Consideration in Using GIS to Delineate Storm Sewersheds (Storm Sewer Watershed/Drainage Area)

For purposes of determining a planning area, calculating pollutant loads, determining necessary pollutant reductions, and determining optimal BMP size and placement, a storm sewershed will need to be delineated. While delineation of a storm sewershed may be conducted "by hand" using a topographic map with storm sewer features, there are automated methods to expedite the delineation of multiple storm sewersheds as well as provide ease of modification for the modelling of BMPs for design purposes. Using GIS, the following technique may be employed. The process described below will generate a storm sewershed based on a high resolution Digital Elevation Model (DEM) and storm sewer system features mapped into a GIS dataset. While the methodology described below utilizes ESRI ArcGIS products, the general concepts can be applied to any GIS software system.

Requisites

The process of using ArcGIS tools to delineate storm sewersheds requires the user to have moderate to advanced knowledge of the ArcGIS software, as well as an ArcGIS Desktop Standard product license or higher, and Spatial Analyst extension. The process uses tools in the ArcHydro toolset, which is a no-cost extension available for download at http://downloads.esri.com/archydro/archydro/.

In order to automate the process of delineating storm sewersheds for outfalls, certain stormwater infrastructure features must first be entered into GIS as a feature class. Required feature classes for this process include the locations considered to be the "pour points" (the point of interest at which flow accumulates, typically an inlet, manhole, outfall, etc.) for the batch delineation. These are usually stormwater drains or inlets to an underground conveyance system, or the outlets of swales, roads, or other surface infrastructure through which stormwater is conveyed. It may be desirable to also have structures such as pipes, swales, roads, and detention ponds digitized. Care should be taken to digitize any polyline structures which influence the directional flow of stormwater in the direction of that flow.

In addition to the stormwater infrastructure, this process uses a high resolution digital elevation model (DEM), and a streams layer. These layers are publically available for download from the Pennsylvania Geospatial Data Clearinghouse, http://www.pasda.psu.edu/. It is recommended that the PAMAP Program LiDAR dataset be used for the surface topography.

Preparing Inlet and Outlet Structure Polygons

The **Batch Watershed for Polygons** tool will be used for this process. This process requires the user to create polygons at each of the pour points for the storm sewershed. Small polygons do not typically yield accurate results, so it is recommended to use a minimum 15 foot buffer of the pour point, unless real-world data is available for any larger dimensions of the infrastructure located at the pour point. If a pour point is discharging directly into a surface waterway such as a stream or river, the pour point and buffer will need to be offset from the waterway, so as to avoid delineating the entire waterway's watershed.

In order to run the analysis the map must contain the DEM, stream layer, pour point buffer, and any infrastructure features (*e.g.* roads, swales, etc.), all projected in a consistent coordinate system.

Please note - There are other ArcHydro and Spatial Analyst tools that do not require the creation of these polygons. If the required local data for these tools is available, one of the other delineation tools in the Watershed Processing toolbox may be preferred. Preparation of the DEM as explained in the following section will still be necessary.

Preparing the DEM

The process outlined below prepares the DEM for delineation, assigning flow directions and accumulations to each grid according to elevation. The higher the resolution of the DEM, the more refined the storm sewersheds delineation will be.

1. **Reconditioning the DEM (optional) –** If stream elevation data is more reliable than the available DEM, **DEM Reconditioning** may be required. This process reconditions the DEM to drain elevations towards the streams. This may be helpful in areas with little topographic relief.
2. **Fill Sinks – Fill sinks** will eliminate any gaps in the DEM where the elevation of the sink cells is much lower than all of the cells surrounding it. The flow of water gets trapped in sinks, and may have an impact on the model.
3. **Flow Direction** – Assign a **flow direction** to each cell based on the elevations of the surrounding cells.
4. **Create Drainage Line Structures (optional)** – If the directional flow of stormwater is influenced by structures such as roads or swales, it may be necessary to **Create Drainage Line Structures.** This will force the flow of water in the DEM along the input polylines as if they were streams. After creating the drainage line structures, **adjust the flow direction in streams** to flow along your created features.
5. **Flow Accumulation** – Determine the **flow accumulation** grid. This operation will determine the number of accumulated cells flowing into each cell of the grid, so that lower values lie at the up-gradient edge of a basin, and higher values are where more water has accumulated, such as the main stream segment. Examine this grid to ensure drainage patterns look accurate.

Batch Delineation

To delineate storm sewersheds for multiple inlet structures, an automated process can run as a batch. Using the created polygon file of pour point buffers and the flow direction grid, run the **Batch Watershed Delineation for Polygons** tool.

The batch delineation will provide sub-catchments for each inlet structure (pour point buffer). To create the storm sewershed of all of the inlet structures that lead to a single outfall, dissolve all sub-catchments which drain into a single outfall.

Field Verification

As with any automated model, inaccuracies in this process will occur, especially in areas which contain complicated stormwater infrastructure and topographic features. Verifying the boundaries of each storm sewershed is highly recommended before using the area to calculate pollutant and sediment loading levels or for BMP design. The storm sewershed boundaries should be adjusted to include or exclude any stormwater structures known to influence the flow of stormwater. Preliminary estimates of pollutant loads may only require a general knowledge of the storm sewershed and storm sewer system. However, field verification is required for BMP design.