DEVELOPING A WATERSHED IMPROVEMENT PLAN TO MEET MULTIPLE COMMUNITY OBJECTIVES IN GAINESVILLE AND HALL COUNTY, GEORGIA

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REFERENCE: *Proceedings of the 2009 Georgia Water Resources Conference*, held April 27–29, 2009, at the University of Georgia.

Abstract The City of Gainesville and Hall County have developed a Watershed Improvement Plan (WIP) for Flat Creek, which is partially funded by a Section 319(h) Nonpoint Source Implementation Grant, in partnership with GADNR Environmental Protection Division. In concert, the City and County have also developed an Ecosystem Restoration Report (ERR) to potentially obtain federal funding under Section 206 of the Water Resource Development Act (WRDA). The Flat Creek Watershed was one of three areas identified in both the 2000 Watershed Assessment and Management Plan and the 2006 Watershed Protection Plan as not currently meeting the desired level of health. Reasons for this finding were largely attributable to urban growth, as evidenced by 303(d) listings for violations due to high fecal coliform concentrations and impacted biota, unstable banks, and degraded stream quality. In 2003, the Metropolitan North Georgia Water Planning District (District) classified Flat Creek as a substantially impacted watershed due to high effective impervious cover estimates.

Implementation of watershed improvement projects can be costly. In order to assure that implementation efforts are targeted toward the most cost-effective and beneficial projects, a customized prioritization strategy was developed to: (1) identify problem areas in the watershed using GIS and field assessments, (2) develop potential watershed improvement projects, and (3) prioritize projects based on estimated costs and benefits.

Since the project began in February 2007, coordination between multiple stakeholders has occurred with tasks including data collection, analysis, project development, prioritization, and identification of recommended alternatives. Potential ecosystem costs and benefits of restoration combinations (or alternatives) were compared using sediment modeling, stream and stormwater structure assessments, biological monitoring, planning-level cost estimates, feasibility constraints, and long-term water quality data collected by the City. For the ERR, benefits were ranked using the Ecosystem Response Model developed by the US Army Corps of Engineers (USACE) and the North Georgia Water Resources Agency team. This summer, the draft WIP and ERR documents were prepared to summarize efforts and submitted for approval to the GA-EPD and USACE, respectively.

INTRODUCTION

There are a number of drivers for the development of a restoration plan for the Flat Creek Watershed, including previously identified degradation and requirements for watershed management. Flat Creek is a tributary to Lake Lanier, which was created in 1957 and remains an important resource for drinking water and recreation. As the watershed continues to become developed, as indicated by future land use plans, the need for watershed restoration and management becomes stronger. The City and County understand the importance of these needs and developed the WIP and ERR to achieve the following major objectives:

- Develop a restoration plan for Flat Creek, in accordance with the 9 key elements for Section 319(h) Nonpoint Source Implementation Grant, in partnership with GADNR Environmental Protection Division, which will improve water quality, channel stability, and aquatic habitat.
- Follow District and Section 206 guidelines for watershed improvement.
- Address nonpoint source impacts to a 303(d)-listed stream and identify causes of stream degradation.
- Identify the retrofits or restoration needed to improve watershed conditions and meet water quality goals.
- Evaluate the benefits and costs of potential watershed improvement projects and priority areas where projects could have the greatest impact.
- Involve the public in the WIP and ERR development process to promote watershed stewardship and an understanding of the project goals.
- Develop budget and timeline plans for watershed improvement project implementation.

Watershed improvement projects in the WIP and ERR were identified through analysis of current and historical watershed data and through field assessments of Flat Creek, its tributaries, and stormwater BMPs in the watershed. Two types of potential projects were identified: (1) BMP retrofit projects, aimed at improving structures to retain and treat stormwater, and (2) stream restoration projects, intended to stabilize stream banks and restore aquatic habitats and riparian corridors to improve water quality, promote ecological integrity, and reduce erosion and sedimentation. The process of identifying and prioritizing potential projects included multiple components that differed for the WIP and ERR based on prescribed approaches for 319(h) grant and Section 206 funding requirements. The ultimate recommended plan for the WIP includes a number of cost-effective projects that can be selected to improve watershed conditions. For the ERR, one preferred alternative consisting of multiple watershed improvement projects was selected based on cost-effectiveness and incremental cost analysis tools that were developed by the USACE.

WATERSHED ASSESSMENT

The first step in the development of the Flat Creek WIP and ERR involved the assessment of current conditions in the watershed, to identify severely degraded areas and those expected to be impacted by future growth and development. The characterization of the watershed involved GIS analysis, field assessments of Flat Creek and its tributaries, BMP field inventories, biological monitoring, and analysis of long-term water quality provided by the City. The watershed assessment provided insight into areas of the watershed which would benefit from stream restoration and BMP retrofit projects.

GIS Analysis

The initial desktop study of the watershed included overlaying of various GIS data, including land use, impervious cover, and potential pollutant sources from industrial facilities, wastewater dischargers, and toxic chemical sites. Pollution sources were identified from databases maintained by the U.S. Environmental Protection Agency (USEPA), and land use and impervious cover percentages were calculated from Atlanta Regional Commission datasets, made available to the public for regional planning purposes. Of the 78 potential pollution sources identified, more than 75 percent are located in upper third of the watershed, near downtown Gainesville, and only 1 is located in the lower third of the watershed, close to Lake Lanier. Additionally, the upper portions of the watershed are dominated by industrial and commercial land uses, with high impervious coverages, as opposed to the lower portion of the watershed, which is mainly residential. While both land use types can contribute to nonpoint source pollution, the high impervious coverage in the upper portions are likely contributing relatively high nonpoint source pollution from chicken processing plants, feed mills, and other nearby industries.

GIS was also used to delineate the drainage areas of existing stormwater detention ponds and to evaluate the proportion of drainage area to actual detention area. Many ponds that were constructed prior to the development of current stormwater regulations are improperly sized and do not allow for optimal stormwater treatment. The identification of improperly sized BMPs was used to prioritize field inventories to further evaluate stormwater control efficiency.

Stream and BMP Assessments

In 2007, approximately 21 miles of streams were assessed by walking the stream and collecting data at various points. A global positioning system (GPS) unit was used to note the locations of various channel alterations, including anthropogenic channel impacts, hydrologic alterations, bank erosion, inadequate buffers, water quality problems, structural maintenance issues, physical stream habitat score, and channel types. Comparable to trends seen in the GIS analysis, the lower portion of the Flat Creek watershed was assessed as being the least impacted, with a greater degree of hydrologic alterations found in the more developed areas of the watershed. Many segments of the main stem and tributaries of Flat Creek have been channelized, in most cases to protect sewer lines, and much of the headwaters have been piped. Stream segments located near industrial/commercial and high-density areas exhibited a high degree of bank erosion and disrupted riparian buffers, both contributing to instream sedimentation and physical habitat degradation. The more developed areas of the watershed appeared to be severely affected by stormwater runoff from nearby impervious surfaces which have the potential to introduce pollutants such as animal waste, pesticides, herbicides, industrial chemicals, and trace metals.

Following the stream assessment, a field inventory was conducted for the 30 stormwater BMPs that were identified through GIS analysis as being constructed prior to 2000. This inventory was conducted to: (1) evaluate the extent to which the BMPs are providing water quality protection (such as removing suspended solids and nutrients from stormwater) and channel protection (such as controlling flow velocity to prevent downstream erosion) and (2) identify potential retrofitting opportunities to improve functioning. To determine if BMPs appeared to be functioning at a level that would meet current design specifications, field teams compared each BMP to standard designs for water quality treatment and channel protection in the 2001 Georgia Stormwater Management Manual (GSMM). According to the GSMM, water quality sizing criteria should be based on treating runoff from 85 percent of the storms that occur in an average year, which in Georgia is equivalent to providing treatment for stormwater runoff resulting from 1.2 inches of rainfall. The GSMM defines proper channel protection as providing stormwater detention for a 1-year storm event which is released over a 24-hour period, which is imperative for reducing bankfull flows and flow velocity, thereby reducing downstream erosion. According to the field assessment, only 5 of the

30 assessed BMPs offer adequate water quality protection only 1 offers adequate channel protection. The location of the less efficient BMPs was considered in the determination of final priority areas in the Flat Creek watershed.

Biological Monitoring and Water Quality Analysis

The final component of the Watershed Assessment involved biological sampling and analysis and an assessment of long-term water quality data, both which provide a measure of long-term stream health. Biological monitoring included assessments of fish communities, benthic macroinvertebrate communities, and physical habitat, all in accordance with current Standard Operating Procedures outlined by GAEPD. Biological sampling was conducted at four locations on the mainstem of Flat Creek, and results provide evidence that aquatic integrity in Flat Creek is degraded, with the two upstream locations being more affected than the two downstream stations. The fish community assemblages were rated as “Poor” and “Very Poor,” as defined by the GAEPD, and included no sensitive species, or no fish intolerant of pollution, which is indicative of poor water quality conditions. Similarly, the benthic macroinvertebrate community compositions suggest low species richness, poor habitat diversity, and impaired water quality, due to a lack of sensitive species and to taxa which prefer rocky riffle areas and large woody debris. Physical habitat results support the conclusions drawn from fish and benthic macroinvertebrate sampling and suggest that instream and riparian habitat has been compromised in Flat Creek, especially at the upstream stations. Relatively low scores are attributed excessive sedimentation, embeddedness (covering of bottom substrate), low frequency of riffles, cleared riparian buffers, and reduced amount or absence of adequate shelter for fish and substrate for macroinvertebrates.

Water quality data from January 2005 through June 2007 were compiled from the City’s from the Surface Water Quality Program and the Environmental Monitoring Program. To assess water quality throughout the watershed, and prioritize areas for ecosystem restoration, sampling stations were ranked based on several parameters, including bacteria, nutrients, metals, suspended solids, organic matter, and dissolved oxygen content. Data was analyzed for spatial comparison and also to determine whether point or nonpoint source pollution is contributing to water quality degradation. Results indicate that water quality had not declined over the past 2 years, though elevations of many parameters during storm events suggest that nonpoint source pollution is ubiquitous throughout Flat Creek. Most of the watershed appears to be affected by stormwater runoff, and certain areas influenced by permitted discharges of wastewater; however downstream portions of the watershed are much less affected. This lower portion has less impervious cover than the other two subwatersheds and is influenced by slower flows due to the presence of the Lake Lanier backwaters. As demonstrated by biological and stream assessment data, the water quality data indicate that excessive sediment and high stormwater flows are a prevalent problem for streams in the Flat Creek Watershed.

Identification of Priority Areas

To focus the watershed improvement efforts, six priority areas for restoration were identified based on the conditions observed in the watershed. All priority areas were located in upper two-thirds of the watershed based on higher levels of degradation observed in land use, pollution source, water quality, biological, and stream assessment data. Priority areas were used to ensure that prioritized restoration measures were identified in areas with the greatest degree of stream degradation.

POTENTIAL PROJECT IDENTIFICATION AND PRIORITIZATION

Development of the Flat Creek Watershed has involved straightening and dredging of streams, clearing of riparian areas, and piping of many stream segments, resulting in poor physical habitat and many instances of aggrading, widening, and incising channels. Stream restoration and BMP retrofitting projects are recommended as two effective methods to improve streams such as Flat Creek that are affected by nonpoint source pollution and flashy pulses of stormwater. In addition to stormwater controls already being implemented by the City and County, watershed improvement projects can be used to attenuate existing, ineffective stormwater controls, particularly in areas that were developed before new development was met with site-specific erosion and sedimentation requirements. Based on the watershed assessment and the priority areas identified, potential stream restoration and BMP retrofit project areas were selected (Figure 1).

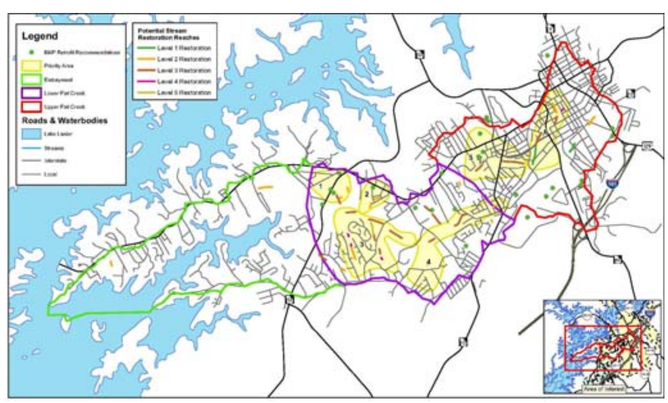

Figure 1. Priority Areas and Potential Stream Restoration and BMP Retrofit Projects

These projects were then prioritized based on estimated costs, feasibility constraints, potential habitat improvement, and sediment reduction to develop a plan for watershed improvement in Flat Creek.

Stream Restoration

Stream restoration projects involve the use of natural channel design techniques to return a stream to a more natural condition to prevent further bank erosion, provide appropriate habitat for aquatic organisms, decrease sedimentation, and increase stormwater filtration in riparian areas. Based on the priority areas identified and the data collected from the stream assessment, a total 42 stream restoration projects were identified. Each project was assigned a recommended level of restoration according to the current channel dimensions and surrounding riparian conditions. The five stream restoration project levels are intended to be complemented by one or more stream restoration techniques, including stream bank/channel stabilization, grade control, vegetative management, riparian planting, and flow deflection, each of which is intended to enhance watershed benefits.

BMP Retrofit

BMP retrofit projects are recommended to provide downstream channel protection, by controlling the release allowing sediment and pollutants to settle out of stormwater before it enters the stream. A total of 24 BMP projects were identified based on GIS analysis an on the field inventories which were conducted. These BMPs were assessed as either being improperly sized or as not meeting GSMM standards for water quality and channel protection. For each of the potential BMP projects, specific BMP retrofit measures were identified which would increase the efficiency of the BMP to treat and store stormwater runoff. These measures include:

- Input pipe resizing
- Structure removal
- Redesign of outlet control structure
- Outfall retrofitting and downstream channel stabilization
- Detention pond redesign / reconstruction

TSS Modeling

As a watershed becomes more developed, sediment yield is expected to increase as impervious land uses lead to higher velocity flows to streams. The increase in runoff flow rates decreases the amount of sediment that is able to settle out of stormwater before it enters the stream. Additionally, an increase in stormwater velocity leads to an increase in bank erosion and, thus, instream sediment production. Hydraulic models provide insight to the amount of sediment delivered to a stream from both upland and instream sources.

Changes in sediment yield are important in the determination of future biological conditions, as sediment affects aquatic ecological processes and conditions, including nutrient cycling, carbon processing, substrate availability, and function of filter-feeding organisms. Sedimentation degrades biological conditions both by covering crucial habitat and by creating unstable environments to which certain species may be sensitive.

For the purposes of project prioritization in both the WIP and ERR, a TSS model was developed to estimate the benefits of stream restoration and BMP retrofit projects. The TSS model accounts for both hydrologic and hydraulic conditions by estimating TSS production and streamflow erosivity. The TSS model employs data from multiple sources and accounts for stream velocity, upland TSS production, and instream TSS production. In the TSS model, stream flow is represented by streamflow erosivity, a measure of runoff rates which is based on land use data and modified by BMP efficiencies in the drainage area. Existing conditions can be evaluated using current land use data and BMP assessment field-collected data, and future conditions can be evaluate using projected future land use data. In addition to runoff rates, the TSS model estimates TSS production based on the streamflow erosivity described above and on the stream bank erosion data collected during the 2007 Watershed Assessment. The use of future land use data allows the analysis of projected future TSS production. The outputs of the TSS model were used to prioritize the potential stream restoration projects identified in Flat Creek.

Prioritization Process

Potential stream restoration and BMP retrofit projects were subjected to thorough prioritization procedures, to ensure that the selected watershed improvement activities would supply an optimal amount of watershed and biological benefit and would also be cost-effective to implement.

Figure 2 outlines the prioritization process for the WIP and the datasets which were employed in each step. For both the WIP and ERR, projects were initially prioritized according to the degree of degradation at the project site, based on stream assessment, land use, and TSS model data. A total of 12 stream restoration projects were selected as high-priority, and implementation cost estimates were developed for these projects. Cost estimates were based on historical, regional project costs and current construction costs and were dependent on the stream restoration level, stream order, length of the project, and project area. The cost estimates allowed for cost-benefit analysis, where a project's benefit was quantified using a TSS model to estimate the potential reduction in TSS. Projects were ultimately ranked according to the estimated cost per TSS reduction.

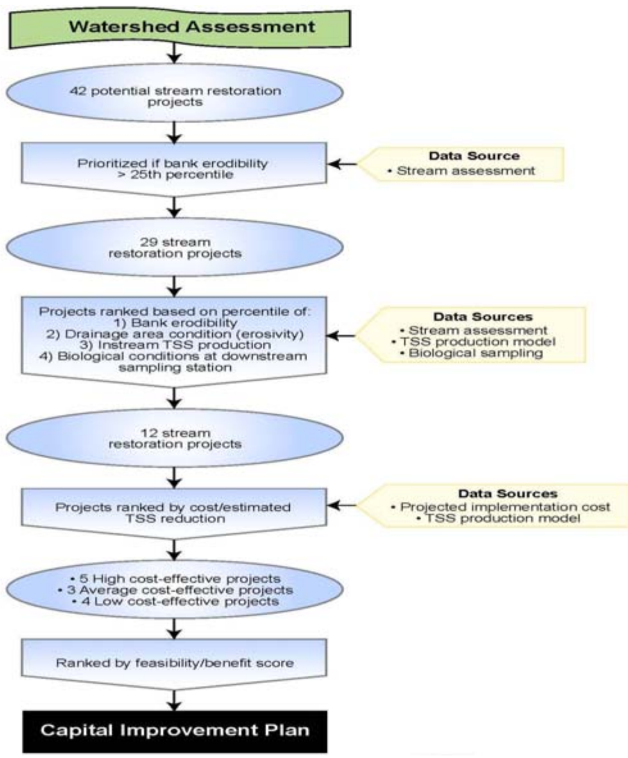

Figure 2. Watershed Improvement Project Prioritization

While BMPs can reduce both nonpoint source pollution and sediment loading to a stream, the combination of a stream restoration project and a BMP retrofit will maximize the improvement of water quality and stream conditions. Therefore, BMPs within the same drainage area as any of the 12 prioritized stream restoration projects were identified as the having the greatest potential to provide benefit to the watershed. A total of 16 BMPs were identified as high-priority projects. Similar to the process for stream restoration projects, the initially prioritized BMPs were further evaluated based on cost-benefit analysis for both the WIP and ERR. Planning level cost ranges were developed for each project based upon the various implementation components associated with BMP retrofit projects, and cost ranges were further categorized according to the size of the BMP, as a larger BMP will require a greater level of effort. The potential benefit of the BMP was approximated using a computer model to estimate a reduction in upland TSS production, and projects were ranked according to the estimated cost per reduction in TSS.

To identify the preferred alternative for the ERR, data from the Watershed Assessment and TSS modeling were used to run the USACE's Ecosystem Response Model, which provided a prediction of potential improvement to the biological community for each prioritized project and logical combinations of projects (or alternatives). Outputs from the Ecosystem Response Model were evaluated along with cost estimates in the USACE's cost effectiveness and incremental cost analysis tool. Alternatives that were identified as cost-effective were then screened in a similar manner to screenings conducted as the final prioritization for the WIP, discussed below.

As a final prioritization for the WIP, a feasibility/benefit screening was conducted on the 12 stream restoration and 16 BMP retrofit projects. The scoring categories which were considered most important to the feasibility of restoration measures in Flat Creek included: parcel ownership, implementation constraints, flood protection, accessibility, and upland imperviousness. Each project was assigned a score for each of the four categories, and the cumulative ranks of the projects were compared. The relative cost-effectiveness and feasibility/benefit scores provided the basis of the ultimate capital improvement plan (CIP) which was developed for the WIP.

CONCLUSIONS

For the ERR, the preferred alternative recommended for Section 206 funding consists of two stream restoration projects and one BMP retrofit project. This combination of projects in the upper Flat Creek subwatershed is expected to provide water quality and physical habitat improvements through a large portion of the watershed. In the WIP, a CIP was developed, including a recommended implementation schedule and cost allocation and responsibilities guidance. The 28 projects in the CIP list are expected to provide the most measurable water quality and physical habitat improvements while also being cost-effective watershed improvement efforts. Watershed improvement projects may be selected for implementation depending on current City and County plans and other opportunities to feasibly implement watershed improvement projects in the Flat Creek Watershed.

In combination with other watershed management activities that are conducted by the City and County, watershed improvements are imperative for the improvement of existing, degraded conditions and for the mitigation of impacts expected to result from further growth and development in this impaired watershed.