Assess For Less: A Solution-Oriented, Ground-Based Geomorphic Analysis of an Urban Watershed in the Piedmont of North Carolina

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Abstract

In the summer of 2007, a group of stakeholders, including the ~~EPA~~Environmental Protection Agency, North Carolina Division of Water Quality and the Towns of Carrboro and Chapel Hill, contracted with Earth Tech to conduct a geomorphic analysis of an urban watershed of a Federal 303(d)-listed stream in the piedmont of North Carolina. The goal of the project was to examine the stability of the streams within the watershed, to identify specific stressors and problem areas and, most notably, to develop specific solutions that could address and treat these problem areas with measurable results. Previous efforts conducted in the Bolin Creek watershed, and throughout North Carolina, have relied heavily on desktop GIS analysis. However, GIS data are often accurate only on large spatial scales and watershed analyses based on them tend to overlook specific areas of stream instability and "hot spots" of pollutant input. The Bolin Creek assessment possessed a short time-frame and a budget considerably less than other watershed analyses conducted by Earth Tech, and therefore a field-based approach to identifying sources of watershed impairment was undertaken in lieu of an extensive GIS analysis.

Teams made up of staff from Earth Tech, the North Carolina Division of Water Quality and the EPA, completed a visual, geomorphic assessment of every stream and drainage feature in the watershed, including ephemeral streams. GIS was used to provide the initial field maps showing background data, such as impervious surfaces, topography, stormwater infrastructure and land use. The watershed was divided into a grid of field maps, sequentially numbered from the upper watershed to the lower watershed. The watershed was then systematically walked by two to three person crews, who would investigate all of the hydrographic features shown on one field map before moving to the next. Initial plans called for investigation of only perennial and intermittent stream features, but it became apparent during the survey that all perceived areas of flow, including ephemeral drainages, should be investigated for an understanding of stormwater flows and sources of stream instability. Data was collected at observed changes in stream geomorphology and stability, and anywhere that a structural best management practice (BMP) or BMP retrofit could be implemented. Both quantitative and qualitative data was recorded on standardized field forms, which provided a consistent means of comparing the relative severity of each location, and was critical for later comparison and prioritizing of instability areas. Global positioning system (GPS) points and photographs were also taken at these locations. A brief narrative of observations was recorded in a field book, and field crew members used a field map to sketch the relationship and perceived connection of instability areas in relation to the landscape and topography.

The survey revealed over 100 locations and sources of stream instability, most of which would not have been detected using conventional GIS analysis methods. These problem areas included stormwater outfalls, road crossings, headcuts, and eroding stream banks. The visual assessment provided the data needed to develop prioritized locations for stormwater BMP's that could effectively treat these specific problems. The collected "raw data" was combined and digitized onto a set of field maps, and linked to a set of field forms. This format provided a means for stakeholders to review and prioritize potential project sites at a stakeholders meeting. Potential projects included stream stabilization to reduce sediment export from stream bank erosion, and BMP retrofits. The stakeholders meeting produced a prioritized list of sites to

investigate for development of conceptual plans and cost-estimates. An in-depth analysis of each of these sites was undertaken, and involved a second field effort to gather site-specific data, including the type of BMP that could be implemented, the available area, potential constraints, potential impacts to the surrounding area, ease of access and visibility of the site. Challenges were encountered at many of the site locations, as steep slopes, narrow valleys and proximity to structures and roads posed constraints not typically encountered in conventional BMP design. This necessitated the design or modification of several traditional BMP types. One such structure was intended to solve the problem of needing a linear retention function on a steep, narrow slope, while still allowing for a gradual conveyance of flow down the hillside and into the floodplain of a stream channel. The structure, labeled as a "Bio-grade Step", is designed to function like a linear series of bio-retention areas, each lower in elevation than the previous and connected by pervious drainage layers.

At many areas of stream instability, bank erosion was seen as a probable contributor of sediment into the watershed. The magnitude of the sediment contribution from these eroding banks was evaluated using the BANCS model, as used in the WARSSS (Watershed Assessment of River Stability and Sediment Supply) methodology developed by Rosgen (2006). The BANCS model combines Bank Erosion Hazard Index (BEHI) and near-bank stress (NBS) ratings and empirically derived erosion rates for a given physiographic region. The erosion rate is multiplied by the length and height of the affected bank to produce a quantification of sediment contribution from that affected bank in tons per year. This method was used on sites where bank erosion was seen as the primary source of instability. The results helped to prioritize the sites and show the potential benefit obtained from bank stabilization practices. Potential solutions at the bank erosion sites included bank stabilization and natural channel design.

To complete the conceptual plans, cost-estimates and potential reduction in pollutant load and sediment contribution were calculated. It was at this stage that GIS was relied upon to gather necessary inputs for these calculations. Construction estimates were developed from various sources, including North Carolina Department of Transportation (NCDOT) specifications and experience with other projects. A beneficial source of construction pricing was the "Urban Stormwater Retrofit Practices" manual, which was released mid-way through the project (Schueler, et. al, 2007). This document provided equations to estimate construction costs of various BMP types, as a function of contributing drainage area and volume of water treated. Narratives of the proposed practices at each site, conceptual figures, and cost-estimates were combined into a Project Atlas of 32 sites. A system was developed and used to rank or prioritize the 32 sites based on their relative cost-benefit.

An important result of this project was to provide a metric of the cost of a solution-oriented, ground-based study focused on producing specific solutions to improve water quality. The cost of the assessment was approximately $450 to $500/mile of stream, and $2,000/BMP site assessment. This metric helps to provide a reasonable guidepost for the cost of similar watershed assessments in the Southeast. This study also indicates that a comprehensive, field-based analysis of a watershed is a cost-effective means of identifying specific sources of impairment and generating specific solutions to water quality problems. Increasingly stringent water quality laws are pushing local governments to "put the shovel to the ground" when it comes to improving water quality. Urban watersheds such as Bolin Creek need a cost-effective and efficient method to identify problems and implement solutions, rather than succumbing to "analysis paralysis". One of the most important factors in moving towards this goal is that those conducting these studies give feedback to the greater watershed community, so that the practice can improve as a whole, and so that local governments can make informed decision about how best to address the water quality problems facing their communities.

References

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