hardware (computers, GPS, storage media) can be configured in relatively short order. Many utilities may already have a good start on assembling equipment from existing stores. It is important to consider, however, that equipment used for lower volume field activities may not be ideal for a full inventory.

Inventories require the technician to cover the entire system, usually from a substation breaker to every pole and meter on a circuit. This requires foot travel much or all of the time. Laptops and pen computers suited for trucks and short trips to the field will be difficult to manage 8 to 10 hours per day in rugged conditions.

The best form factor for field-based inventories is usually the handheld computer. The handheld computer, especially a rugged model, is suited for long periods of use. They are typically lighter in weight and can run on battery power for extended periods of time.

Data Collection Software

Selecting software to run on the field computer is determined mainly by the computing platform. After this, consideration should be given to factors such as ease of adoption and use, stability, and capacity for running data quality processes (validations, required fields, error warnings).

When selecting inventory software, it is helpful to consider the function of the software. Most field software applications used for GIS updates are variations of the GIS itself. This means that speed and ease of data entry are not primary considerations. GIS software is built for simulating the GIS environment. As such, it is a very effective GIS tool, but can slow down and complicate an inventory designed for speed.

Post-disaster “Data Restoration” inventories (as mentioned above) will involve several inventory personnel, often with different skill and experience levels. Selecting a data collection tool that can produce accurate results without requiring users to be GIS experts will be essential for rapid completion.

The application should allow the user to focus on his or her observations in the field, and not on maneuvering in the application. Several good data collection tools are available commercially, and some GIS professionals may be able to develop an adequate tool using the mobile GIS itself, with some planning.

The keys to success for any data collection tool are in the ease of data entry, visualization functionality, and real-time data verifications to catch data entry and business rule errors.

Table 1 provides examples of these keys to success.

Key To Success	Example
Ease of Data Entry	Keypad entry fields should be limited to reduce typographical errors. Large number pads available when entry is numeric. Pick lists or checkbox fields should appear when appropriate.
Visualization Functionality	Spatial data should be available in a simple, uncluttered map view. Collected features should be symbolized and color coded to reflect collection status (red = not verified, yellow = visited with possible errors, green = visited and verified). Layer and view switching should be minimized or eliminated to reduce complexity for less-experienced operators.
Real-time data verifications	Visual and text warnings to alert operator that required data is missing or that a GIS business rule is being violated (B phase transformer connected to an A phase primary).

Table 1. Inventory Software: Keys to Success

Original System Data – Start Over or Verify Existing Data?

The purpose of the post-disaster inventory is to verify and update the existing spatial model. While there may be situations where it is preferred to “scrap” the existing model and collect everything as original data, this is rare. In cases of anything other than complete devastation, using the original pre-disaster GIS data as the background and source of data edits will allow better long-term information use (insurance claims, storm performance metrics, etc.).

Selecting the right data to send to the field is an important task, and the decision should be made carefully. A balance must be struck between taking data out that allows a complete picture to be created, and taking out so much data that the inventory process becomes bogged down either by verifying too many features or trying to manipulate a crowded map view.

A good rule of thumb is to only take out and verify the information that can be determined by eye from the ground and is critical to rebuilding the spatial model and the key dependent support systems. For an electrical utility, this means that any data related to running the outage management system that can be spotted by a technician on the ground should be included.

For outage management, device presence, phasing and connectivity are all important attributes to be fielded and verified. Detailed data about joint use attachments may not be important initially, so less information should be fielded on attachments during a post-disaster inventory. Of course, a basic set of landbase data should be sent to the field for navigation and facilities placement.

Putting It All Together – Training, Supervision, and Quality Assurance

Training

After the decisions of hardware, software, and data have been attended to, it is time to think about deploying the inventory force. Unlike typical utility mapping projects, a post-disaster inventory will almost certainly involve several less experienced inventory technicians. In many cases, a contractor will be called upon to handle an inventory while the utility's personnel work to get other aspects of the operation back to normal.

Regardless of who the project is staffed with, they will probably be operating in a dynamic environment with equipment and software that is new to them. The success of the project depends heavily on the development and execution of an inventory training program. The training program should balance the need to provide consistent and thorough orientation with the need to get started in the field as quickly as possible.

As a reference, new hires with little utility experience will take approximately three weeks of full-time supervised training to attain proficiency at detailed electrical collection and modeling. After three weeks of training, an aggressive supervision and QA program is still required, but technicians are essentially autonomous. Table 2 offers a suggested training course schedule.

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Project Orientation (Objectives, Background) /Safety Orientation and Test	Fundamentals of Electrical Distribution/OH Recognition Session	OH Recognition (continued)	OH Recognition (continued)	OH Recognition Test
Week 2	OH Recognition Review/Data Collection Software Sessions	Data Collection Software Sessions	Data Collection Software Sessions/Test	Training Course (Collection of Pre-inventoried circuit)	Training Course (Collection of Pre-inventoried circuit) /Test
Week 3	Supervised Collection on Training Circuit	Supervised Collection on Training Circuit	Supervised Collection on Training Circuit	Supervised Collection on Training Circuit	"Solo" Collection on Qualification Gauntlet

Table 2. Sample Training Program Schedule

The training program should include some basic sections and be delivered by an individual or team of trainers with a common understanding of the project.

One significant issue with complex inventory projects is one of interpretation. Every electrical distribution system (and every other type of constructed system for that matter) contains elements open to interpretation. Even experienced field personnel from the same utility can interpret wire sizes or construction standards differently. For this reason, documenting a common interpretation and communicating it throughout the project is essential. Any changes or updates must be communicated to the entire project team quickly. An organized training program is the best way to ensure this happens.

Supervision

An adequate level of crew supervision is the most important factor for an inventory project being completed on schedule. Inventory technicians, especially new ones, will confront issues of all types once trained. First, consider the support that a new technician needs just doing the basics of inventory. Questions about identification, navigation, and use of the hardware and software arise several times daily for most new technicians. Beyond that, technicians operating in post-disaster areas are going to encounter access problems, vehicle breakdowns (especially flat tires), hazardous situations, and uncooperative or distressed residents.

Experience has also shown that operating in disaster-affected areas brings unique logistical challenges. Obtaining gasoline and lodging can be next to impossible. Communications (voice and data) is difficult and requires extraordinary efforts. Having enough capable supervision to handle all of these issues becomes one of the most challenging aspects of operating in a post-disaster setting.

For practical purposes, it should be assumed that a supervisor to technician ration of five to one (5:1) is the upper limit if the project is to be successful. Even with these ratios, it’s advisable to have a dedicated logistics supervisor who can coordinate crew movements with available fuel and lodging. Additional communications staff may be required to secure communications for voice and data. Even if these additional supervisors can accomplish their work ahead of schedule, they can be put to good use supporting crew supervisors.

Figure 1 shows a typical project organization for a post-disaster inventory.

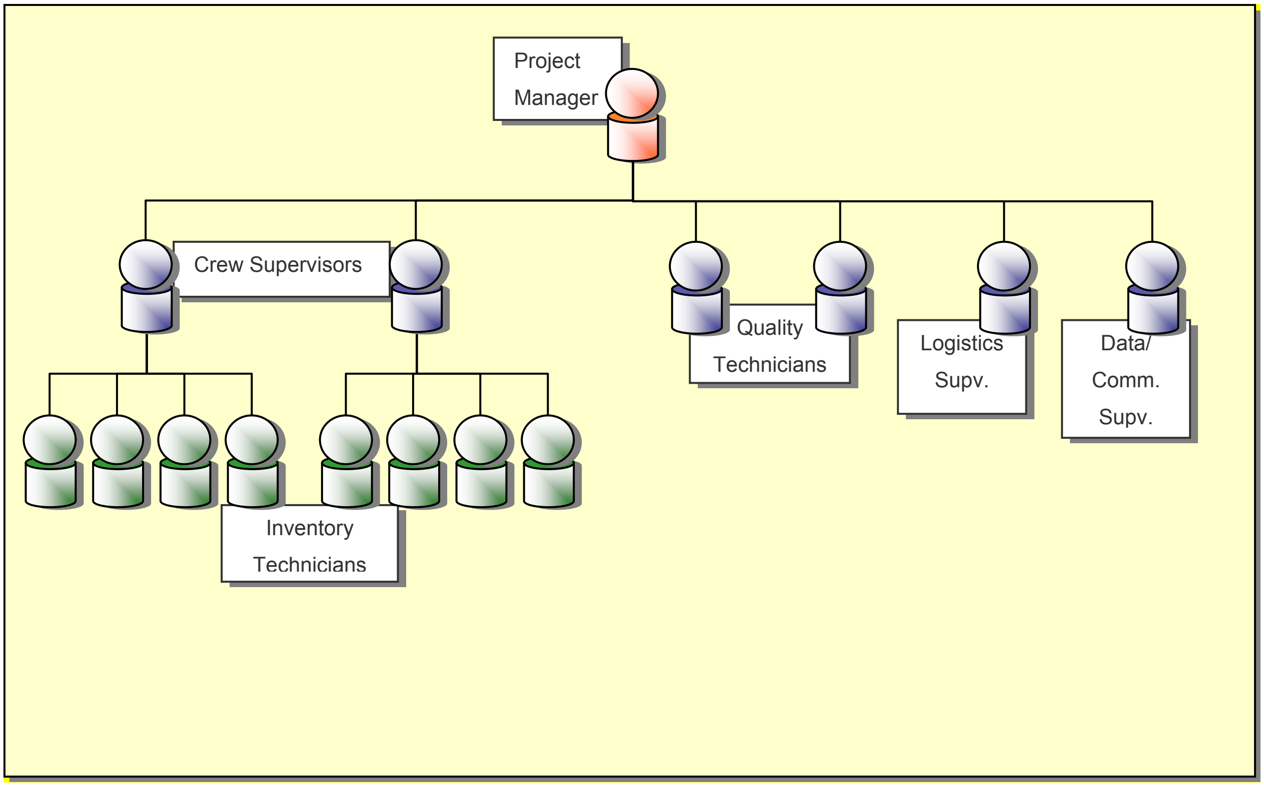


Figure 1. Typical Project Organization

Quality Assurance

If adequate supervision is the success factor for completing the project on time, adequate Quality Assurance (QA) is the biggest success factor for achieving the data goals of the project. A rigorous and formal QA program should be developed jointly by the project stakeholders. This means utility and contractor if the inventory is performed by a contractor. All parties should be in agreement up front regarding the levels of accuracy required for the project and how that accuracy will be measured. Typically accuracy is measured as a percent error of all countable attributes in a data set. Standard error rates range from 3% to 5%. In standard accuracy programs, not every attribute is counted in the percentage (mainly estimated or interpreted values), but each counted attribute is weighted equally.

QA processes should include quality control elements involving random checks on in-progress work (with subsequent spot corrections). These spot checks can be performed by supervisors or by dedicated quality technicians. The aim of the quality control is to ensure that technicians are performing as expected before they progress too far, and to correct minor inaccuracies.

The formal QA program should be applied to each completed data set once the inventory technician has submitted it to his or her supervisor. At that point, the data set will be assigned to a quality technician who will select a random sample from the data set to recollect and compare to the original results.

The keys to a successful QA program are experienced quality technicians, and sophisticated automation. Experienced quality technicians are able to identify trends and collect sample data with consistently high levels of accuracy – ensuring that the sample is effective. Sophisticated QA automation should be relied upon to programmatically select a random sample for QA and to generate metrics on all aspects of the QA. These reports will form the basis of any decisions regarding recollection or retraining.

For the most success with the lowest risk to the overall project, the QA program must be adequately staffed. QA should be a decision point for the entire inventory. If the data is accurate, the inventory can continue. If unacceptable levels of errors are consistently found, steps need to be taken to recollect, retrain or hire new technicians. The entire process can flow smoothly unless too much data sets for too long between collection and QA. The "bottleneck" effect can cause crews to cover areas multiple times or sit idle awaiting approval if QA staffing is low.

Conclusion

GIS inventories are complex and involved under the best of circumstances. Doing the same work after a disaster brings serious challenges that will only be met if the project team is organized, well-staffed, and flexible in its approach to the technology and workflows it brings to bear. The fortunate lessons from these unfortunate occurrences are that organization and teamwork can bring results, and in a shorter time than most might think.

Jeremy Sadler
Osmose Utilities Services, Inc.
5703B Enterprise Parkway
East Syracuse, NY 13057

Hyperlinking Critical Information through a Customized GIS Application for First Responders

Boone County, Kentucky

Overview

This case study will outline the use of a custom GIS application (BooneMap LT) and additional document management techniques that benefit first responder agencies in Boone County, KY. The responder agencies include eight Fire Protection Districts, the City of Florence Police Department, the Boone County Sheriff's Department, and the Boone County Emergency Management Agency.

Boone County is located near Cincinnati, OH, along the Ohio River in Northern Kentucky. The county is approximately 256 square miles in total land area, has about 105 internationally-based companies, is home to the Cincinnati-Northern Kentucky International Airport, and has a population of about 112,000 people.

The BooneMap LT software described in this case study has evolved over time, but has been deployed county-wide in some capacity for eight years. The hyperlinking functionality covered later in this case study has been in use since April 2008 and at this time approximately 40% of all Mobile Data Terminals (MDTs) have the hyperlinking technology available. Full deployment is scheduled to be completed in January of 2009.

At the time of publication, network-based BooneMap LT installations are able to take full advantage of the hyperlinking technology, but Boone County GIS realizes the real impact of this technology is in the field with first responders.

How the System Operates

The flagship product that Boone County GIS manages is a software package known locally as BooneMap LT. This application is essentially a customized .NET application that runs on the ESRI ArcReader platform using the ArcReader Control.

The first responder agencies in Boone County have MDTs mounted in their vehicles. Numbering nearly 200, these MDTs are ruggedized laptop computers, comprised of Panasonic CF-19 ToughBooks (tablet PC, 38 deployed) and Panasonic CF-30 ToughBooks (160 deployed). The

MDTs are managed by Boone County Public Safety Communications Center (PSCC), and all have the custom BooneMap LT software installed on them. The data is stored locally, eliminating the dependency on wireless signal strength for software functionality.

Information Utilized

The information and documents used by the first responders are the focal point for the hyperlinking project. The documents can be stored on a network drive or local drive, depending on the installation location of BooneMap LT. BooneMap LT uses a folder/subfolder hierarchy to easily replicate and deploy hyperlinking technology. A documents folder is stored at the same level as separate folders housing the Vector and Raster data used within the GIS. Inside of the documents folder are several subfolders which are named according to the document type.

At the time of publication, the following documents are integrated: *Crisis Plans* for each school, *Emergency Contact Sheets* for businesses, *Evacuation Plans* for schools, *Facility Liaison Documents* for businesses, *Material Safety Data Sheets (MSDS)* for hazardous materials, *Building Pre-Plans* or floor plans for non-residential buildings, *Sara Title III Worksheets* for hazardous materials, and *Tactical Worksheets* for coordinating on-site emergency operations.

Because of the wide range of information and documents being used, there was a wide range of file types or file formats being submitted by the first responder agencies. Boone County GIS did not try to curb this trend because it was important to maintain a high-level of flexibility in the hyperlinking project.

The most common file types that are currently being used include: Excel files (.xls), Word files (.doc), Portable Document Files (.pdf), Cad Zone files (.czd), video files (.mov), and image files (.jpg, .tif, .bmp, etc.). The only limitation for acceptable file types is whether or not an application exists on the computer or MDT that can open that particular document.

In addition to the document hyperlinking, BooneMap LT integrates the *Emergency Response Guide*, published by the US Department of Transportation, to aid first responders in the field. The *Emergency Response Guide* can be easily accessed from within BooneMap LT by performing a chemical name or number search. The potential hazards, public safety measures, and emergency response guidelines for thousands of chemicals are all at the fingertips of the first responders using BooneMap LT.

The Geographic Component

The backbone of this implementation is the geographic data and application software that provides positional context for all agencies that perform in a first responder capacity. All of the MDTs have a full array of GIS data that is readily accessible. Some of the most essential data layers included are parcels (and ownership attribute information), building footprints, street centerline information, edge of pavement, school locations, urgent care/hospital facilities, and 1":100' county-wide aerial orthophotography.

Since all of the agencies use BooneMap LT software, they have the ability to initiate a response from a common geographic framework. This fosters improved coordination, communication, cooperation, and collaboration.

In order to take advantage of the hyperlinking technology, users must have BooneMap LT. The first responder performs an address search using the dialog box shown in Figure 1.

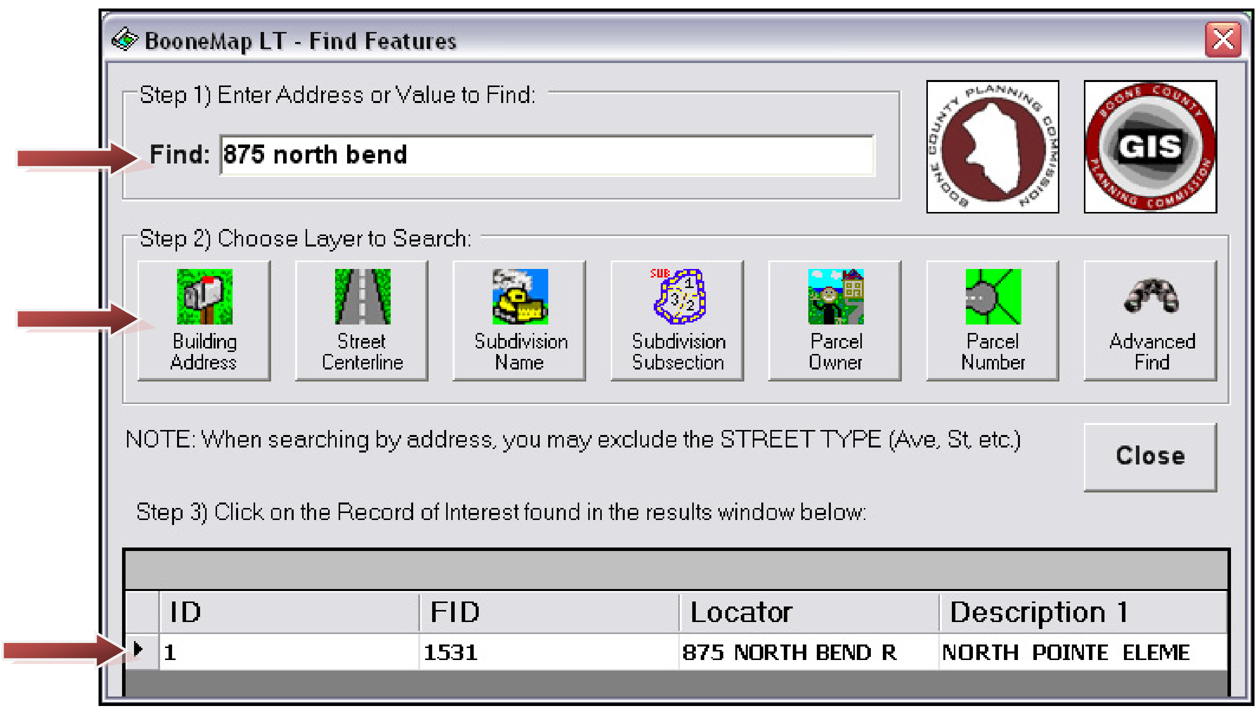


Figure 1: BooneMap LT Search Dialog Box

The first responder clicks on the address of interest and the application will automatically zoom to the appropriate building, 875 North Bend Rd. in the example below (see Figure 2).

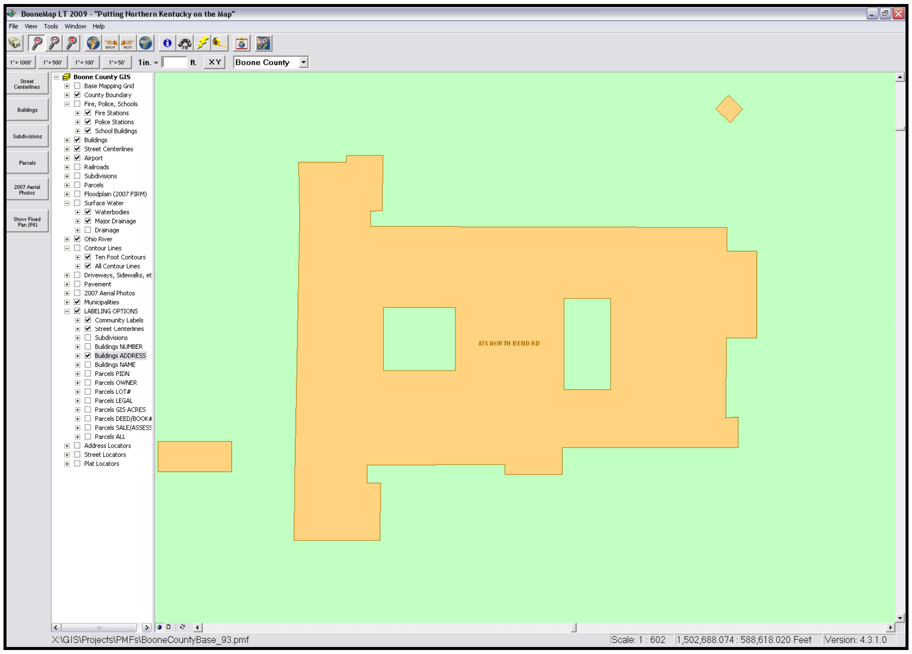


Figure 2: Building Footprint of 875 North Bend Rd.

Once the map view has centered on the appropriate location, the user selects the hyperlinking tool, which then places a hatch pattern (see Figure 3) on vector features that have related documents assigned (or "attached") to them (first responders are most concerned with buildings, but other vector layers may have documents assigned as well).

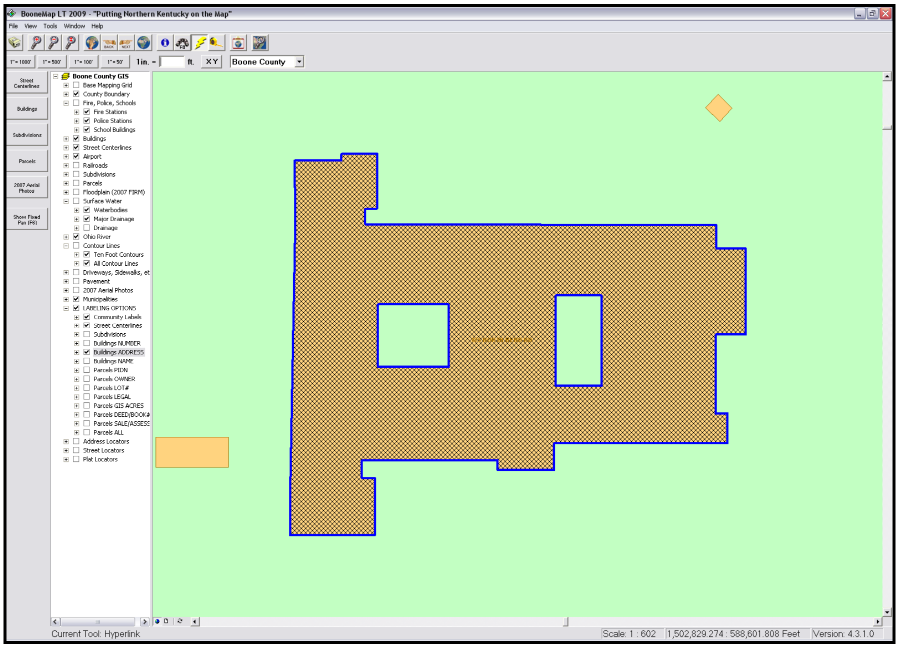


Figure 3: Building footprint with Hyperlink Symbology

When the user clicks on the building, an HTML page (stored locally on the C drive or D drive) will list the documents that are available in a standard web browser window. This HTML “jump” page bridges the gap between the features on the map and important non-geographically referenced documents critical to first responders (see Figure 4).

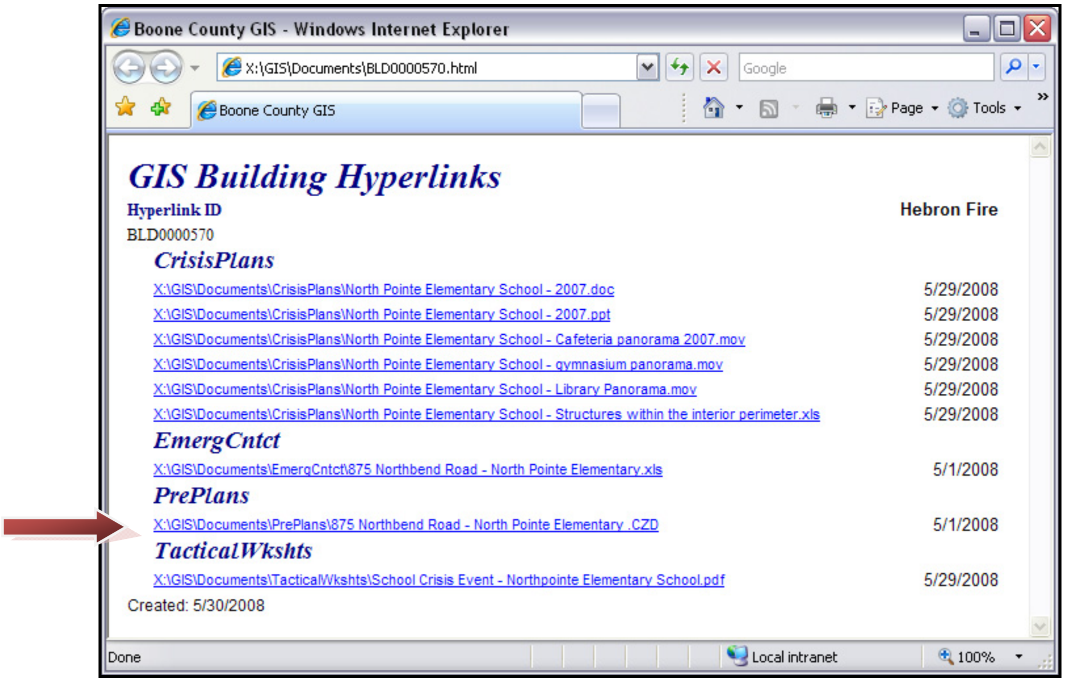


Figure 4: HTML “Jump Page”

The user then selects the appropriate link, and the document will be loaded and displayed in its native application. For example, an *Emergency Contact Sheet* will open up in Excel; a *Building Pre-Plan* will be loaded into the Cad Zone Diagram Viewer application; and *Tactical Worksheets* will be displayed in Adobe Reader.

The actual *Building Pre-Plan* for 875 North Bend Rd. is shown in Figure 5.

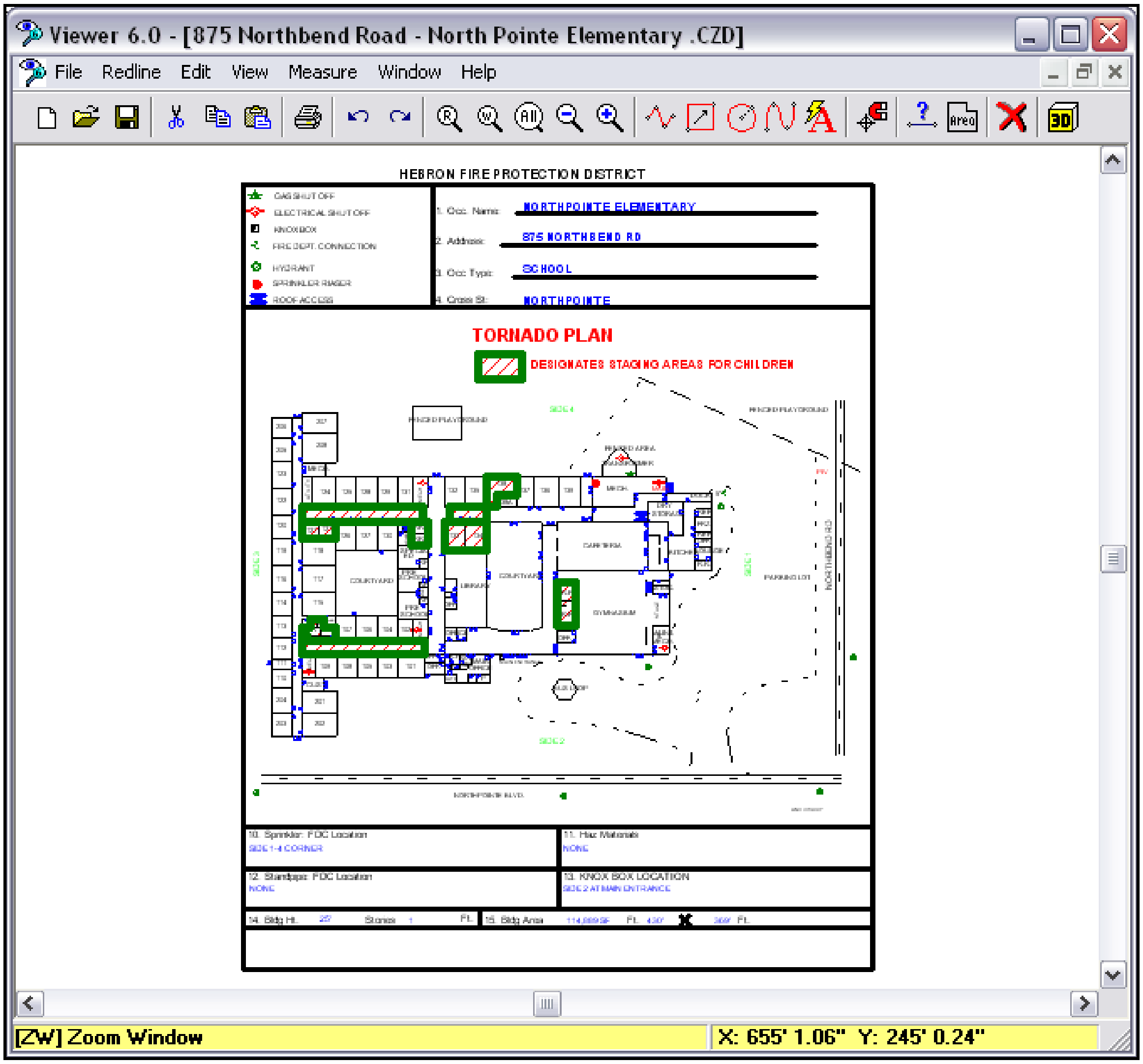


Figure 5: Building Pre-Plan for 875 North Bend Rd.

Technology and Infrastructure

Although the case study outlined in this article does not use an Automated Vehicle Locating (AVL) technology or a real-time data capture and display (weather conditions, Cincinnati Metro ARTIMIS traffic cameras, etc.) it does show an outstanding advantage of the Boone County GIS approach in that it is efficient, cost effective and rather intuitive for the end user by making GIS the central interface in order to access numerous critical documents.

The BooneMap LT application runs on ESRI's ArcReader technology, which does not have a licensing requirement. This means that whether the application is deployed to 70 users, or to 700 users, the cost remains the same.

Additionally, most of the data and aerial photography available to first responders is paid through by the Boone County GIS Consortium's member agencies, meaning that the costs of expensive datasets (especially aerial photography) are spread out across a large number of agencies.

Finally, by sharing existing information across jurisdiction boundaries, first-responder agencies are able to extend their capabilities and resources, all without incurring additional costs.

The technology at the center of the hyperlinking project is an MS Access database used to store two important tables (*Documents* and *Hyperlinks*), and is shown in Figure 6.

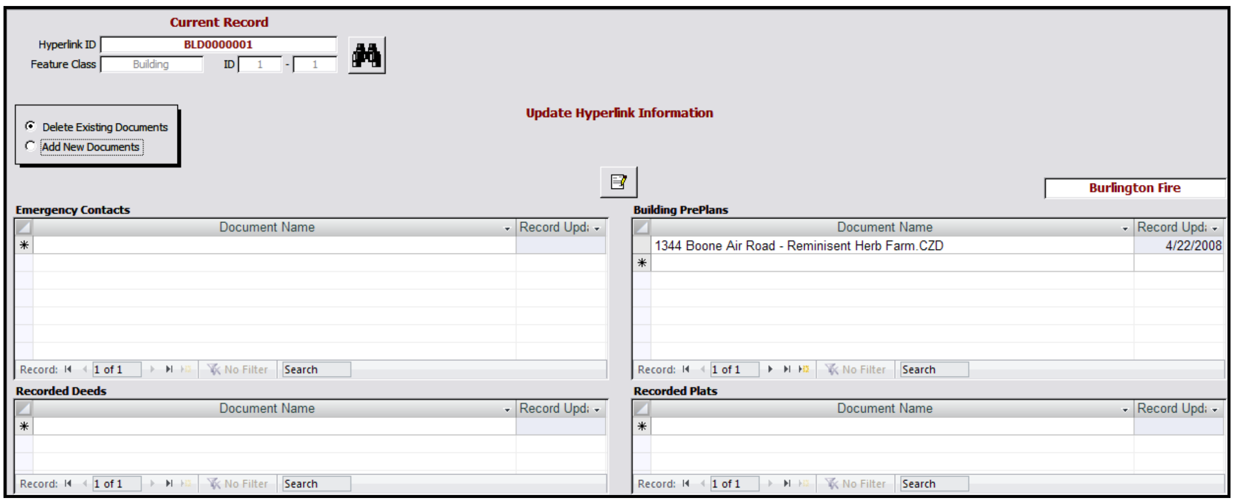


Figure 6: MS Access Hyperlinking Database

The *Documents* table stores general information regarding each document being hyperlinked such as the Hyperlink ID, file name, agency name, feature type, and the document type. This information is used to create the hyperlink, which is stored in the *Hyperlinks* table (Figure 7).

ID	Hyperlink ID	Feature Type	Document Name	Site Check?	Agency	Document Type	Record Updated
1	BLD0000001	Building	1344 Boone Air Road - Reminisent Herb Farm.CZD	☐	Burlington Fire	PrePlans	4/22/2008
2	BLD0000002	Building	1371 Production Drive - U.S. Broadcast.CZD	☐	Burlington Fire	PrePlans	4/22/2008
3	BLD0000003	Building	1388 Production Drive - Eagle Transportation.CZD	☐	Burlington Fire	PrePlans	4/22/2008
4	BLD0000004	Building	1389 Production Drive - Tri-State Color.CZD	☐	Burlington Fire	PrePlans	4/22/2008
5	BLD0000005	Building	1396 Production Drive - Boone Crane.CZD	☐	Burlington Fire	PrePlans	4/22/2008
6	BLD0000006	Building	1400 Production Drive - Turner Plastic Innovations.CZD	☐	Burlington Fire	PrePlans	4/22/2008
7	BLD0000007	Building	1404 Boone Aire Road - Rainbow Rascals.CZD	☐	Burlington Fire	PrePlans	4/22/2008
8	BLD0000008	Building	1412 Production Drive - Natures Way.CZD	☐	Burlington Fire	PrePlans	4/22/2008
9	BLD0000008	Building	1412 Production Drive - Scotts Lawn Service.CZD	☐	Burlington Fire	PrePlans	4/22/2008
10	BLD0000009	Building	1432 Production Drive - Schwann's.CZD	☐	Burlington Fire	PrePlans	4/22/2008

Figure 7: Documents Table in MS Access Database

The *Hyperlinks* table stores the actual hyperlink for each document along with the Hyperlink ID (see Figure 8). Each time a record is added to the documents table, a macro automatically creates the hyperlink by creating the file path for each file name by using the information stored in the documents table.

ID	Hyperlink ID	Document Hyperlink
1	BLD0000001	X:\GIS\Documents\PrePlans\1344 Boone Air Road - Reminisent Herb Farm.CZD
2	BLD0000002	X:\GIS\Documents\PrePlans\1371 Production Drive - U.S. Broadcast.CZD
3	BLD0000003	X:\GIS\Documents\PrePlans\1388 Production Drive - Eagle Transportation.CZD
4	BLD0000004	X:\GIS\Documents\PrePlans\1389 Production Drive - Tri-State Color.CZD
5	BLD0000005	X:\GIS\Documents\PrePlans\1396 Production Drive - Boone Crane.CZD
6	BLD0000006	X:\GIS\Documents\PrePlans\1400 Production Drive - Turner Plastic Innovations.CZD
7	BLD0000007	X:\GIS\Documents\PrePlans\1404 Boone Aire Road - Rainbow Rascals.CZD
8	BLD0000008	X:\GIS\Documents\PrePlans\1412 Production Drive - Natures Way.CZD
9	BLD0000008	X:\GIS\Documents\PrePlans\1412 Production Drive - Scotts Lawn Service.CZD
10	BLD0000009	X:\GIS\Documents\PrePlans\1432 Production Drive - Schwann's.CZD

Figure 8: Hyperlinks Table in MS Access Database

The final component of the MS Access database is the macro that creates the HTML pages. Each HTML page is linked to a feature in GIS using the hyperlink ID. HTML pages were used because most computers and MDTs in the county have Internet Explorer (even if it is without an Internet connection) and therefore have the ability to open generic HTML pages.

The HTML pages can store many hyperlinks, so one feature in GIS can now have many documents linked to it (essentially, a one-to-many relationship). In essence, this was the breakthrough development that launched the Hyperlinking project and made it very appealing to the first responders in Boone County.

Effectiveness Measures: Case Study Example

The timing of this article is appropriate because on October 3rd of 2008 the services and products of Boone County GIS were called into use while responding to a strange odor near the Pebble Creek neighborhood. It turned out to be much more than simply an unusual odor.

On the morning of Friday, October 3rd, Boone County public safety agencies responded to the breach of a 21" crude oil pipeline. The breach (see Figures 9 & 10) would ultimately cause the release of 6,100 barrels of crude oil (about 256,000 gallons).

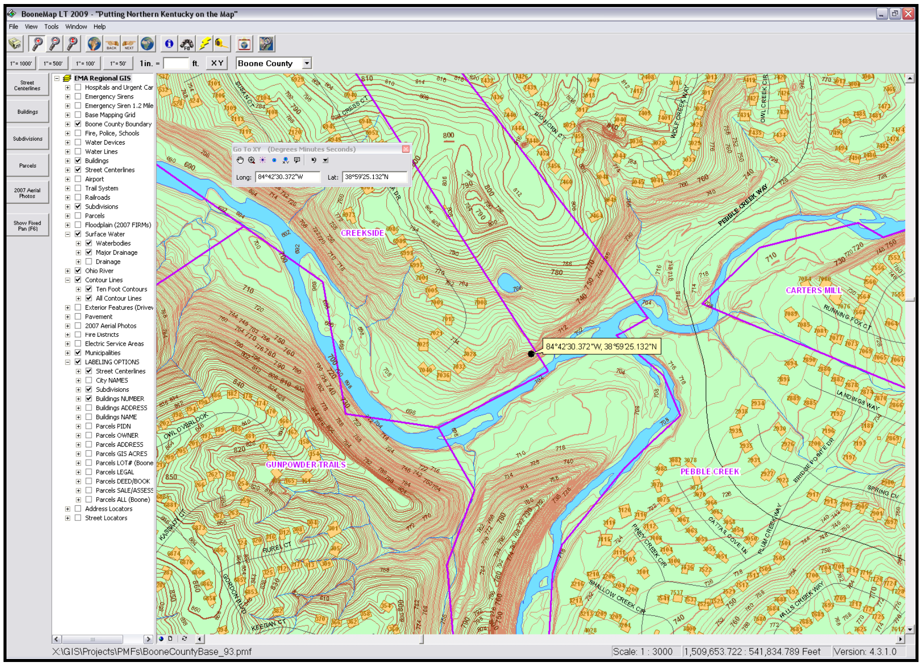


Figure 9: BooneMap LT on MDT using Latitude/Longitude to Locate Incident

Using GIS, first responders were able to graphically display the deployment of air monitoring equipment within the affected area. Members of the unified command staff were also able to use GIS to identify affected populations and classify potentially environmentally sensitive areas within our incident action plan.

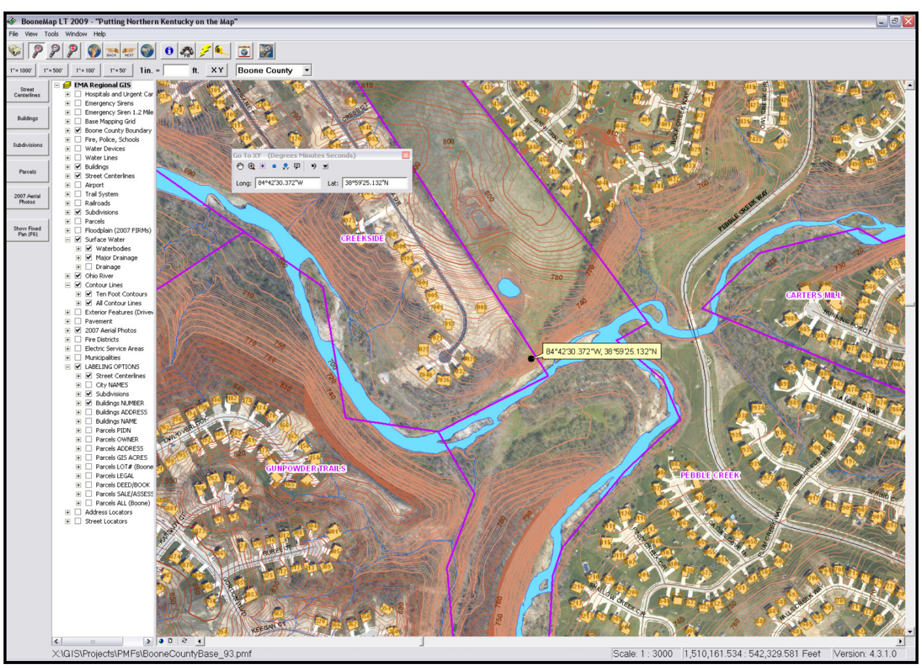


Figure 10: BooneMap LT on MDT using Latitude/Longitude to Locate Incident (w/Aerial Photography)

The staff was then able to immediately convey this data electronically to state and federal response officials. All of the situational mapping data for this incident was created using the BooneMap LT software product installed on an MDT.

According to Bill Fletcher, Deputy Director, Boone County Emergency Management Agency, *"Our agency has recognized the need for our planning products to include the most current mapping data, and we have realized the benefits of having a GIS mapping application immediately available to first responders in the field. All of the plans produced by our office since 1998 have included mapping and data derived from Boone County GIS.*

"The creation and subsequent revision of SARA Title III EHS facility emergency response plans have been made easier and more efficient as the sophistication of our GIS product increases. School crisis planning has included aerial photos, not only to identify critical portions of the building, but to also graphically depict facility response points and staging areas. Our agency recognized the advantages of GIS many years ago. We continue to use the services of Boone County GIS to enhance our capabilities and make our plans and our responses more effective and efficient."

Also responding to this same incident was the Burlington Fire Protection District (F.P.D.). According to Shaun Klaserner, Assistant Chief of Operations, Burlington F.P.D., and Incident Command, "Staff was able to pinpoint the location of the incident and quickly determine the potentially affected homes." The direction of the blowing wind was also mapped; this assisted in determining the location of Hazardous Atmosphere Area Monitors. Eight of these monitors were deployed in the field and their location was pinpointed on the BooneMap LT software for ease of identification.

Burlington F.P.D. also uses BooneMap LT to manage and update Emergency Service Zones (ESZs). The ESZs are used by PSCC to identify the type of equipment that is needed to respond to an incident (i.e. Ladder trucks, tanker trucks, and other special equipment). Furthermore, Burlington F.P.D. has completed a review of their district using the BooneMap LT software to determine the location of each house in the district that is located more than 1,000 feet off the roadway. This is important information because their apparatus only carry 1,000 feet of supply hose and if the residence is located more than 1,000 feet off the roadway they will have to shuttle water to the scene using fire department tanker trucks.

Future Direction of BooneMap LT for First Responders

The next phase of the BooneMap LT software development and Hyperlinking project is the implementation of a maintenance plan that allows for growth. It is inevitable that Boone County GIS will see growth in the number of documents being submitted or updated and it is very possible that the number of participating agencies will increase as well.

Now that a preliminary implementation plan is in place, several first responder agencies in the county are moving forward with creating and organizing their documents for submittal to the Hyperlinking project.

Also, Boone County GIS continues to modify and improve the MS Access database to better accommodate the documents being submitted and to ensure the overall integrity of the project is not jeopardized.

About the Authors

The authors are currently employed by the Boone County Planning Commission, located in Burlington, KY. The GIS Services Division is one of four divisions at the Planning Commission.

Steven T. Gay, Director of GIS Services Division, has been with the Boone County Planning Commission since March 2004. Steve manages the daily activities of GIS staff, oversees all large GIS projects, and guides GIS integration projects with other software packages.

John N. Harney, GISP, GIS Application Analyst, has been with the Boone County Planning Commission since April 2002. John manages application development for Boone County GIS, including the BooneMap LT software highlighted in this article. He is also responsible for IMS and ArcGIS Server setup and deployment.

Louis R. Hill, Jr., AICP, GIS Specialist - User Support, has been with the Boone County Planning Commission since November 2004. Louis provides daily support activities for the 700+ members of the Boone County GIS consortium. He also manages a number of special projects, including GPS activities, for member agencies.

Additional Acknowledgements

William D. Fletcher, CEM, Deputy Director, Boone County Emergency Management
Shaun D. Klaserner, Assistant Chief, Burlington Fire Protection District

Louis R. Hill, Jr., AICP
GIS Specialist - User Support
Boone County Planning Commission
2950 Washington St., Room 317
PO Box 958
Burlington, KY 41005
lrhill@boonecountyky.org
(859) 334-2196
(859) 334-2264 fax

Registration & Repatriation of Disaster Evacuees: A Geospatial Approach

City of Fort Worth, Texas

Overview

Although the Dallas/Fort Worth Metroplex is located hundreds of miles away from the Gulf Coast, during Hurricanes Gustav and Ike many residents of Louisiana and the upper Texas coast found refuge in North Texas. The City of Fort Worth Office of Emergency Management relied heavily upon geospatial technology for logistical management during the response and recovery of these two disasters.

The initial response to both disasters involved identifying a shelter coordination hub for the region and multiple shelters for evacuee short term housing, and then providing route maps between the hub and shelter sites. A standardized web application with a database back-end was then implemented to capture evacuee identification information, place of origin, special needs, and transportation requirements. The database was the foundation for successful evacuee registration, background checks, shelter tracking, and family unification.

Furthermore, it was used as the basis of the recovery effort by analyzing the place of origin and transportation need statistics within a Geographic Information System to ensure a successful repatriation process. The power of geospatial technology guaranteed the full and efficient utilization of resources during both the response and recover efforts.

Response

As Hurricane Gustav was bearing down on the coast of Louisiana, the Texas Governor's Division of Emergency Management notified the City of Fort Worth (CFW) to prepare for the arrival of dozens of buses and hundreds of personal vehicles full of evacuees; all requiring shelter and food.

The City of Fort Worth Office of Emergency Management (CFWOEM) immediately began researching facility resources that would be able to provide a place to eat, shower, and sleep. It was also decided that these temporary shelter sites should only accommodate up to 100 people to avoid disorder due to masses of people in a confined area.

The GIS Mapping Team (GMT) referred to the GIS Enterprise SDE database for community asset data such as community centers, churches, nursing homes, schools, hospitals, and recreation centers. Using the required variables in a facility query a total of 22 sites were identified for sheltering purposes.

A few of these sites were noted as being able to accommodate medical and special needs evacuees. The CFWOEM worked closely with American Red Cross, Tarrant County, Salvation Army, and the Clergy and Police Alliance (CAPA) to supply the shelters with cots, linens, toiletries, food, and water.

As the evacuation of Southern Louisiana and Texas began, people were loaded onto buses or jumped in their cars to begin their escape. It was at this point that some were separated from their family and loved ones.

Upon arrival in Fort Worth evacuees were directed to our shelter coordination hub. The hub was designated as the single coordination point for evacuees in hopes that any separated families could be quickly reunited. Since most of the drivers were not familiar with the North Texas area providing a single arrival address made it easier and supported bringing families back together.

As the evacuation convoys began arriving at the hub, families and friends were reunited and shelter assignments began. As mentioned, evacuees are usually not familiar with the area, so route maps from the hub to assigned shelters were created. Fortunately the GIS Enterprise SDE database included street centerlines and orthophotography.

The GMT had established a shelter data layer from the facility query making the generation of shelter route maps simple since all required datasets were readily available. Route maps from the hub to individual shelters were given to logistical managers at the hub to disseminate to buses and cars traveling to individual shelters.

Once the shelters began reaching capacity, population updates became essential for effective shelter resource management. Besides needing to know how many meals to prepare, linens to clean, and personal hygiene products to replenish, The Texas Governor’s Division of Emergency Management needed evacuee population counts to incorporate into the disaster relief statistics from across the state.

Disaster Evacuee Registration

In response to the need to track evacuees and shelters a web-based Disaster Evacuee Registration application was created in ASP code so that evacuee information could be entered and maintained. Shelters were equipped with laptops and wireless hubs so that the application could be accessed through the Internet.

To protect personal data, the application was a secured site using a Secure Socket Layer protocol that also required a username and password. The information collected was stored in a centralized database which was created in SQL Server 2005.

As evacuees arrived at their assigned shelter, information was gathered from each individual including name, date of birth, home address (address, city, county/parish, state, and zip code), number of pets, any health conditions, and if they required transportation back to their home city. This allowed the application to group the evacuees together as families at the time of registration.

Each person and/or family was assigned to a shelter within the system. Additionally, the evacuees could be transferred to another shelter, find temporary housing in a hotel, or find permanent housing, and have each action tracked within the system with a date/time stamp. This level of documentation is required for reimbursement of City expenses from the state and/or the Federal Emergency Management Agency.

The Disaster Evacuee Registration application had a built-in search engine, so queries could be done within and across shelters. One of the first analyses the GMT was asked to perform was shelter population compared to shelter capacity. During the initial influx of coastal residents, updated shelter census maps were routinely generated to assist in shelter resource management. The CFWOEM managed over 1200 evacuees in the system using this application. As shelters filled, the Texas Department of Public Safety was given access to the application so it could run mandatory criminal background checks against evacuee information.

The database also supported family reunification efforts with shelters outside the Fort Worth/Tarrant County area. As the word spread about the Disaster Evacuee Registration application, the City of Dallas and the City of Tyler contacted the CFWOEM to assist shelter evacuees in searching for extended family members.

With ability to search the database by evacuee name, it could be verified if the family member was being housed in one of the 22 shelters being coordinated from the CFWOEM. On several occasions people's minds were put at ease because they had found their loved ones had made it to safety.

Repatriation

The database application was the backbone of a successful repatriation process. During the registration process, evacuees were asked if they needed return transportation home. The transportation field was a required field so it had to be answered before an evacuee could be officially registered. Once the State of Louisiana started announcing that parishes were open, a query was run on the database to identify evacuees in our shelters from those parishes. The people who had arrived in personal vehicles were notified by shelter managers to head home.

The remaining required transportation home, which necessitated a two-part analysis. The first part of the transportation equation was how many people needed a ride home so that the CFWOEM could acquire the appropriate number of buses.

The second half of the analysis involved generating bus itineraries based upon the number of passengers and stops while considering the best routes. Approaching the bus manifest in this manner ensured the full and efficient use of transportation resources.

The repatriation planning began by grouping evacuees by city and parish origin, and then shifted to creating bus routes. Since all of the evacuees needing transportation were from Louisiana, geospatial datasets of Louisiana roads and place names were required.

The GMT tried downloading datasets from the Internet, but had no luck as data warehouse servers containing Louisiana data were jammed due to an infinite amount of requests. Fortunately, ESRI Data and Maps CDs which are provided with all ESRI software licenses could be utilized. These data CDs contain regional geospatial data layers such as city, county, interstates and highways.

Once these datasets were loaded into the GIS Enterprise, the GMT was much more competent in creating efficient bus routes. A total of 407 evacuees were scheduled into 10 bus itineraries.

Recovery, Back to Response

As Hurricane Gustav after action reports were being written the CFWOEM began preparing for Hurricane Ike. Although all the shelters were empty and staff had begun cleaning, they were directed to replenish supplies and stay open for the people fleeing Hurricane Ike from the upper Texas coast.

The Texas Governor's Division of Emergency Management stated that the number of evacuees would be more than double when compared to Hurricane Gustav. The reason behind that statement was the fact that the Houston area was a place of refuge during Hurricane Gustav, and now that area was being directly impacted by Hurricane Ike.

Additional shelters were identified under the same specifications as they were for the previous evacuation and were entered into the Disaster Evacuee Registration application. During the Hurricane Ike response the application was utilized once again for evacuee registration, shelter census updates, background checks, family unification and shelter resource management. Over 2500 evacuees were provided meals and a place to shower and to sleep.

The storm surge and electrical outage impacts from Hurricane Ike were so significant that it delayed residents from returning home for almost 10 days. After a few days, the Fort Worth Independent School District (FWISD) was contacted to start enrolling school-aged children into school. A query was run against the database so that the number of school children including their age could be provided to the FWISD.

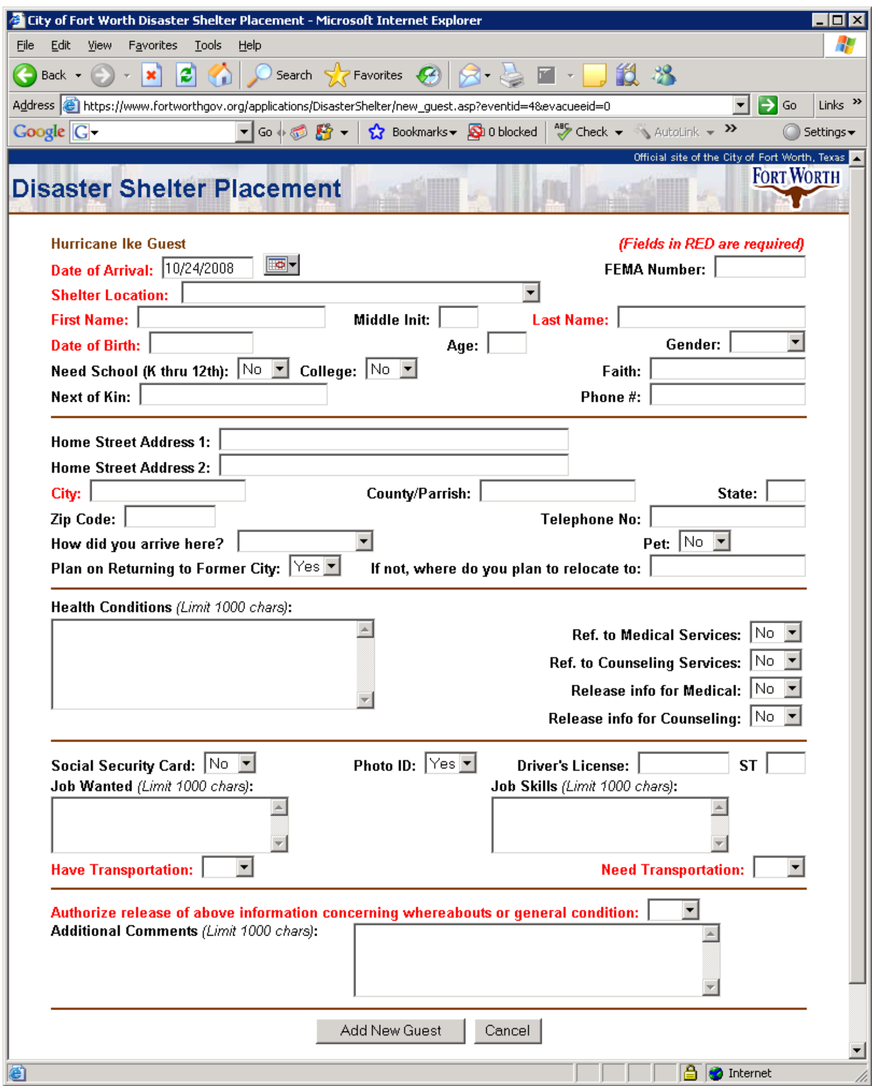
The repatriation process for Hurricane Ike was much easier than Hurricane Gustav because it did not require bus route planning. Emergency managers in the Houston area collaborated and established three staging areas where buses could transport evacuees. A total of 34 buses with around 1500 people were taken to the Houston, Beaumont or Harris County hub.

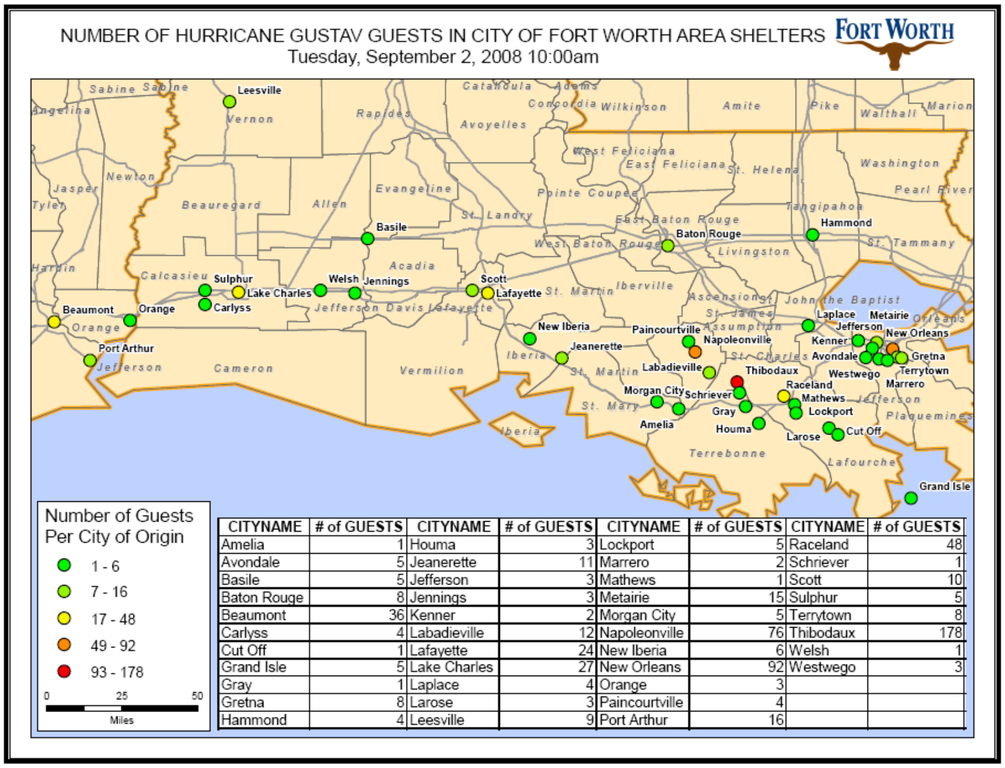
Conclusion

In Fort Worth the use of geospatial technology for registering and tracking evacuees as well as logistical management was essential for effective and efficient operation of mass care shelters during Hurricanes Gustav and Ike. The Disaster Evacuee Registration application and centralized database proved to be invaluable throughout both the efforts of response and recovery. Moreover, a few improvements to the application would increase its worth even more:

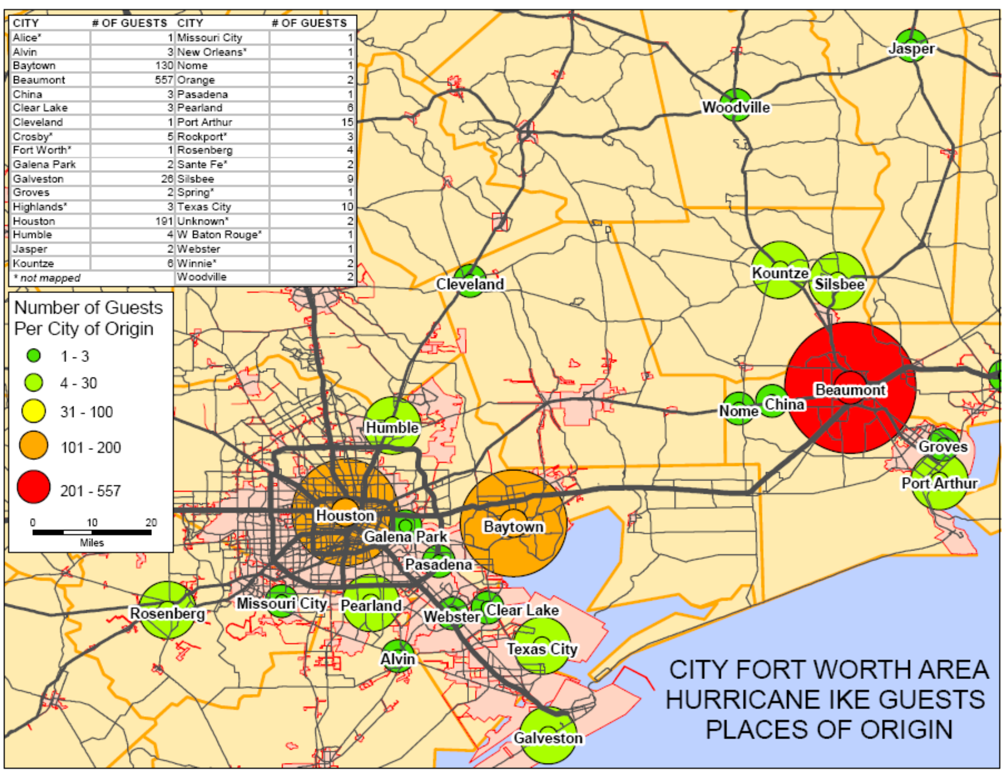
- First, by upgrading the application to a more current technology such as ASP.net 2.0 or higher so that a robust mapping capability could be implemented so geographical displays could be created online.
- Secondly, to enhance reporting capabilities by enabling users to not only select their own criteria, but have the ability to export it to a format of choice.

Finally, by providing more levels of security by providing field-level and function-level permissions and increasing the protection of the login process. The combination of the Disaster Evacuee Registration application and GIS professionals familiar with City GIS resources and Emergency Operations Center functions provided Fort Worth with a resource that proved to be essential in shelter operations.





CITYNAME	# of GUESTS	CITYNAME	# of GUESTS	CITYNAME	# of GUESTS	CITYNAME	# of GUESTS
Amelia	1	Houma	3	Lockport	5	Raceland	48
Avondale	5	Jeanerette	11	Marrero	2	Schriever	1
Basile	5	Jefferson	3	Mathews	1	Scott	10
Baton Rouge	8	Jennings	3	Metairie	15	Sulphur	5
Beaumont	36	Kenner	2	Morgan City	5	Terrytown	8
Carlyss	4	Labadieville	12	Napoleonville	76	Thibodaux	178
Cut Off	1	Lafayette	24	New Iberia	6	Welsh	1
Grand Isle	5	Lake Charles	27	New Orleans	92	Westwego	3
Gray	1	Laplace	4	Orange	3		
Gretna	8	Larose	3	Paincourtville	4		
Hammond	4	Leesville	9	Port Arthur	16		



CITY	# OF GUESTS	CITY	# OF GUESTS
Alice*	1	Missouri City	1
Alvin	3	New Orleans*	1
Baytown	130	Nome	1
Beaumont	557	Orange	2
China	3	Pasadena	1
Clear Lake	3	Pearland	6
Cleveland	1	Port Arthur	15
Crosby*	5	Rockport*	3
Fort Worth*	1	Rosenberg	4
Galena Park	2	Sante Fe*	2
Galveston	26	Silsbee	9
Groves	2	Spring*	1
Highlands*	3	Texas City	10
Houston	191	Unknown*	2
Humble	4	W Baton Rouge*	1
Jasper	2	Webster	1
Kountze	6	Winnie*	2
* not mapped		Woodville	2

Contributors

Betsi Chatham, GISP
Senior GIS Analyst
City of Fort Worth Environmental Management Department

Mark Deboer
Senior IT Manager
City of Fort Worth IT Solutions Department
Keith Wells
Emergency Manager
City of Fort Worth Office of Emergency Management

Betsi Chatham,GISP
Senior GIS Analyst
City of Fort Worth Environmental Management Department
1000 Throckmorton Street
Fort Worth, TX 76102
Betsi.chatham@fortworthgov.org

Emergency Incident Management

Miami-Dade County, Florida

Overview

Miami-Dade County, located in the southeastern tip of Florida, has an estimated population of 2.5 million making it the most populous county in Florida and the eighth most populous county in the United States. It is also Florida's second largest county in terms of land area, with 1,946 square miles.

The county is comprised of 35 incorporated cities and a large unincorporated area. The eastern portion of the county is heavily urbanized, has a coastline sustaining the majority of the county’s high rises, and contains the county's central business district, also known as Downtown Miami.

Although more visible during times of disaster, the Department of Emergency Management and Homeland Security (DEM&HS) works daily in support of its proclaimed mission; to lessen the impact of disasters and potential catastrophic incidents by meeting the needs of the community through planning, response, and coordination of information and resources. This includes residents, the business and tourist populations, and those attending school in the area. During times of activation, the Emergency Operations Center (EOC) coordinates emergency response and recovery operations, maximizing the use of all resources within Miami-Dade County.

The DEM&HS manages the Duty Officer (DO) program. This program assures that emerging events are closely monitored and the appropriate agencies are alerted and respond as necessary. The program also provides for department staff, designated as emergency response officers, to deploy to events meeting established criteria. On-scene response includes providing assistance to the first responders and on-site humanitarian agencies. Activities meeting the criteria for DO response include but are not limited to:

- Assisting at fires that result in multiple family evacuations,
- Responding to Turkey Point (nuclear facility) emergency events,
- Assisting with gas leaks that result in evacuations,
- Assisting with aircraft and/or transportation emergencies, and
- Incidents requiring the staffing and activation of the county EOC.

How the System Works

It is paramount that emergency managers and first responders receive as much timely information as possible about an incident. This information is requisite to best assess the situation, assure for the safety of all involved, and affect a successful response.

Essential information can include ingress and egress routes, the location of potential hazardous materials, and special populations within the area such as schools, day cares, and senior centers.

To assure that accurate and up-to-date information is readily available the county uses a GIS application that allows emergency managers and first responders to access critical information pre-incident, on-route, and on-scene using wireless laptop, tablets, or Blackberries. Also all the geo-spatial data are saved and are accessible from the EOC servers in case the Internet connection is not available.

This includes:

- Aerial photographs showing the incident location.
- Pictometry or oblique photographs.
- Residential building occupancy information, HazMat sites, and disabled residents.
- Structural building information, building height, longitude, owner, contact phone number, number of occupants at the time of the incident, building square footage, stored chemicals, and floor plans.
- Rapidly accesses all the information in the county central databases from GIS servers.
- The information must be up-to-date and readily available at all times.

The Emergency Incident Management (EIM) GIS application tool was developed primarily as an aid to the duty officer. It is a secure web-based application that gathers all the available critical location data and places it on a map along with a report for the first glance at visualizing and assessing any incident.

The following is a typical use of the application: “The duty officer was notified about a building 7430 SW 59 Court. During this contact the duty officer was informed that the building will need to be shut down with multiple units affected and one fatality. The duty officer notified the Red Cross with the following: possibly 100 or more individuals may be displaced and will need assistance. Manager Serrano reporting on scene in the event DEM&HS assistance is needed."

Typically, we get similar notifications on a weekly basis. The emergencies vary from shootings, hostage situations, building fires, oil spills, school lock downs, suspicious packages, train derailments, etc. What should emergency managers and/or first responders know in any emergency situation in order to save lives and to protect property when an emergency occurs?

The EIM-GIS tool is an easily accessible, essential, fast, informative, and user-friendly application that provides critical information to a first responder in two clicks of the browser. It is a secure web-based application accessible from anywhere with Internet capability.

Information Utilized

- The application contains nearly 6000 critical locations within 26 GIS layers such as schools, parks, nursing homes, fire and police stations, and HazMat sites. Each county department is responsible for updating their own GIS layers and placing them in the county's central GIS server which serves as the back-bone for the critical location layer used in EIM. Data such as facility type, address, latitude and longitude, capacity, capacity description, contact person, phone number, hyperlinks to other web pages, e-mails, and floor plans are all included.
- The application also uses nearly 1 million property records from the property appraisal office, including owner name, land use, number of stores, building square footage, and elderly and disabled records. Over 90,000 commercial facilities from the county's occupational license files are included as well. The information in these files includes: the owner's name, business name, square footage, and contact phone numbers.
- The most recent Aerial Photography is available for all maps.
- For ease of use, the application has incorporated all the essential tools such as measuring tools, magnifying glasses, zooming/panning capabilities, overview maps, printing, exporting to .pdf, .jpg, Excel, and E-mail, and hyperlinks to available web pages.
- All data is updated automatically and regularly.

Localized Incident

To start, select either the facility name or the drop down list of over 6,000 critical locations, or enter the address or intersection this will create a search for the location against the county's local address repository.

Once your address has been located - click go. On the next page, a map showing the location of the incident along with all the essential information will be available to you.

Based on the extent of the incident, the emergency managers or first responders can view the information and critical locations from one quarter mile to three miles out from the incident.

In addition, on the left side of the screen, other important information is listed such as: property information, land use, owner contact, building square footage, year built, and most importantly is the building elderly or disabled owner occupied.

Large Scale Incident using Boundary Search

In a large scale incident such as a hurricane or wildfire, aggregate information is the key to evaluating the situation. Imagine the impending direct hit of a Category 5 hurricane while Miami Dade County evacuation zones A, B, and C are under evacuation orders. By clicking on "Boundary Search" from the first page of the application, emergency managers can extract all the critical facilities by evacuation zones. Municipalities can narrow down this search and receive municipality-specific information by selecting "Secondary Boundary Search."

The result of the above scenario produces 82 pages of 1,378 critical locations summarized by facility count such as total number of schools, number of students, total beds in nursing homes or assisted living facilities, residential population, and employment population; HazMat chemicals, acreage of the parks, total number of parking spaces within metro stations, and the number of hospital beds. The list includes every essential piece of information needed by emergency management to enable sound decision-making.

In addition to hurricane evacuation zones and municipal boundary searches, the application includes search capability by commission district, zip code, and Turkey Point Nuclear Plant emergency protective zones. New boundary searches such as U.S. national grids and police and fire grids will be added in the next phase.

Database Update

In addition to the county departments' responsibility for updating the critical location database, the county's 35 municipalities are also responsible for updating and communicating any new information or revisions to their critical location data. By sharing the application with all 35 municipalities, the county's goal is to get as much updated data as possible for a more comprehensive county-wide emergency incident management tool.

The Geographic Information System

- The application was developed using ESRI's ArcGIS 9.2 Server & .Net.
- Critical Location Data is a layer merged from 22 SDE feature layers using ArcGIS Model Builder and Python Language for automatic update.
- The aerial photograph is 2007, and will be updated as soon as 2008 is in production.
- New 2008 oblique photo is ready to be added to the application.
- The property appraisal data and commercial facility data are located in an ArcSDE database.
- Updated on a regular basis.

Effectiveness Measures

The application is used on a regular basis by Miami-Dade County emergency managers and first responders, other municipal emergency managers, and first responders, colleges and universities, the Miami-Dade School Board, and other government agencies interested in critical location data and mapping for emergencies and day-to-day activities.

Next Step Forward

The application is robust and able to accept more functionality by adding more critical location data and including additional boundary searches. For the next phase the county is planning to incorporate:

- Expansion of existing hyperlinks for information such as facility floor plans provided by the fire prevention, building department, school board, etc. or the U.S. National Grid, and police and fire district boundary search.

- A residential and employment population estimate for the incident and vicinity.
- Additional live data such as weather from NOAA and live cameras from the Department of Transportation.
- The addition of Pictometry or Oblique photography that is currently available in the county's GIS server
- A larger map view and dockable data view.
- Addition of new GIS layers to the critical locations as needed

Sohelia Ajabshir
Sr. Systems Analyst / Programmer
Miami-Dade County Department of Emergency Management & Homeland Security - DEM&HS
www.miamidade.gov/eoc/
9300 NW 41 St., Doral, FL 33178
(305) 468-5417

Best Practice for GIS Support for Emergency Management

Montgomery County, Maryland

Overview

Montgomery County is Maryland's most populous jurisdiction with just under one million residents. The county delivers emergency management services through several departments and agencies. These include the Montgomery County Police Department, the Montgomery County Fire and Rescue Service (MCFRS), the Sheriff's Office, and the Office of Emergency Management and Homeland Security (OEMHS).

These departments utilize several emergency support and information support systems and often rely upon GIS technologies and solutions provided by the county's Department of Technology Services (DTS) centralized GIS team as well as departmental GIS staff. The county presents four examples of best practice solutions implemented by the DTS-GIS team in support of the county's emergency management and public safety needs.

Assembly of a GIS Database that supports in-county and Mutual Aid Areas Montgomery County's Department of Fire and Rescue Service (MCFRS) maintains standing mutual aid agreements with surrounding jurisdictions. These agreements obligate MCFRS to provide fire and rescue services to residents of neighboring jurisdictions within a specific distance from the common borders if requested and, likewise, for county residents to receive similar services from neighboring jurisdiction's first responders.

To support these mutual aid requirements, DTS-GIS expanded the content of the data layers on the county's computer aided dispatching (CAD) system to include data relevant to neighboring jurisdictions. These new data layers include:

- Street centerlines with address ranges
- Building footprints
- Fire hydrants
- Points of interest
- Other water sources
- Orthophoto images

Just like the points (e.g. fire hydrants) and polygons (e.g. building footprints) data, the street centerlines data for in- and out-of-county needed to be merged. DTS-GIS developed a script to automate this process. Currently, the merged file includes 70,000 street segments: 41,000 in-county and 29,000 for the mutual aid areas (Figure 1).

The merged GIS data layers were then converted and uploaded to the Public Safety CAD system and are updated on a continual basis to meet operational needs. This street centerline data includes attributes (one-way streets, speed limits, turn restrictions, and grade separation indicators) that allow for route generation.

This is one of a few ‘routing grade’ centerline databases in the country. The expanded county GIS database constructed under this program has met the needs of the county’s Public Safety CAD system since July 2003.

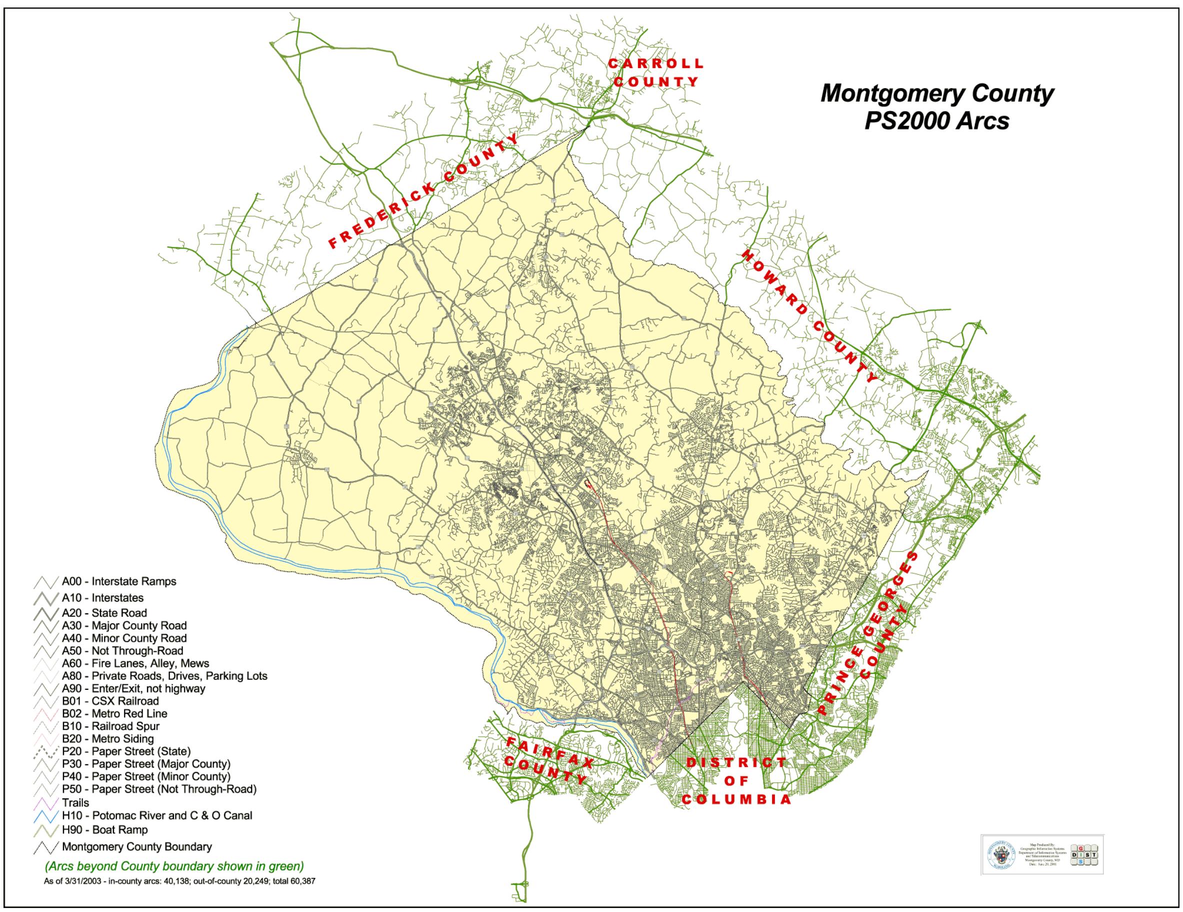


Figure 1: The merged in- and out-of-County (mutual aid areas) centerlines

GIS Support for the County Emergency Operations Center

In addition to the support of the new CAD system, the expanded county GIS data layers were also made available to the county's EOC, which is co-located within the county's Public Safety Communications Center (PSCC).

This was accomplished via a Web-based GIS Map Viewer application and displayed as Shapefiles residing on the GIS File Server. A dedicated GIS workstation, equipped with ESRI ArcGIS software, is available at the EOC.

During EOC activation—either due to a real emergency or to an exercise—a GIS analyst is typically made available to the center. The GIS analyst can come from the Police Department, MCFRS, or DTS-GIS, and can quickly produce various maps requested by emergency managers (Figure 2). These maps enhance situational awareness for emergency managers and help response planning and execution.

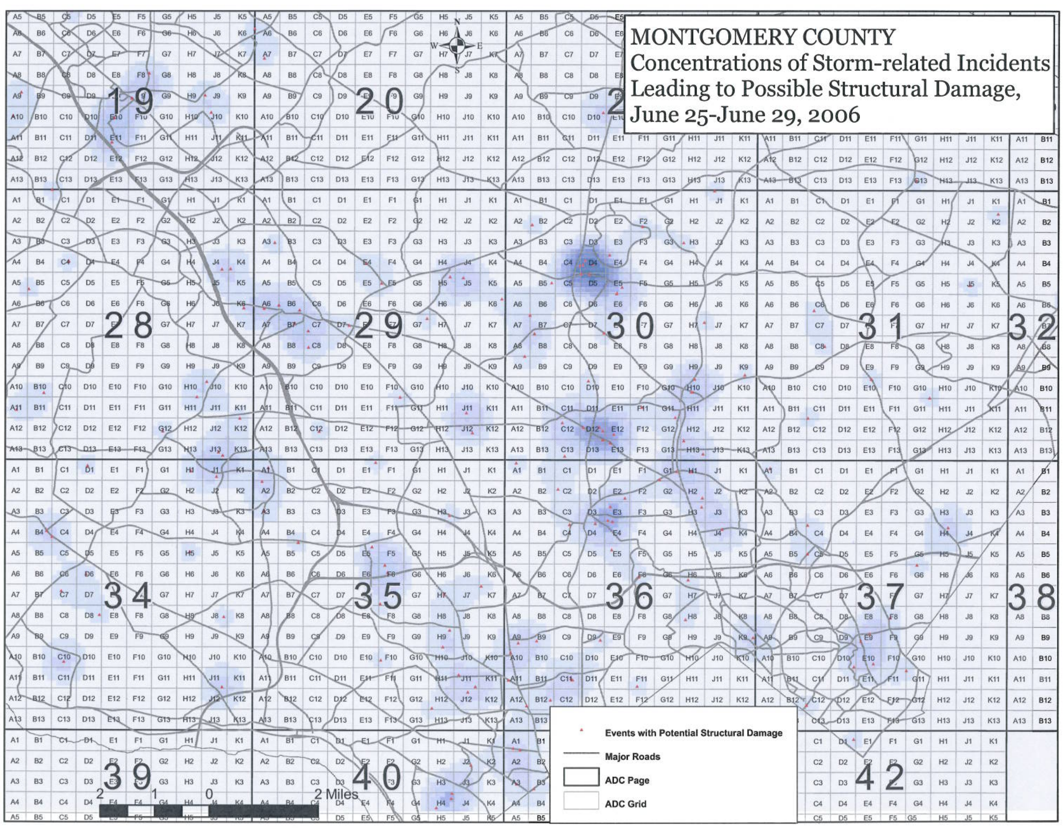


Figure 2: GIS map to aid emergency managers

Development of an Oblique Aerial Image Library for Emergency Responders

DTS-GIS acquired oblique (perspective) views of the entire county under contract with *Pictometry International* of Rochester, New York, and maintains these views in an aerial image library. Typically, seven or eight (or more) pictures are available for any building or structure in the county. In effect, all sides of a building, as well as access paths, parking lots, entrances, ramps, and outside stairways are also visible from the images. These images provide enhanced situational awareness for first responders (Figure 3).

In addition, Pictometry software enables measurement of distance, area, and height. This makes response planning more precise. Traditional vector GIS data layers can also be incorporated into the display. One can even zoom into the target by specifying an address or a property ID.

Figure 3: Oblique aerial image

Implementation of a Web-Based GIS Data Service

DTS-GIS, with technical assistance from Towson University GIS Services (tuGIS) and *ESRI Inc.*, has, via a Web-based GIS data service, successfully served up GIS data to support the needs of emergency managers within the county and at the state and regional levels as well.

The county's OEMHS plays a major coordinating role for emergency response and management functions within the county. One of these responsibilities is overall management of the county's EOC. OEMHS licensed *Ramsafe* as its emergency management application, and requested that DTS-GIS provide relevant GIS data layers.

Within the State of Maryland, the Maryland Emergency Management Agency (MEMA) coordinates emergency management functions. MEMA selected WebEOC as the states and counties' preferred emergency management application. Similar to Ramsafe, WebEOC also requires access to a rich set of relevant GIS data layers. To that end, MEMA contracted with tuGIS to develop a web-based GIS data service for the state's emergency management community, which consists of MEMA and the EOC's of the 23 Counties and Baltimore City in Maryland. The project was dubbed the Maryland Emergency Geographic Information Network (MEGIN).

At the regional level, the CIO Council of the Metropolitan Washington Council of Governments (MW-COG) tasked its GIS Committee to embark on a Geospatial Interoperability Initiative. The goal of the initiative is to develop a federated network of GIS web sites among the 19 National Capital Region (NCR) member jurisdictions to provide a selected set of GIS data layers for access by any agencies' first responders and emergency management personnel.

To satisfy the GIS data needs of the three initiatives, DTS-GIS was tasked to develop a web-based GIS data service, with technical assistance provided by the county's police department and MCFRS. The county viewed the MEGIN pilot project as a natural entry point.

The MEMA MEGIN pilot project enlisted the participation of a large urban county (Montgomery), a medium suburban county (Frederick) and a small rural county (Garrett). To make the Montgomery County GIS data understandable by other web users, on-line metadata was established. The metadata for the 100 data layers was developed and uploaded to the Maryland GIS Network Web site (http://www.marylandgis.net/) (Figure 4).

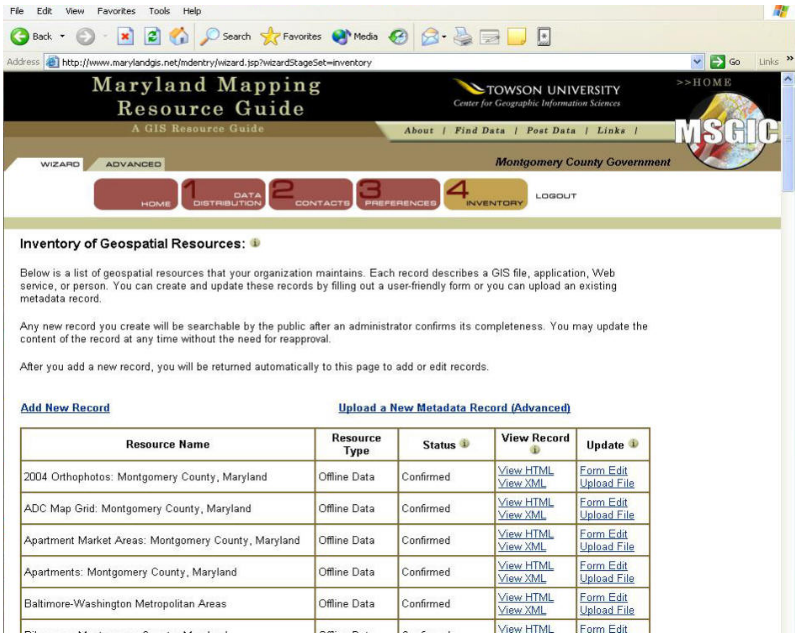


Figure 4: Montgomery County GIS Metadata

Patterned after the DTS-GIS on-line Map Viewer, the joint DTS-GIS/ESRI Inc. project team implemented a map viewer to verify that the 100+ Montgomery County GIS data layers are indeed available from this MEGIN member site (Figure 5).

This particular map display pulls four GIS data layers (county boundary, municipalities, interstate highways, and hospitals) from the MEGIN map server's 100+ layers.

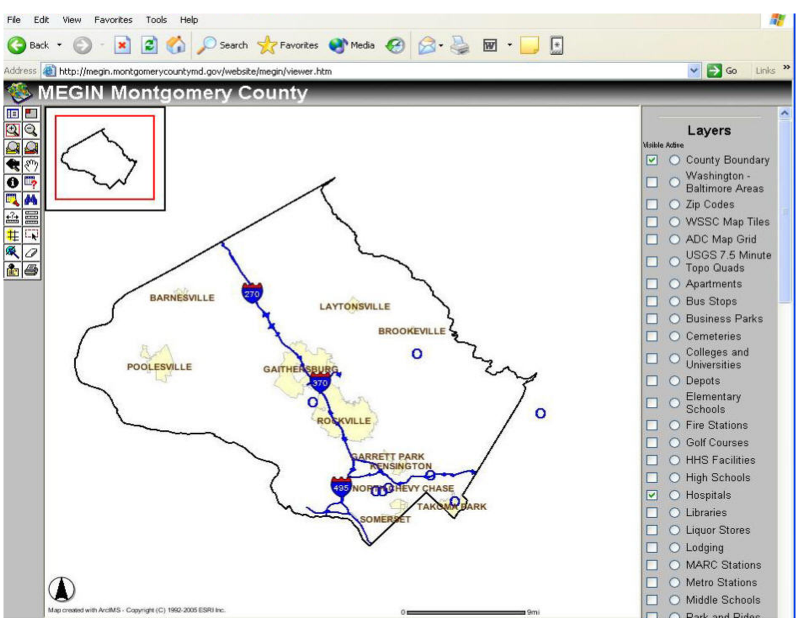


Figure 5: Map Viewer

The 100+ GIS data layers meet the needs of the county EOC. It also fulfills the needs of the MEMA pilot program. For the GIS data needs of first responders and emergency managers in the NCR, the MEGIN server provides much more than the 10 data layers currently identified by the MW-COG GIS Committee.

The Web-based GIS data sharing and technical processing approaches employed in this project serve as a model for other counties or urban centers contemplating similar programs.

Ivan Galic
Chief, Enterprise Applications & Solutions Division
Department of Technology Services
Montgomery County, Maryland
240-777-2898
Ivan.galic@montgomerycountymd.gov

GIS Data in the FDNY: A Response Tool

City of New York, New York

Overview

As first responders to fires, public safety and medical emergencies, disasters, and terrorist acts, the Fire Department City of New York (FDNY) protects the lives and property of New York City residents and visitors.

FDNY advances public safety through its fire prevention, investigation and education programs. The timely delivery of these services enables the FDNY to make significant contributions to the safety of New York City and homeland security efforts.

The Fire Department City of New York maintains these Core Values:

- SERVICE: The department continues its unwavering call to protect and serve.
- BRAVERY: The ability to overcome fear through fortitude, instinct, compassion for others and training.
- SAFETY: The department strives to keep our citizens free from danger, especially deliberate, harmful acts. With the best equipment and training, the department can reduce the risk to the public and its members at fires, emergencies, and medical incidents.
- HONOR: The department maintains excellence of character. We inspire each other through pride in our unit, which is a belief that every action reflects on all the members of the unit, both past and present.
- DEDICATION: A commitment to the objectives of our mission is an essential part of our code of conduct. The faithful observance of duty calls for us to fulfill our obligations professionally and honestly.
- PREPAREDNESS: By combining all of the components of our core values, the FDNY will maintain its constant state of readiness to meet all threats and challenges, traditional and new.

Statistics of the Fire Department City of New York

- 10,725 Firefighters and Fire Officers running 341 Engine Companies, Ladder Companies and 65 Specialty Fire Apparatus (such as Squads, Rescue, etc.).
- 2,740 EMTs, Paramedics, and Officers running 378 Ambulances
- 171 Fire Marshals
- 247 Fire Inspectors
- 174 Dispatchers
- 1,101 Administrative Support Personnel (Mechanics, Trades-people, Technologists, Civilian Professionals, etc.).
- Fire Apparatus responded to: 432,969 fires and non-fire emergencies (average 1200 calls per day).
- EMS responded to 1.3 Million medical emergencies (average 3300 calls per day).
- Fire Marshalls investigated 6,292 fires for potential arson.
- Conducted 183,403 fire code regulatory inspections.
- Conducted 1,834 fire safety events.

How the System Works

Since 09/11/2001, the FDNY has been re-evaluating response procedures to large-scale incidents. Based on requirements that have been determined from a number of various sources, GIS technology and the associated data have become an increasingly valuable resource to the department's individual bureaus and units.

Accurate and informative mapping of current conditions, structures, and infrastructure is now required as essential visual aids by the incident commander and incident command structure, whether the response is to a natural or man-made catastrophic event that affects a large area or number of people, involves fire, structure collapse, severe weather conditions, or a weapon of mass destruction or terrorism related incident.

There is a growing demand for GIS technology in the FDNY, especially in regard to Fire and Emergency Medical Service (EMS) response-related GIS data assets, dispatch operations, building inspections, and the integration of operational data for analysis, planning, mapping and distribution through the department's intranet.

The FDNY GIS Unit maintains the following mission statement:

- Obtain and maintain up to date information on assets and infrastructure.
- Develop and implement data specific to FDNY needs.
- Provide customized mapping, analysis, and reporting solutions to support FDNY Emergency responders of all ranks.
- Research, promote, and support the use of GIS technology.
- Inter-agency liaison to local, state, and federal GIS organizations.

The FDNY GIS Unit has been working continuously to provide mapping and coordinated aerial photography products and FDNY specific geospatial data to bureaus and units operating throughout the department. The FDNY GIS Unit continues to work on projects to support first responder dispatching such as: fire alarm box geo-code verification, fire response area mapping, hydrant verification, FDNY administrative areas verification, fire and EMS computer aided dispatch (CAD), automated vehicle location (AVL) project, oblique angle aerial photography, special events and dignitary protection incident action plans (IAPs), emergency action plans for commercial high-rise buildings/digital blueprints, fire prevention building violations, fire investigation fatal tires and arson incidents, safety command's accident investigations, collaborative projects with special operations command HazMat, rescue and marine units, as well as ad-hoc field requests from borough commanders and company officers.

The FDNY GIS Unit has an extensive geo-database with FDNY specific datasets that are enhanced by shared datasets from various key city, state, federal, and private sector agencies including: DOITT, OEM, city planning, NYPD, DEP, DOT, MTA, parks, Con-Ed, National Grid, NYS-GIS, NYS Emergency Management Organization (SEMO), US DHS, National Geo-Intelligence Agency (NGA), mutual aid partners (New Jersey, Nassau and Westchester Counties), etc.

The FDNY has various applications that utilize state-of-the-art technology that can be incorporated with the current and future geospatial datasets.

One of the FDNY's key goals is the integration of upgraded technology that will allow for a greater distribution of information throughout the department and to other city agencies. However, significant challenges exist with regard to FDNY operations and the widespread adoption and dissemination of GIS information within the agency. The FDNY GIS Unit is currently focused on addressing this issue as described below:

- Centralizing and standardizing the GIS data within the FDNY, ensuring that all FDNY applications access the most current data by integrating the GIS server into our existing systems utilizing a Homeland Security Standard Data Model consisting of FDNY geospatial datasets and geospatial data obtained from non-FDNY resources.
- Creating a means for FDNY personnel to readily access the current geospatial data that is created and maintained by the FDNY GIS Unit and geospatial data that is obtained from other government, public, and private agencies.
- Instituting a process for users to provide GIS data updates and corrections based on field observations or utilizing mobile technology to the FDNY's geospatial repository and/or to the appropriate GIS custodial external authorities.
- The FDNY GIS Unit is currently working to build on and improve the effectiveness of its utilization of GIS technology by taking the following measures:
- Evolving its existing geo-database resources managed by the FDNY GIS Unit into a centralized enterprise-wide geospatial data repository and to incorporate non-geospatial data to form a common operating picture.
- Providing a customized web map and search/explorer tool to accommodate specific workflows for the use of GIS technology within the FDNY's Operations Center. Some of the custom ideas to enhance daily workflows include longitude/latitude lookups, fire alarm box lookup, and enhanced queries developed for models involving plumes, bomb blast buffer zone and a natural disaster zone to identify critical infrastructures, FDNY resources, hospitals, etc. within the various zones. This would include password protected map services, globe services and geoprocessing service models.
- In the future, the FDNY GIS Unit seeks to implement a secure automated GIS data exchange solution between the FDNY and external agencies. A primary focus of these proposed enhancements is to further assist the FDNY's high-level decision makers, operations center staff and first responder operations during a crisis situation. A

secondary focus of these proposed enhancements is assisting daily workflows of personnel involved in our strategic planning, fire prevention, fire investigation, safety command, building/hydrant inspection activities, and terrorism/disaster preparedness.

The FDNY has been working to incorporate systems for efficient and accurate sharing of information department-wide so that all designated users will have access to the GIS Unit's general geospatial repository and identified secure users will have access to critical infrastructure datasets.

There are many GIS projects currently underway within the FDNY, such as an Intranet Web Mapping application, Multi-agency Data-sharing Cooperative, Automatic Vehicle Locators, FDNY Subway Radio Repeater mapping, FDNY Deployment Site Modeling project, NYC Department of Information Technology and Telecommunications GIS Committees, the Citywide Street Centerline Project (Geofile Project), Critical Infrastructure Project, Center for Terrorism and Disaster Preparedness Exercise Design Team, Plume Modeling, Nautical Modeling, Digital Blueprints/Emergency Action Plans, etc.

All of these activities will greatly benefit from the common operational picture and a centralized geospatial repository currently under development.

Establishing a centralized geospatial repository to support FDNY geospatial data will further assist the department to:

- Maintain and update geospatial data associated with FDNY assets (for example, fire alarm call boxes and EMS response district polygon overlays ("atoms"), etc.).
- Provide a means for FDNY users to access the repository data. The FDNY GIS Portal will be enhanced to support the repository. Field units must be enabled to access the repository.
- Standardize GIS data structures, formats, and domains shared by FDNY units. For example, the FDNY bureaus and units will develop a standardized data structure for alarm boxes, which contains the set of required attributes (e.g., common key, circuit number, borough, box number, administrative unit).
- Apply city-wide GIS standards to the geospatial data provided to FDNY units.

- Provide easy access to GIS technology within the FDNY by supporting simple to use pre-configured interfaces. This enables high-level decision makers including the department chief, high-ranking staff chiefs, and operations center staff to easily and consistently access agency-wide data.
- Review FDNY application requirements to ensure that the geospatial components are compatible with FDNY GIS standards.
- Serve as the FDNY coordinator to obtain and verify GIS-related data from other organizations needed by FDNY units, and to monitor and provide data updates when they become available.
- Provide GIS technical consulting and support for geographic analysis, and FDNY GIS product development.

The FDNY GIS unit is also in the process of developing and implementing a data exchange solution between the FDNY geospatial repository and other organizations that provide data to the repository such as city agencies, New York state agencies, federal agencies, regional GIS data sharing cooperative, and the citywide street centerline project (Geofile Project).

This solution will:

- Facilitate the provision of geographic information (e.g., streets and addresses) that is observed by FDNY field personnel to such organizations.
- Require a staging area in the repository to temporarily store the missing or corrected geospatial data and make it accessible to FDNY GIS applications.
- Send the temporary data to the appropriate organizations to update their custodial data (e.g. hydrants for Department of Environmental Protection). Once the custodial organization updates their data to incorporate a geographic addition or correction, the FDNY will implement the change into the repository.
- This methodology for developing data and applications will improve the internal knowledge base, enhance decision support and extend GIS throughout the FDNY enterprise. The common operational picture application will enable FDNY to achieve integration within the FDNY and widespread use of GIS.

Units of Measure for Determining Success

The GIS unit expects that the updated information afforded by these collective efforts will further enhance the FDNY's responses at emergencies and further increase efficiency. In order to measure the effectiveness of this new technology, the FDNY will observe any productivity increases that may occur due to the new GIS resources and tools under development. The FDNY will monitor operations where GIS played a role in developing critical decisions during emergencies.

Time savings will also be an important measure, as the new tools will allow for greater access to pertinent information at emergencies at a faster rate as evident by GIS' support at the recent Manhattan crane collapses. Units will be equipped with more complete and expansive knowledge of their surroundings to help them during operations. These new tools will also assist in the development of pre-incident plans for specific types of structures and events.

The FDNY is one of the largest fire departments in the world, and protects one of the largest cities as well. The ever-changing landscape of New York City often makes it difficult to maintain current information on structures and roadways, which could pose problems for our first responders. However, because of our dedication to incorporating the latest technology, such as GIS in our daily operations, we consistently aim to further enhance our response to emergencies.

The FDNY is a major government agency with a strong existing GIS Program. The GIS Unit is dedicated to further developing its GIS enterprise to broaden its applications within various bureaus in the department and to expand access of this essential information to the field.

In summary, the overall perceived benefits and return on investment for a sophisticated state-of-the-art GIS Unit within the FDNY will only further improve the safety measures of Firefighters and EMS personnel, as well as other emergency responders and New York City residents that we are sworn to protect.

Captain Steven Pollackov, Commanding Officer
FDNY GIS Unit
9 Metrotech Center, Room 7S-17
Brooklyn, NY 11201
Phone: 718-999-5195 FAX: 718-999-7173
E-mail: pollacks@fdny.nyc.gov

A Rural County Approach to Using GIS in Emergency Management Operations

Pacific County, Washington

Overview

The Pacific County Emergency Management Agency (PCEMA) was formed as a result of federal mandate in 1986, through a multi-jurisdictional agreement between Pacific County and the cities of Llwaco, Long Beach, South Bend, and Raymond. The PCEMA mission is to coordinate the four phases of emergency management: mitigation, preparedness, response, and recovery to protect the people, property, and environment of Pacific County.

A primary function of the PCEMA is to act as a liaison between local jurisdictions and state and federal agencies during times of emergency or disaster. This is accomplished through the use of the Emergency Operations Center (EOC), located in South Bend. During an emergency or disaster, information is gathered from involved local agencies and jurisdictions and is jointly submitted to various state agencies in an effort to coordinate local resources, information, and emergency response efforts.

The PCEMA strives to be proactive in the area of preparedness and mitigation through an enhanced system of communication and information sharing. The county GIS system, located and funded through the department of public works, assists with these efforts. The GIS works in the resource support section of logistics, reporting directly to the incident commander during active EOC operations and training exercises.

Situated on the southwest coast of Washington State, Pacific County (population 21,800) is particularly vulnerable to storms, flooding, high winds, erosion, and tsunami activity. The area was hit hard by a winter storm in December, 2007. Hurricane force winds caused power outages, persistent flooding, blocked highways and resulted in a large number of downed trees. Washington State National Guard and Red Cross personnel used GIS to create maps for help in conducting door to door checks on flooded areas.

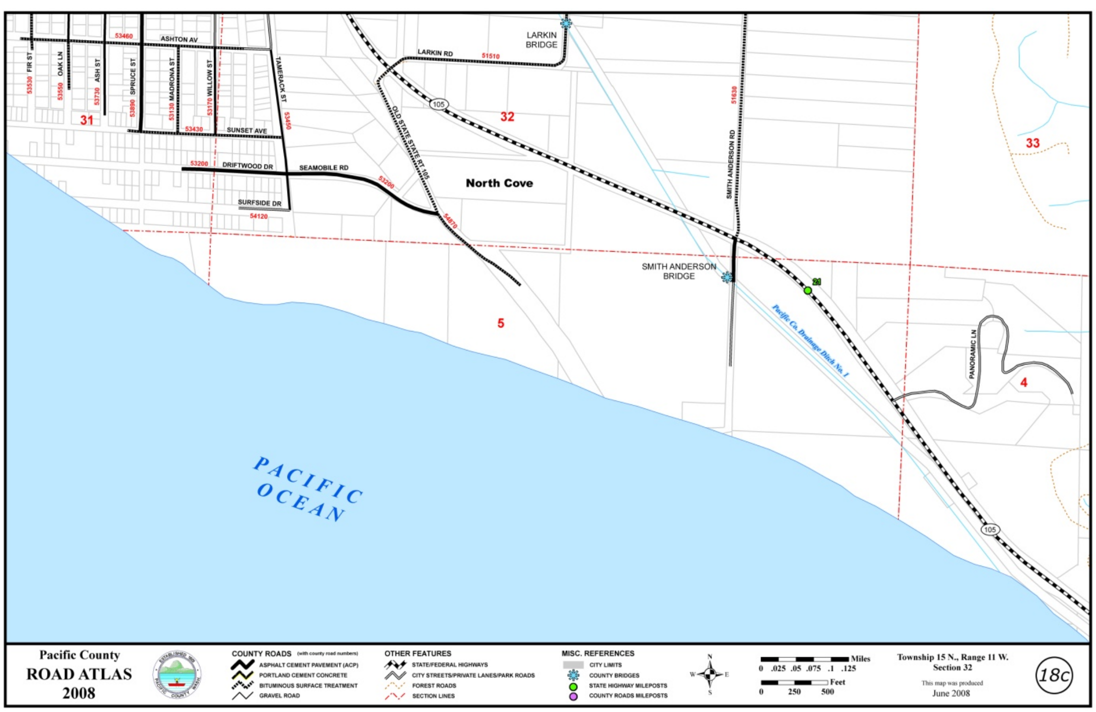
After the storm, maps were used to locate downed trees, trees in danger of falling, and brush piles to assist with cleanup efforts. GIS was also used to help document the record flooding that occurred during the storm.

How the System Works

To assist with emergency management operations, the GIS department maintains several spatial data layers. Of these layers, one of the most useful is the county address layer. The Public Works Department updates all new address and address changes to a spatial layer, insuring that there is only one address per parcel. Address points are assigned based on whichever street the property's driveway accesses, and the points are placed directly on the house or building depending on the quality of available orthophotos.

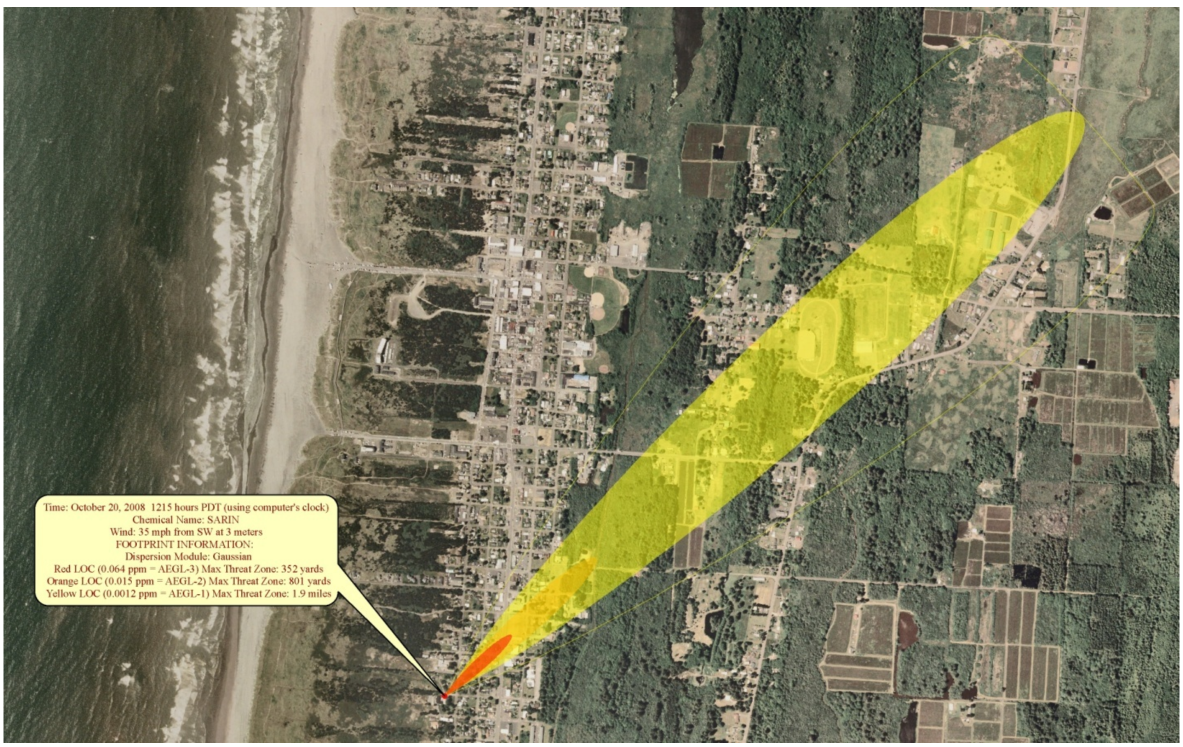
Tax lot data are also useful in emergency management by being able to identify property owners and SITUS information. The tabular data for this layer is kept up to date by the county assessor's office, while the spatial component is maintained by the GIS system. GIS is used to update the county road layer and helps to maintain this data for use in the county E911 system.

The county road layer is also used to create another useful tool for emergency responders, the county road atlas. This mapbook is valuable for being able to quickly identify routes to emergency locations. The addition of highway and county road mile markers, along with county bridge locations, provides further reference points that help emergency responders locate areas on the map.

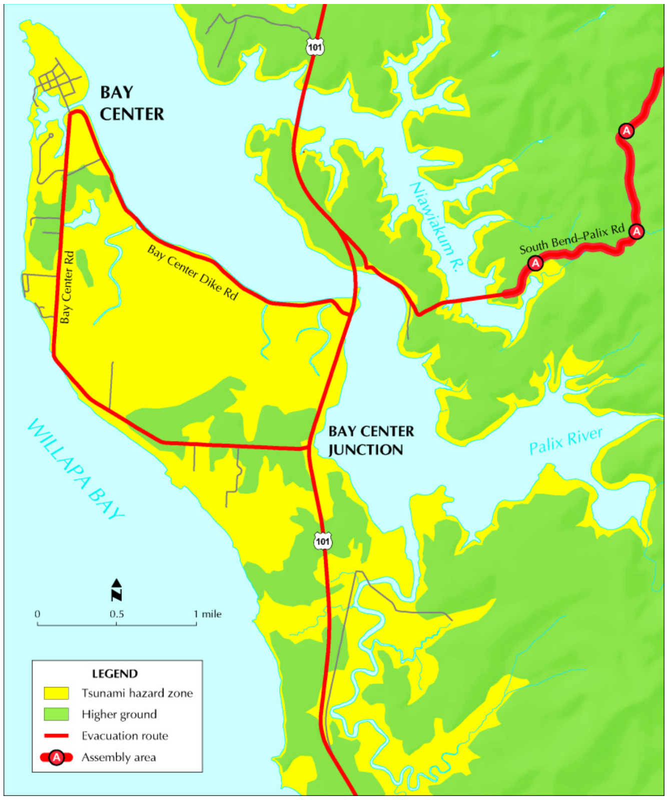


The Pacific County Sheriff’s Office has found this GIS data useful by having maps created for them when planning for drug searches and seizures, finding marijuana growing sites, and during search and rescue operations.

The locations and identification of hazardous materials sites is another data layer that proves invaluable to emergency responders. GIS can be used in conjunction with FEMA’s software programs such as ALOHA (Area Locations of Hazardous Atmospheres), CAMEO (Computer-Aided Management of Emergency Operations), and MARPLOT (Mapping Application for Response, Planning, and Local Operational Tasks), to model plumes of known hazardous materials and overlay this data onto existing maps. In the event of a hazardous material spill or leak, this plume data quickly shows which areas need to be evacuated and contained.



Being uniquely situated within a tsunami inundation area, Pacific County has used GIS to help prepare evacuation maps. These maps, available in PDF format on the county web site, show tsunami hazard zones, areas of high ground, evacuation routes, and assembly areas. Further maps have been prepared that identify congregation areas, and show the locations of warning sirens. Using GIS to buffer the approximate distance from which these sirens can be heard, serves to identify areas that need further sirens to be installed.



Several other environmental types of data layers are useful for the GIS department when providing map services to the Emergency Management Department. Data such as horizontal earthquake acceleration probability, soil liquefaction susceptibility, and the National Earthquake Hazard Reduction Program (NEHRP) site class – which measures the potential for ground shaking – all help identify areas that would be particularly vulnerable during earthquake activity. Other environmental layers include FEMA flood zones and county maintained "frequently flooded areas", both useful in determining which areas of the county are prone to flooding.

The Emergency Management Department maintains a list of critical facilities that the GIS Department uses to create a spatial layer from. This list is updated on an annual basis and includes facilities such as: banks, churches, electrical substations, fire departments, communications offices and towers, state patrol and police departments, emergency services, post offices, hospitals, nursing homes, port facilities, airports, bridges, water and wastewater treatment plants, grocery stores, hotels, building supply stores, pharmacies, city and county government offices, military locations, schools, and public works locations.

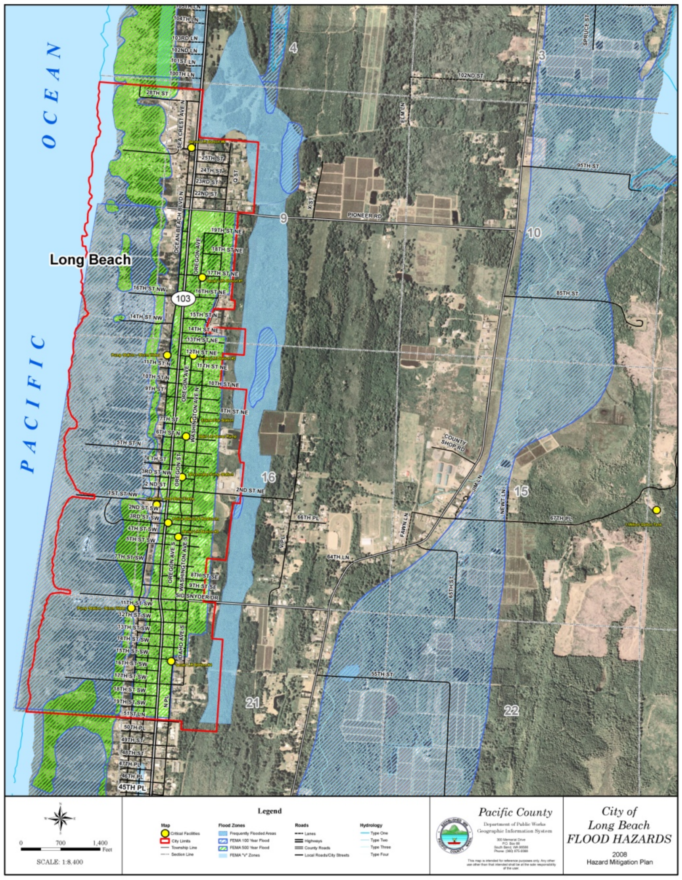
This critical facilities layer has proven to be especially important to the emergency management department recently due to its current participation in a FEMA funded hazard mitigation plan.

Mitigation planning is described by FEMA as, “A process for state, local, and Indian tribal governments to identify policies, activities, and tools to implement mitigation actions. Mitigation is any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. This process has four steps:

- organizing resources;
- assessing risks;
- developing a mitigation plan; and
- implementing the plan and monitoring progress.

For the Pacific County GIS staff, this means preparing maps that identify the locations of many of the features already mentioned in the critical facilities list in addition to: vulnerable populations, flood zones, water districts, emergency shelters, animal care shelters, population and housing density, site class, storm drainage, transportation corridors, public transit, high erosion and other special areas.

Critical facilities are then placed over maps that show the areas of earthquake hazards, flood hazards, and tsunami hazards to identify which facilities are at risk. FEMA’s HAZUS-MH (Hazards U.S. Multi-Hazard), will then be used to determine the replacement costs for loss or damage to these facilities in the event of a natural disaster.



Going through this planning process is giving us a reason to pull all of our critical data together. Most of our spatial data is being used in some way during this planning effort and is really helping us realize which data layers are important to have for emergency responders.

The value of high resolution, and current digital aerial photography also became apparent while working on this project. The hazard mitigation plan is also helping the GIS department by identifying areas to work on. Improving HAZUS-MH capabilities, and increasing access to spatial data through enterprise GIS and mobile technologies are at the top the list.

Tim Triesch
Senior GIS Analyst
Pacific County Public Works Dept.
300 Memorial Drive
PO BOX 66
South Bend, WA 98586
(360) 875-9368 ext. 2268

GIS Evolution within County Emergency Management

St. Clair County, Michigan

St. Clair County is a historic maritime, border community north of Detroit. As the easternmost Michigan County, the county is separated from Canada by the southern tip of Lake Huron, the St. Clair River and Lake St. Clair. Due to this water border, the area is home to one of the oldest cantilever truss bridges and the first full-size subaqueous tunnel built in North America. When combining these border crossings with the convergence of I-94 / I-69 and our two ferries; St. Clair County is home to essential connections within our nation's trade network between Canada and Mexico.

While our geographic location and transportation assets provide a national context, the localized emergencies impacting the day-to-day life of our 170,000 residents are similar to other units of government. Our infusion of GIS technology within emergency management was strengthened when the two offices were moved to a new building and shared office resources. As emergency management staff became aware of the capacity of our system; pilot projects were engineered to test the applied technology. While the pilot programs included a high degree of complexity and overhead, many provided less industrious deployments within the emergency response community and increased program awareness.

St. Clair County is committed to continuing and strengthening our already strong collective, collaborative working relationships with local, state, federal and international partners. The county actively participates in developing a full range of plans at all levels of government and private business: encouraging multi-jurisdictional and multi-disciplinary training, leveraging existing resources, optimizing future resource opportunities, partnerships with mutual goals and developing sustainability.

An overall goal is "to prepare the citizens, property, environment, culture and economy of St. Clair County for acts of terrorism and natural disasters and to minimize the effects of these emergencies through a comprehensive public-private planning and response effort."

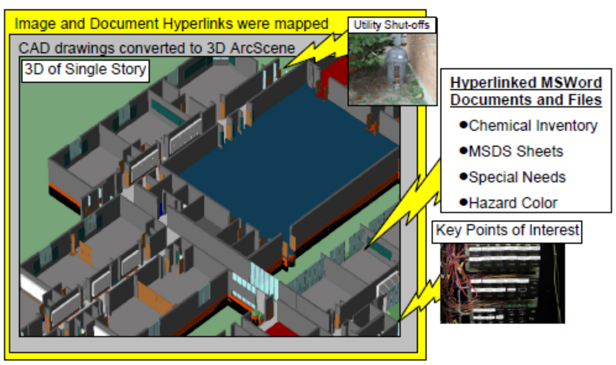
We recognize responding to an emergency should be a county-wide collaborative approach and perspective to all planning and response activities, acknowledging that no individual jurisdiction in the program area stands alone.

Before diving into the Rapid Damage Assessment Application, several preliminary and incremental applications were undertaken which introduced GIS tools to our emergency management community. The projects were: School Planning Demonstration Project, Airport Crash Field Scenario and Ardent Century Training Exercise.

An early planning project involved a local school district's scheduled update to their emergency response plan. GIS staff was initially asked to help provide basic building diagrams and maps; however, as the technical capacity for GIS to link other information sources became apparent, staff was challenged to push the limits of the technology.

Eventually, the pilot campus included 3D building diagrams with hyperlinked images of points of interest, utility shut-offs with instructions, chemical inventories, MSDS sheets, priority color codes, and special needs areas. Due to limited computing capacity (around 2001; ArcView 3.2a) the project was restricted to planning and demonstration purposes.

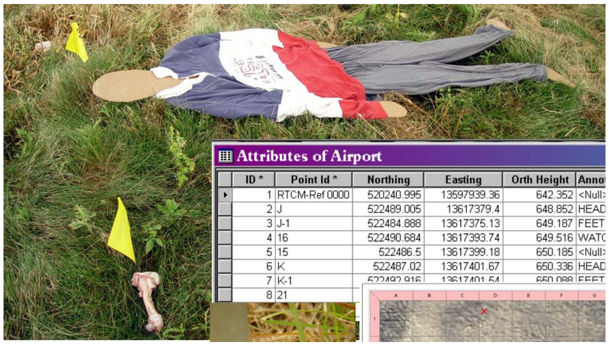
A grant funded project was then completed for all public school buildings within the county. Each school was mapped in 2D with unique room identification, utility shut-off locations / instructions, 360 degree images of hallways, gathering places, and special interest locations. Individual 11x17 maps of the floor plans were distributed in either bound folios or PDFs.



A second milestone application for Emergency Management was during a training exercise at the County International Airport. The event staged was a plane accident which included unique cargo: US Mail.

Due to a need to identify the resting location for each piece of evidence, two technologies were tested against traditional methods. The Michigan State Police assisted by mapping the scene and locating items with a laser rangefinder and GIS staff mapped evidence locations with GPS technology.

The county had recently installed a CORS Tower within operational range of the airport. This tower eliminated the need to establish a site reference station and provided the capacity to collect almost instantaneous sub-centimeter locations. This ability allowed us to focus on the new evidence locations. Utility staff from a local city and county GIS staff mapped and photographed the scene as the first responders were packing up.



After collecting the data, staff was invited to attend an off-site debriefing luncheon two hours later. The invitation provided an unexpected challenge as we chose to attempt an impromptu presentation. This was possible due to the fact all information was collected digitally and reference information was provided within our GIS; we were able to return to the offices, transfer the collected data, and quickly create a gridded scene map including linked photographs and digital video.

An unexpected difficulty was convincing the responders that the maps and photographs were collected within such a short time. One individual remarked, “If this was a real event, I would still be unpacking the equipment to measure the scene”. The discussion then shifted to a hypothetical situation where the GIS could be utilized to integrate data from both the laser-rangefinder and GPS. Although the county has not integrated GPS technology with crime scene mapping, the tools of 360 degree photography, aerial photography and the capacity to produce a wide range of mapping products have been incorporated as routine tools.

The latest integration of GIS system was to introduce the technology within our Emergency Operation Center (EOC). GIS staff was asked to participate in a planned training event by operating within their offices. Maps and information would be shared through networked printers and .jpg exports. However, as the situation unfolded, the requests for information exceeded any potential delivery medium and the system was relocated to the main projector within the EOC itself.

After the containment areas were defined and requests began to slow, staff began to analyze parcel and census information inside the impact area. Individuals who were present became amazed as population estimates, building Values, commercial & industrial facility names, impacted shelters and individuals who have special needs began to appear on the screen. The interest continued as the printers began to hum with 11x17 section maps of the potential contamination zone.

The development of GIS within our Emergency Management has included a gradual escalation of involvement and responsibility. The process has followed a logical progression of: static maps; assistance with planning and visioning; experimentation after field training; incorporation during an EOC training exercise and now to preparing damage assessment tools. This progression was extremely valuable to both emergency managers and the GIS staff: The working atmosphere within the emergency management community is vastly different than most other levels of government. These cooperative efforts were instrumental in establishing the foundation for GIS development.

Over the past decade, our GIS program area has benefitted from the relationship with Emergency Management. Each pilot project not only extended knowledge of the tools available and many projects lead to receiving grant funds or equipment.

Successive grant opportunities have built upon themselves to provide the hardware, software, data and training required to support and extend services within the county. As an example, our schools mapping project provided a springboard for receiving a competitive software grant from ESRI. The software allowed staff to develop an ArcPad application for damage assessment which led to the purchase of tablets and palm computers with OEM grant funding. This provided a hardware platform for receiving a second competitive software and hardware grant for development of an Arc Mobile damage assessment tool.

The development of a mobile damage assessment tool was inspired as a result of the experiences within an active EOC. If the GIS technology available within the confines of the office could be extended to the field; we could realize two substantial benefits: better inform our field staff and reduce the overhead associated with consolidating paper reports or digital files. While a tool had been created for ArcPad two key issues could be solved by moving to Arc Mobile: keeping information on devices current and assembling information collected from multiple devices. These may seem insignificant issues to day to day activities: but at the pace of an active EOC, any delay in the flow of information seems to quickly escalate beyond a mere inconvenience.

In addition to assisting with data transfers, the programming platform provided better integration with the operating systems and allowed more refined creation of a custom tool. These enhanced capabilities have reduced data entry requirements and lessened training requirements.

How the System Works

The ArcGIS Mobile application was developed in Microsoft Visual Basic .NET to display, collect and transfer information between the EOC and field agents. The primary goal is to collect preliminary damage estimates to quickly identify and document when established thresholds to request additional assistance has been realized.

The application replaces a current system of blank paper forms with a digital form. The digital form can be pre-populated with specific site information and general reference data. Due to the integration with our GIS, the map navigation display helps individuals better interpret their surroundings and locate the correct source information.

Once the reference data is selected, the user can focus on the assessing task of assigning a damage category: Minor, Major, Destroyed or No Damage. Once assessed, these classifications are automatically applied to the base tax value to determine a probable cost. Before leaving the site, the digital forms are programmed to verify all critical information has been collected and provide additional reference information which may be of future use.

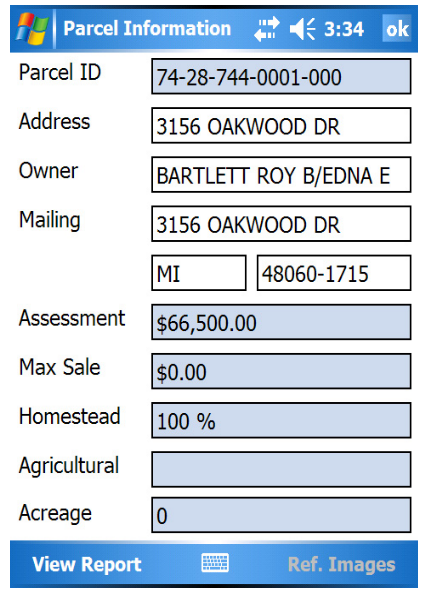
The tools have been designed with several methods to transfer information. The most advanced would be to wirelessly update after each record has been entered. However, this application will most likely be used outside wireless communication areas. Users have the option to connect directly with the county infrastructure at multiple locations around the county. If an event occurs and connections to the computer network become disrupted, a core reporting function will summarize collected information. This information may then be verbally conveyed to the EOC.

When the devices have connections to our servers the device will send all field updates and receive any new information. Again, as the technology is based on our GIS, a map of the incidents is automatically maintained. As the event unfolds, managers can choose to view the evolving map or access a Crystal Reports summary of the reported damage. The report has been customized to sort and summarize the individual records by district, community, and damage level.

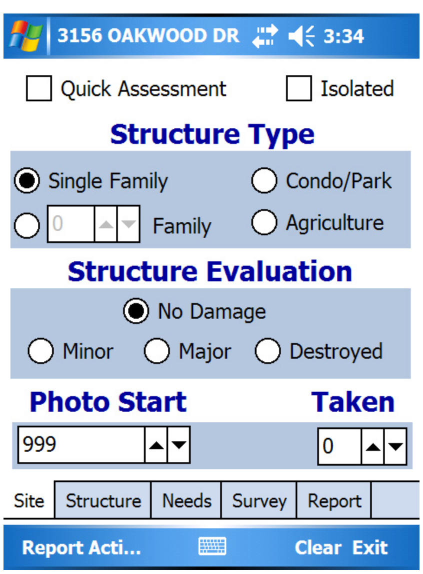
Once the information has been received by the GIS team, additional resources can be leveraged. The tool automatically saves information such as parcel ID, community name, surveyor, survey start time, and survey end time. These details can help access more detailed local assessing records to obtain information such as the number of buildings and building replacement calculations.

Information Utilized

Property information from the local assessing community has been incorporated into the application for general reference. In St. Clair County, each assessing office has elected to maintain data within a software package from a firm called BS&A. This has provided an opportunity to author custom applications to extract the data necessary for this application. All parcels within our emergency services district have the displayed parcel information. In communities where the assessor has elected to share additional information, building photographs and floor plans may also be available.



Upon identifying a map location, the parcel information window displays the associated property information. As field staff creates a damage report, this information and the map coordinates are transferred to the new report record. When known, the address will be placed at the top of all forms to re-verify the property address. The data entry form begins with a “Site” tab. This tab displays all critical fields for a quick assessment. If the system has detected a single record for this parcel and the surveyor identifies this will be a quick assessment, the required data will be verified and the user can progress to the next location.



For those cases where field staff elect to include additional information, or if the application detects more information is required, supplemental data entry forms can be accessed to record details.

Much of the above information would be required to complete overall incident reporting for the State of Michigan. We have elected to add a few items of local interest: These include all items listed on the “Needs” page along with several on the “Survey” page. When evaluating this application for use in your area, review any current reporting forms and field notes for information to collect or even require. Some locations may require collecting specific information related to hurricanes, grass fires or earthquakes. The entire application should be customized to collect and store locally important information.

Geographic Component

A core component of this application is the fact we are attributing an incident to a place on the earth. While this tool is customized to store information specific to building damage; the application could be transformed to track any distributed resource or incident which will remain stationary from reporting to resolution. With this point in mind, the information collected, stored, shared and calculated is all based on unique programming code.

To aid the proper placement of damage locations, we have included reference information such as: aerial photography, transportation infrastructure, parcel maps with assessing data and the evolving incident locations. The tool will be enhanced with additional reference data as the tool evolves. A main limitation for available field resources is the limits of field computing technology including processor speeds, data access or storage capacity and cost.

Technology and Infrastructure

The application was developed using ESRI's ArcGIS 9.2 Server, ArcMobile SDK and Visual Basic .Net. Our supporting enterprise GIS data is stored in a SQL environment which is maintained by individual departments and administered through Information Technology. After installation of ArcGIS 9.3, staff will begin testing the re-introduction of our county-wide 2005 aerial imagery which has been processed at reduced resolution for field devices.

Our earlier ArcPad application collected similar information and was able to operate on a Dell Axim X51v with the aerial photography, property information and transportation infrastructure for the entire county.

The main advances with the server technology as indicated above are: seamless data integration with the servers, increased interaction with the Windows operating system using Visual Basic .NET. A new feature of the Mobile application is the inclusion of linked ground photographs, building layouts and field reporting.

Effectiveness Measures / Case Study

The specific damage assessment application has proven advantages during training and testing exercises. Thankfully, we have not had an incident which would warrant the full deployment for the intended use. However, a parallel application for the county road commission has resulted in the elimination of a need to input paper forms completed in the field. This has resulted in an estimated annual savings of $30,000.

Next Steps

Encouraging locals to share additional resource data and become familiar with the technology is a continual goal. We intend to author specific applications to aid the day-to-day activities of the damage assessors: building inspectors, local tax assessors and emergency responders. The damage assessment tools will then be adjusted to incorporate any new data while providing a similar user interface and experience. Several working data sources include but are not limited to: fire hydrants, homes with special needs individuals, road signs, bridges and culverts, mass appraisals, utility infrastructure including water and sewer.

By introducing this technological tool with more similarities to a new employee than a static device; some agencies have more readily suggested enhancements, modifications and issues. While the application may operate perfectly in a similar context or even a similar organization, many changes may be required. The level of effort required to create a similar application provides opportunities for localized customization.

When researching or designing any new application, consider the adjustments anyone would have to make when changing work environments: the individual may have some new ideas to offer, but will more than likely incorporate the established practices of the new team. Keep all options open when exploring our and your next steps.

Trevor Floyd, GISP
St. Clair County, Metropolitan Planning Commission
GIS Analyst
200 Grand River STE 202
Port Huron, MI 48060

Leveraging Digital Map Data to Support Disaster Response: A Map Assisted Damage Assessment Toolkit

City of Suffolk, Virginia

Overview

The City of Suffolk, Virginia comprises 430 square miles of land in the Hampton Roads area of Virginia. A traditionally agricultural community centered on peanuts, tobacco and cotton, the city is transitioning into an urban/suburban community of high tech services centered in modeling and simulation.

As part of the Virginia Tidewater, Suffolk has focused its emergency management preparedness on mitigating and responding to the impact of tropical storms and hurricanes.

The city uses the Incident Command System (ICS) to manage and control the response to an event. The city manager serves as the Incident Commander with all resources of the city categorized within the ICS structure and available to respond to the event as necessary. The GIS staff is positioned into the planning section of the ICS structure and provides incident mapping support and event documentation services.

A Better Way to Conduct Business

Based on post-event reviews of the GIS response to Hurricane Isabel in 2003, a number of shortcomings in the method of collecting and entering damage assessment data were identified. First, all damage assessment was captured using paper forms and was address based. The data entry technician’s inability to read handwriting made for numerous entry errors.

Second, the lack of easily identifiable addresses in rural areas of the city resulted in many damage cases that were incorrectly located or tied to rural intersections.

Finally, the volume of handwritten information that was developed resulted in long hours of data entry being required before any impact analysis could be performed.

As a solution to issues identified during Isabel, the city’s GIS Division developed the Map Assisted Damage Assessment Toolkit. It facilitates the digital capture of damage information using a tablet computer connected to CDMA cellular data networks via PCMCIA cards.

The toolkit was developed as an extension to the Accela Tidemark Wireless permitting software that was already in daily use by city staff. This daily use allows damage assessment teams to be familiar with the use of the system prior to responding to a stress filled event.

The damage information is entered via a series of drop-down menus and picks lists to speed entry and limit data entry error. Additional coding for customized Crystal Reports summarizing the damage allows for timely generation of total damage statistics at any time throughout the response phase of operations.

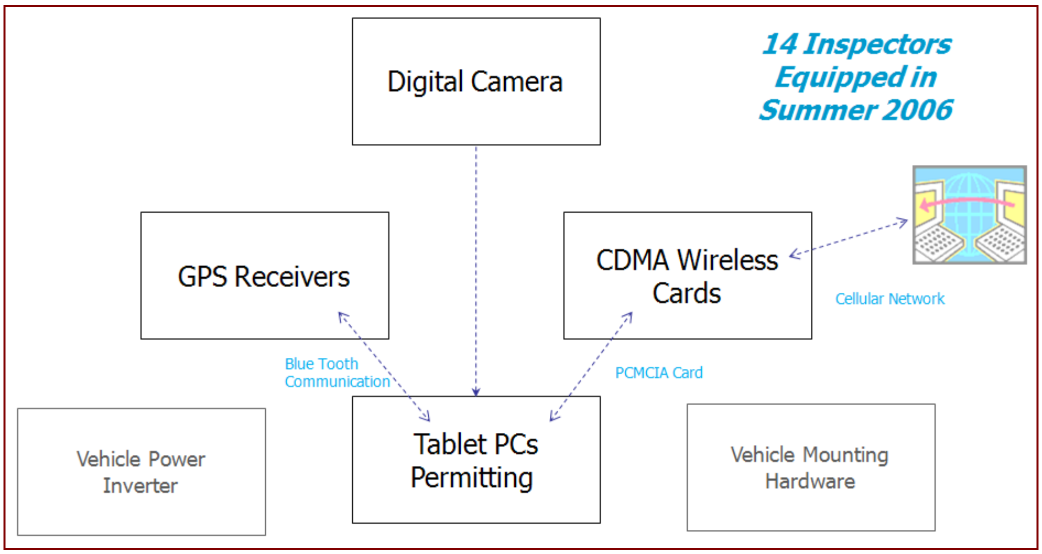
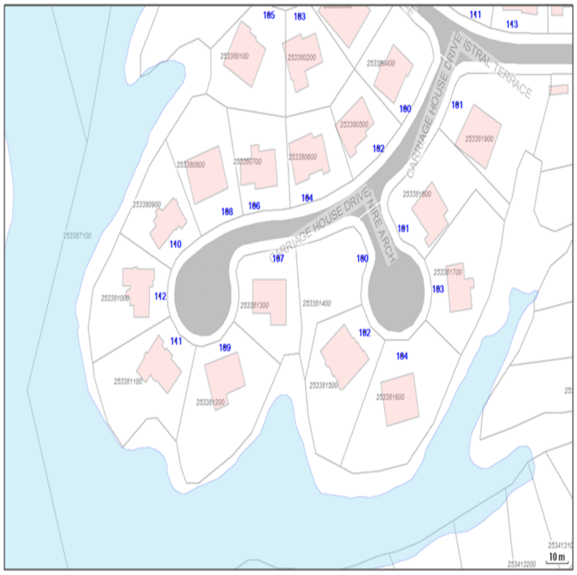


Figure 1 – Damage Assessment Toolkit Hardware Configuration

The toolkit was developed as a new inspection case type for the Tidemark Advantage permitting system. The implementation further required custom coding for the Accela Wireless software that was completed during the winter of 2006. The damage assessment toolkit was deployed to users in the spring of 2007.

The toolkit uses ESRI ArcPad as its map interface. The map base is updated on the tablet PC daily, ensuring that the field teams are always working with the most current map data. The ArcPad is tied to a Trimble ProXT GPS receiver for determining the location of the damage assessment case. When entering damage information, the field team locates the parcel they are standing in front of, query the parcel for its identification and copy and paste the identifier into the damage assessment case. This ties the damage case to the parcel in the permitting software, facilitating geocoding for map display and recovery permit activity tracking.



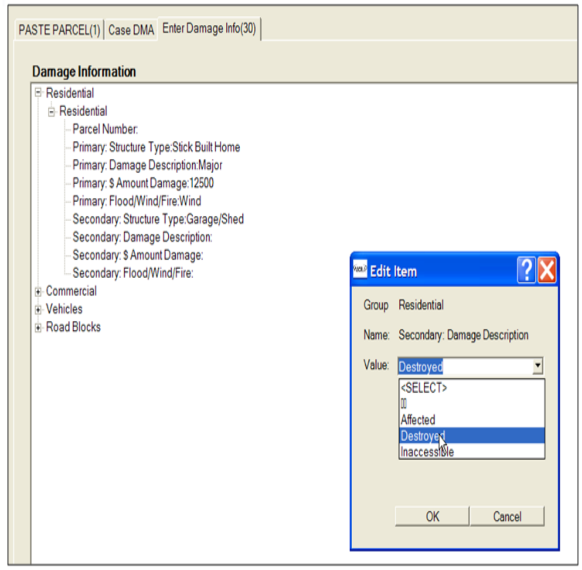


Figure 2 - ArcPad Map Interface

Figure 3 - Damage Assessment Case Entry

April 28, 2008 Tornado

The toolkit was deployed operationally for the first time in response to a tornado. The city was directly impacted by a tornado on the afternoon of Monday, April 28, 2008. The tornado, later classified as a strong EF-3 on the Enhanced Fujita Scale, moved through the city on a southwest to northeast path.

Data received from the National Oceanic and Atmospheric Administration (NOAA) detailed radar indicated Vortex Tornado Signatures (VTS) occurring from 3:46pm at a location southwest of the Village of Holland to 4:21pm at a location near the Village of Driver. The National Weather Service evaluated the funnel cloud as being approximately ¼ mile wide at the point of touchdown.

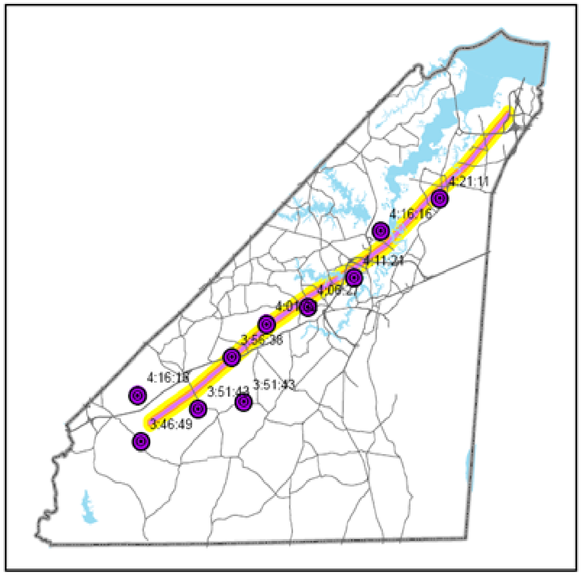


Figure 4 - Path of April 28th Tornado

Figure 5 - Storm Damage - Freedom Plaza

On Tuesday, April 29th, seven damage assessment teams were assembled and dispatched to the Godwin Operations Center for deployment into the affected neighborhoods. The damage assessment teams moved through the affected areas with the GPS enabled mapping software displaying their current location.

When entry of a damage assessment case was necessary, the parcel account number is identified using the map, moved into the Accela Wireless product and the assessment case details populated. By associating the damage case directly with the affected parcel, a discrete location depicting the damage can be created on the map.

As part of the creation of a damage case, teams were required to identify not only the parcel, but the type of structure (residential, commercial) the level of damage (destroyed, major, minor, affected) and an estimated dollar value of the damage. The GIS staff in the Emergency Operations Center (EOC) periodically (every hour from 10:00 a.m. – 6:30 p.m.) polled the Accela database for damage assessment cases. The records contained in the database were exported into Microsoft Access for geocoding and data analysis.

This estimated dollar value was the number that was provided to the Virginia Department of Emergency Management (VDEM), the Federal Emergency Management Agency (FEMA) and the local and national news services throughout the day.

The initial damage assessment sweep through the impacted neighborhoods was completed by 6.00 pm that evening. A summary report generated by the Toolkit detailed nearly 500 structures damage suffering nearly $30 million in loss. A breakdown of the total estimates is shown in the table below.

Summary of Residential and Commercial Damage - April 28, 2008 Tornado					
Personal Residences					
	Houses	23,022,195.00			
	Manufactured Homes	28,000.00		destroyed	49
	Other Primary Residences	245,000.00		major	87
	Sheds	45,750.00		minor	248
	Fencing	19,000.00		affected	78
		$23,359,945.00			**462**
Business/Industry					
	Businesses	5,967,953.00		destroyed	4
	Churches	15,000.00		major	9
	Schools	250,500.00		minor	10
	Other Secondary Business	165,500.00		affected	1
		$6,398,953.00			**24**
		$29,758,898.00			**486**

Figure 6 - Summary of Tornado Damage

Using the geographic location for each of the damage cases allowed the city to develop graphics depicting the concentration of damage within the affected neighborhoods.

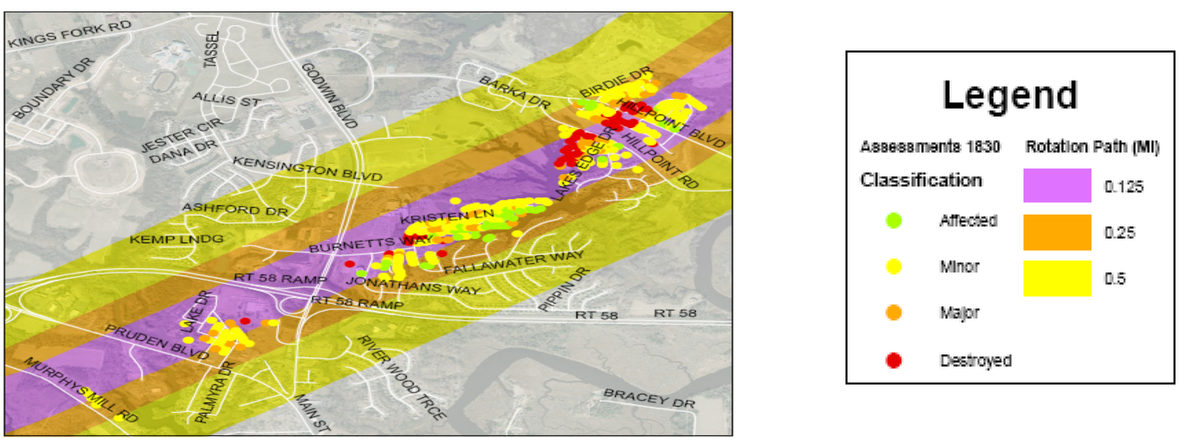


Figure 7 - Map of Damage Case Locations along Storm Path – 6:30pm

Effectiveness and Next Steps

The Toolkit proved to be a highly effective method for inputting the damage assessment information while in the field. By eliminating the need for retyping field notes, the city was able to provide VDEM and FEMA with the information required for the Individual Assistance (IA) reporting within 30 hours of the storm touching down. By integrating the damage reporting and the summary calculations into a single resource, the city was able to assure that the data being released was the most current.

The rapid availability of accurate damage location information was also critical in responding to home owner inquiries regarding the condition of their property. Suffolk has a large military population and many persons serving overseas called the EOC inquiring about their property. The GIS staff was able to quickly query the damage records for each address to provide accurate information to people serving in the armed forces.

As the city moves forward with the Toolkit, we will continue to drill using the technology and procedures. The GIS staff is planning to upgrade the equipment being deployed with computers with onboard GPS receivers and built in wireless modems. City staff is continuing to refine procedures to include the identification of condemned structures using a common definition able to be tracked within the Toolkit.

The Map Assisted Damage Assessment Toolkit has proven to be a very successful deployment of mobile mapping technology integrated with back office permitting applications to support a very specific emergency operations requirement. The ability to leverage up to date location information eliminated data coding errors, the need for rekeying and data cleansing prior to analysis.

The Toolkit facilitated the maintenance of situation awareness of the severity and location of damage caused by the storm, enabling the Incident Management staff to respond in a meaningful and well-thought manner.

Robert Oblinsky, GISP
GIS Manager, City of Suffolk, VA
757-514-7696
roblinsky@city.suffolk.va.us