

# GIS AIDS ATLANTA STORMWATER, WATERSHED PLANNING

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**Abstract.** The purpose of this paper is to share an approach to watershed and stormwater management that uses Geographic Information Systems (GIS) to advance research and analysis of hydrologic processes and how spatial patterns affect water resources. Expanding understanding of the relationship between geographic activities and water resource management has made GIS tools increasingly valuable. The power of GIS for water resource management lies in the ability to collect, store, manage, query and display multiple datasets together and to model that data. For example, land uses, soils, rainfall data, watershed boundaries, land cover, and underground infrastructure and features can all be mapped, attributed, and stored in GIS. At a minimum the various features can be overlaid for analysis. At a higher level, the GIS data relevant to hydrologic/hydraulic modeling can be extracted and modeled without leaving the GIS application. Once GIS has been used to understand the inter-relationships of the features, different scenarios can be run and tested to determine the options for improving storm water runoff. After analyses have been completed, the graphic and mapping capabilities of the GIS are strong tools for conveying the information to the public and to government officials.

## INTRODUCTION

The purpose of this paper is to share an approach to watershed and stormwater management that uses Geographic Information Systems (GIS) to advance research and analysis of hydrologic processes and how spatial patterns affect water resources. The power of GIS for water resource management lies in the ability to collect, store, manage, query and display multiple datasets together and to model that data. For example, land uses, soils, rainfall data, watershed boundaries, land cover, and underground infrastructure and features can all be mapped and attributed and stored in GIS. At a minimum, various features can be overlaid for analysis. One example of analysis currently being

performed by overlaying the data is site selection for stormwater detention ponds. The Atlanta project allowed HDR/WLJorden, Inc. (HDR/WLJ) to utilize tools that were developed within the company to take the traditional GIS tools several steps further.

The City of Atlanta Combined Sewer Overflow (CSO) Separation project is an excellent example of developing GIS into an integrated decision support system (IDSS) for the city's planning and public works department. It will improve departmental cooperation and cooperation with citizens and non-profit groups to help plan the watersheds in the city for sewer and storm water treatment. Water management professionals, federal and local government officials, environmental researchers, and program developers will be interested in this tool because of the efficient way it manages data sources, and its ability to import/export modeling data and results. In addition, municipalities and other government entities will need the information because the methods presented here can help prevent duplication of work, and more quickly perform analyses under strict deadlines and budgets. In addition, intelligent maps are invaluable in communicating ideas to the public and elected officials.

## BACKGROUND

The City of Atlanta is facing a billion dollar program to upgrade its sewerage system. Renovations at the wastewater treatment plants are nearing completion but collection system improvements are proving to be more expensive and challenging.

Atlanta's original sewer system was a combined system (sanitary and storm flows); parts of it are over 100 years old. As the city grew geographically, a separate sanitary sewer system was installed in the emerging areas, but the original combined system remained in service in the core of the city. Dry weather flow in the combined system was diverted to separate sewer interceptors and conveyed to the treatment plants

but combined sewer overflows occurred with even moderate rainfall.

As the City of Atlanta continues to grow and the collection system ages, even the separate sanitary sewers are being taxed by dry weather peaks and surcharged by wet weather flows. The City is now operating under a consent order from the Georgia Environmental Protection Division and U.S. Environmental Protection Agency to reduce the annual numbers of combined sewer overflow events and to eliminate completely sanitary sewer overflows. The program is projected to be a 20-year effort, but the mandate contains many stringent completion deadlines for intermediate milestones.

The City of Atlanta contracted HDR/WLJ, Inc. to develop a GIS based Integrated Decision Support System (IDSS) for Watershed Management. HDR/WLJ's role in the development of the Decision Support System was to integrate infrastructure planning of the Public Works Department with development planning of the Planning Department. In addition, the IDSS will be used to evaluate stormwater management alternatives and potential effectiveness of stormwater controls in each of the watersheds.

## METHODS

### Data Collection

The major data sources for the East Area CSO project and for the IDSS were the City of Atlanta planning and public works departments. The City provided paper documents that provided information on the existing combined system. These documents included archive plans, field books and files dating back to the 1920s, City sewer maps, drainage maps and sewer design plans prepared by various firms contracted by the City over the years. Some information existed in electronic form (excel spreadsheets and sewer map files) and represented partial sewer/CSS pipeline and manhole data. The City's sewer maps were accurate circa 1996 (before Olympic construction). The majority of the data had to be converted from hard copy maps and tables to digital data before any data manipulation or analysis could occur. In addition to compiling existing wastewater pipe and facility infrastructure data, existing and future land use data had to be converted into GIS themes.

Existing land use maps were based on digital building footprint data retrieved from the public works department. A field survey was then conducted to verify building attributes like the number of floors. To generate numbers for existing sanitary sewage flow



**Figure 1. Digital Orthophotography in pilot area used to verify land use and assist in watershed planning.**

rates, a building footprint coverage and building database or attribute table was used.

The database contains specific information about large commercial buildings, multi-family residences, and single-family residences in the study area. The information gathered about the commercial buildings includes the number of floors in each building. In cases of multi-family residences, the data gathered includes the number of units in each building. Finally, a count of single-family residences can be generated from the data gathered. As this data was entered the building footprint shapefile was updated and cleaned. The file was also verified using 1998 digital orthophotography.

The future land use maps were digitized into the GIS from hard copy Neighborhood Planning Unit (NPU) maps stored in the city planning department. The land use maps define the maximum allowable development densities for each parcel in the city. The land use densities allow the engineering team to determine what the future capacity requirements will be for sanitary sewer/storm water runoff. In addition, the integration of future land use data allows insight into potential Best Management Practices (BMP) options such as water reuse and buffering. The percentage of impervious surface was based on land use. The projected future acres of impervious surface were calculated in the GIS

using the future land use density data in the storm catchment areas.

### System Models

To run a computer model of a combined sewer system, two things are necessary: a collection system and the wastewater/storm water flows that run through it. Data collection provides information about the collection system. Wastewater/storm water flow assignment is accomplished based on land-use patterns. With information about the land use in a given area, the land-use/flow extraction process can estimate the amount of wastewater/storm water that enters the system at a given point. Point flows (industrial facilities) are identified and can be added to the model on an individual basis. The model also can account for wet-weather flows (infiltration and inflow from high groundwater levels and rainfall).

HDR Engineering, Inc. has developed an innovative set of tools called HDRLink. These tools enable GIS data to be exported to a hydrology/hydraulic model that models storm water and sewer infrastructure conditions then exports the modeled results back to the ARCVIEW GIS environment. These tools are invaluable for engineers in this field not only for their time savings for building the data necessary to find solutions to water and wastewater management, but for seamless interface between GIS and the hydraulic modeling software. HDRLink bridges the gap between the engineering software and GIS data and enhances the input file generation process and manages the model output process. This approach gives maximum flexibility to the modeling of "what-if" scenarios.

After a model is calibrated and run, the calibrated output file is loaded into the HDRLink interface, creating an output file that contains hydrographs for every pipe in the system and a maximum hydraulic grade line (HGL) elevation for each pipe. The HGL can be recalculated for each 15-minute time step in the hydrograph, giving a detailed assessment of the system's hydraulic condition.

### DISCUSSION/RECOMMENDATIONS

Once the GIS data has been collected and the system has been modeled using HDRLink and a hydrology/hydraulic model, alternative solutions can be developed and presented to government officials and the public. The GIS tools described in this article have made it economically feasible for the city to update their information as it is discovered as well as narrow down alternatives in a more timely manner. The IDSS

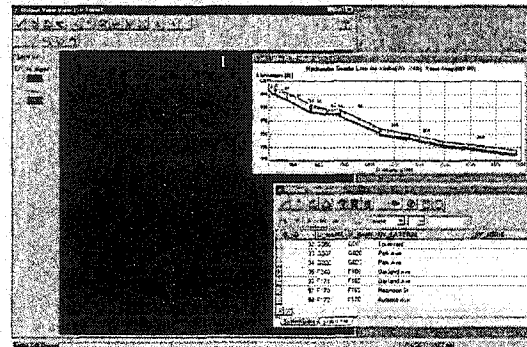


Figure 2. Hydraulic model results from HDRLink extraction of GIS data.

framework also enables the city to make more informed community-based decisions because capital improvement plans, neighborhood plans, and comprehensive land use plans are incorporated into the system. This provides the opportunity to coordinate efforts with neighborhoods as well as public works to minimize construction costs and disruption of traffic flows and neighborhoods.

Currently, alternative solutions to the city's water management issues are being presented to the citizens, the elected officials, and to peer review groups. The work completed in the city's pilot area using the process above has provided a foundation for a comprehensive IDSS. The next steps will be to expand the information to other parts of the city and model in the rest of the city to more effectively analyze alternatives for storm water and wastewater management.

### ACKNOWLEDGMENTS

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