Enabling Water Quality Protection Charge Program
Montgomery County, Maryland

Program Category #14: Information Technology

1.0 Abstract

The Montgomery County, Maryland Department of Technology Services - Geographic Information Systems (DTS-GIS) team has developed an automated digital process to update two GIS data layers to support the Water Quality Protection Charge (WQPC) program administered by the County Department of Environmental Protection (DEP). The WQPC was initiated for the fiscal year 2003. To assess water quality protection charges equitably, the amount of impervious surface of each land ownership parcel needs to be determined. The existing County GIS data layers—property parcels, building footprints (BLDG), transportation features (parking lots and driveways, TRANS) and the assessment database maintained by the State of Maryland were identified as data sources to enable the calculation of the impervious areas for the ownership parcels.

A system of GIS data layer maintenance was designed to update the data layers so that as many parcels as possible will have the impervious areas correctly calculated. The system entails making use of the up-to-date digital orthophoto imagery as the source for updating the BLDG and TRANS layers. Technician time was paid for by the WQPC operating budget. The cost for this type of GIS database maintenance is estimated to be about one third of what it would cost if a conventional photogrammetry contractor were used. Updated data layers also benefit other County programs such as the new Computer Assisted Dispatching (CAD) system of the County's Public Safety 2000 program.

2.0 Need for the Program

The Montgomery County Council enacted legislation authorizing the County DEP to levy water quality protection charges so that funds would be available to implement programs to safeguard water quality within the County. The amount of water run-off generated from a parcel is proportionate to the impervious area. Thus the amount of impervious surface is a relatively objective measure for assessing the charges for the individual ownership parcels. Different rates can be set for different categories of land uses—residential, commercial, and industrial, etc.

Although the BLDG and TRANS are two of the planimetric data layers that were created several years ago, the constraint of funding has rendered the data quite out-dated. A significant percentage of the tax accounts (ownership parcels) do not have up-to-date BLDG and TRANS layers. This would lead to the inaccuracy of impervious area calculation and consequently the inequality of fee levies.

DEP was looking for a mechanism by which to update the two data layers. As well, DTS-GIS had been looking for resources to update the selected planimetric layers to meet the needs of several County programs.

Additionally, anticipating the influx of phone calls from tax payers once the WQPC was sent out (as part of the semi-annual real estate tax bills), DEP asked its WQPC consultant CH2M Hill to develop a web-based customer service application. CH2M Hill requested that DTS-GIS serve up the property, BLDG, TRANS, and digital orthophoto layers to the application.

3.0 Description of the Program

BLDG and TRANS are two of the GIS planimetric data layers. Planimetric features refer to the ground features that are visible from the air. The other important planimetric layers include edges of pavement, hydrographical features, railroads, boundaries of wooded areas, etc... Traditionally, planimetric data layers are generated by mapping service companies using the photogrammetric procedures which are typically expensive. The Montgomery County Planning Commission, which is responsible for maintaining the planimetric base maps, continues to contract with these service companies to update the planimetric layers. Due to funding limitations, only about 20% of the County can be updated each year. This resulted in data layers with varying levels of currency. For the DEP WQPC program, an up-to-date set of property, BLDG, and TRANS layers is needed.

In October, 2002 DTS-GIS took delivery from VARGIS (Herndon, VA) a County-wide set of digital orthophoto images created by ISTAR (Herndon, VA) from a March 2002 fly-over. Orthophoto (images) have feature distortions corrected so that the resulting image files are regarded as map layers, co-registered nicely with other vector map layers. This set of ortho images has a geolocation accuracy level of 1 meter (3.3 feet), which is better than the 5-foot accuracy level of the planimetric layers in the GIS database. The ISTAR TrueOrtho orthophoto images have one added characteristics—the roof lines are projected onto the building footprints, making tracing/digitizing of the latter a breeze. (Most conventional orthophoto images have the roof lines leaning onto the streets or parking lots. The building shadows block the footprints, making the tracing/digitizing of the latter quite difficult.) Consequently, these recent ortho images can serve as the backdrop with BLDG or TRANS layer overlaid (Figure 1).

Figure 1: The March 2002 Ortho-photo is an excellent source document for updating both the buildings and parking lots data layers. Note the new office tower and its parking lot were missing from the pre-updated versions of BLDG and TRANS layers

An operator can readily identify the missing (from the BLDG layer) building footprints and perform heads-up digitizing to add in these recent building footprints. Heads-up digitizing is efficient because the source document (the digital orthophoto files) is displayed on the monitor all the time—no need for the operator to turn his/her head away from the monitor. Reference layers (e.g., lot lines, existing version of planimetric layers) can also be brought on the screen. With adequate zoom level in the graphics display window, an accurate tracing of the building footprint can be achieved, thus preserving the 5-foot accuracy level of the BLDG layer (Figure 2). Similar operations were applied to the TRANS layer (Figure 3). DTS-GIS staff developed Avenue scripts (which turn into menu buttons) off the ArcView desktop GIS software (licensed from Environmental Systems Research Institute, ESRI) to accomplish these digitizing tasks.

The following sub-sections describe the main steps taken by DTS-GIS for the development of the data layer maintenance system as well as the serving up of the on-line GIS data layers to the WQPC customer service application.

Figure 2: Additions to (red) and deletions from (blue) the building footprints (BLDG) layer

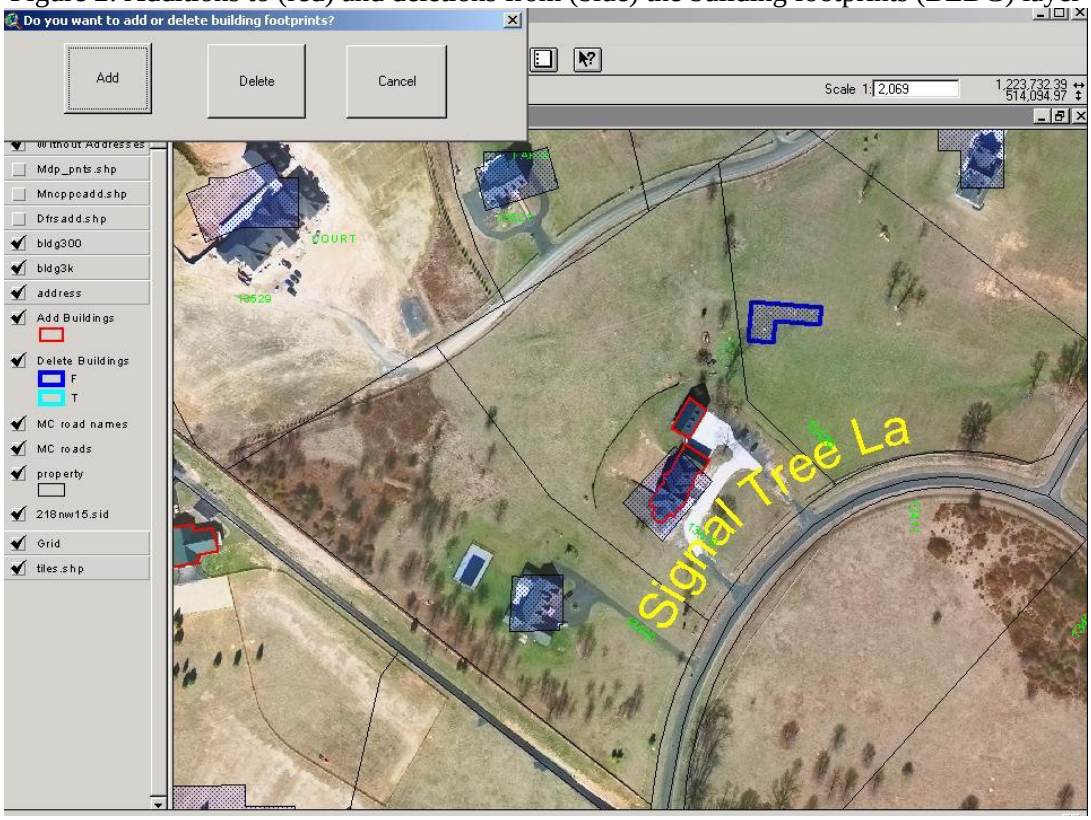
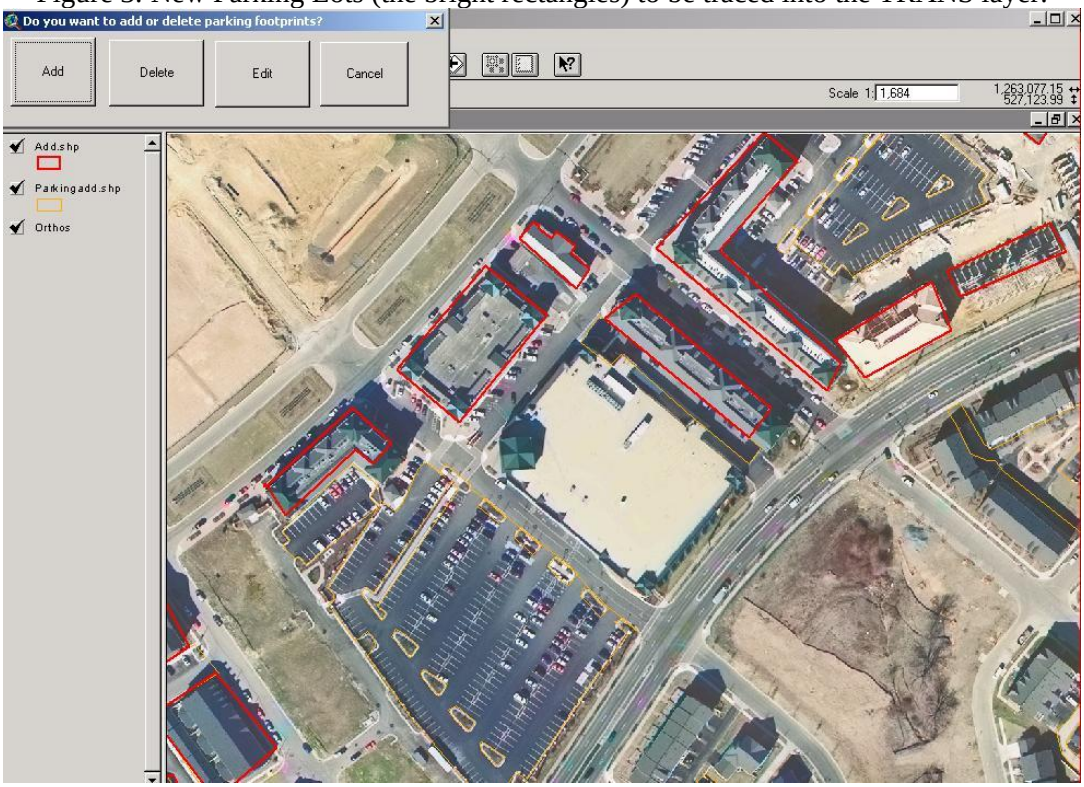


Figure 3: New Parking Lots (the bright rectangles) to be traced into the TRANS layer.



Step 1: Establish functional requirements
To update the BLDG data layer with the help of recent digital ortho-photos, a customized ArcView 'project' was developed. The background data layer is the recent ortho-photo. Vector layers being accessed in the project include lot lines, building outlines (footprints) and building addresses. Three custom buttons—Add, Delete, and Cancel—are available to the operator. Building outlines being added to BLDG are displayed in red. Building outlines being deleted from BLDG are displayed in cyan.

Step 2: Collect data, documents, and information
All the data layers needed for BLDG/TRANS update reside in the DTS-GIS Unix database server. Before running the ArcView-based update program, the needed Unix disk drives need to be 'mapped' into the PC network drive letters.

Step 3: Programming and Creating the BLDG/TRANS Update Menu
Two separate set of ArcView programs (Avenue scripts) were created to handle the update operations of the BLDG and TRANS layers separately. The County-wide BLDG layer was divided into four subsets to allow for four operators working at the same time.

Step 4: Review and revise EOC Application
The staff assigned to lead the digitizing tasks worked closely with the application developer during the training period and the initial weeks of production. Enhancements were suggested or requested. Most of these have been incorporated into the current version of the programs. Since the developer and the users sit in the same office, additional refinement or enhancement of the programs can be easily accomplished.

Step 5: Serving GIS Data Layers to WQPC Customer Service Help Desk
DTS-GIS staff worked closely with DEP consultant CH2M Hill on setting up database access account, synchronizing data layer and data item names, and initiating the web-based ArcIMS service for the Help Desk application.

4.0 Use of Technology

Using the heads-up digitizing to update the GIS data layers to meet the program needs of WQPC is relatively 'low tech'. However, the idea of using high accuracy digital ortho-photos as the backdrop in a heads-up digitizing session is noteworthy. It leverages the investment in digital ortho-photos for expanded uses. It reduces the cycle time before the customer can benefit from the data update. It reduces the cost for updating planimetric data layers.

In terms of serving up the required GIS data layers for DEP's web-based WQPC tax payer help desk, DTS-GIS tapped into its existing Arc Internet Map Server (ArcIMS) technology licensed from ESRI and has been providing the needed data layers over the Internet.

5.0 The Cost of the Program

One week of developer time (about $1,200) has been spent. In terms of updating the County-wide (660 map sheets) BLDG data layer, the staff labor cost is estimated at $66,000; the TRANS data layer at $13,200. The combined operator cost is $79,200. Adding developer time, the total cost is thus about $80,400. Adding supervisor's time and system management, the grand total is thus about $90,000.

Estimating that the BLDG and TRANS data layers constitute 20% of the planimetric database, the cost share of these two layers through conventional photogrammetric procedures would amount to approximately $264,000. Consequently, the in-house developed GIS data update system cost about one third of what it would cost if the County contracted externally for a photogrammetric mapping service.

6.0 The Results/Success of the Program

With the timely supply of GIS data layers to the DEP consultant CH2M Hill for calculating impervious area acreages and thus the protection charges for the land ownership parcels subject to WQPC, the County DEP had a successful start to the program. Calculations based on the high accuracy GIS map layers contribute to the fairness of the program. Revenue collected will be used to implement the various water quality protection measures.

The heads-up digitizing of new buildings and parking lots using high-accuracy digital ortho-photos expedited the supply of up-to-date data to DEP to ensure the success of the program. The accuracy level of the GIS database was also preserved during the process.

The provision of needed GIS data layers over the Web to the consultant-developed DEP customer service application enabled the success of the application. This new DEP customer service feature is a critical link in the whole WQPC program.

7.0 Worthiness of an Award

This program, jointly sponsored by DEP and DTS, leverages the County investment in the GIS database for an innovative use of the data for supporting the WQPC program. The out-dated GIS data layers—unfortunately, a common phenomenon among local governments—got a 'shot in the arm' and were made current using funds from the WQPC program.

The actual update process entails a novel use of the county-wide digital orthophoto images. The end result is a low-cost, 'low tech' way of updating the BLDG and the TRANS data layers for the benefit of the WQPC and other County programs.

The use of the up-to-date State assessment database provides an effective way of making sure that ALL tax accounts are being considered in the WQPC process. The comparison (against

the GIS property data layer) report enables GIS staff to pay special attention to the accounts that were missing from the GIS database.

The provision of the relevant GIS data layers to the web-based customer service application enables DEP customer service staff to answer tax payer questions efficiently, objectively and truthfully. Without on-line map layers and relevant impervious area acreages a mouse-click away, DEP customer service staff would be hard pressed to respond to tax payers' inquiries in a responsive manner. This critical capability also contributes to the success of the WQPC program.

Finally, the updated BLDG and TRANS data layers benefit the County's brand new Public Safety CAD program. In this case, County Public Safety personnel (Police and Fire & Rescue staff) use these data layers to make decisions regarding the deployment of personnel and equipment to emergency incidents in the County.

In a tight fiscal environment, this program is a good example of a critical efficiency enhancement.