Gwinnett County's program is targeted at the unique problems facing the county. The first step in developing the program was the county wide watershed assessment. From the data collected for the watershed assessment a Watershed Protection Plan (WPP) was developed.

The WPP consisted of three primary components, new development requirements, improving affected areas and related activities to improve watersheds. The improving affected areas component involves retrofitting or restoring watershed function in areas already affected by development or past land use practices. In order to address this component, the County began developing Watershed Improvement Plans (WIP) one watershed at a time.

One of the primary objectives of the WIPs was the development of the watershed capital improvement plan (CIP) that consists of stream restoration projects and storm water detention facility retrofits (commonly referred to as best management practices (BMP)). With the WIP complete, Gwinnett County is now moving forward with the implementation of the CIP projects.

Watershed Assessment and Protection Plan

In 2000, Gwinnett County developed a Watershed Protection Plan (WPP) which was subsequently approved by the Georgia Environmental Protection Division (EPD) to support its National Pollutant Discharge Elimination System (NPDES) discharges. The plan set countywide priorities including the identification of impacted watersheds and regulatory improvements. New development requirements were implemented county-wide as a result of the plan to help control non-point source pollution (such as TSS). However, for those basins that already had a high degree of development, the WPP recommended improving affected areas by a series of measures including:

- Retrofitting or improving existing BMPs
- Installing new BMPs
- Disconnecting impervious areas
- Improving stream stability and habitat.

Watershed Improvement Planning (WIP)

To assess where these measures could be effectively applied to the watersheds in Gwinnett County, the Department of Water Resources (DWR) began a program of preparing Watershed Improvement Plans (WIPs) for its watersheds. In order to improve areas already affected by urban development, a systematic analysis of targeted retrofits aimed at restoring watershed function was needed. In order to address this component, the County began developing WIPs one watershed at a time. The following paragraphs briefly describe the WIP process.

Data Collection and Desktop Inventory. This task involved compiling the most recent Geographic Information System (GIS) data and using the data to develop watershed characteristics such as subwatershed delineations, cumulative impervious area, urban/rural runoff ratio, and the land use washoff TSS yield. The miles of stream, using a 25-acre threshold for stream delineation, are also determined. Next, existing BMPs are located by reviewing aerial photographs, digital topography, and hydrography. Potential new BMP sites are located in areas of development that do not have existing BMPs.

Field Inventory and Assessment. A field assessment is conducted at all existing BMPs to assess their potential for retrofit, and for new BMPs to assess their constructability. Stream walks are conducted to assess stream conditions and identify potential stream restoration sites. For both the BMP and stream field inventory data is collected using handheld PDAs (Personal Digital Assistants) running GIS software connected to a GPS unit. In addition, maintenance concerns are noted during both field inventories.

Modeling. The data collected during the stream and BMP inventory is reviewed and then used to develop the Grid Based TSS Model. This model represents the watershed as a network of grids, allowing for the direct use of spatial data. The model integrates both stream and BMP processes, and incorporates hydrologic methods developed within the Georgia Stormwater Manual (Atlanta Regional Commission 2001). Existing BMPs in their present condition are added to the model in order to account for benefits already being provided and help build the existing conditions scenario. Stream walk data is then added to develop the stream load component of the TSS yield. After integrating this information, the baseline TSS yield model is developed. New BMP, retrofitted BMP and stream restoration projects are developed. This includes estimating the TSS reduction benefits provided by a project and the cost of the project. Habitat and other evaluation criteria for each project are summarized. A two page project summary sheet is created for each project, which includes key project information such as project score, estimated cost, location maps and more.

CIP Development. The complete list of ranked projects is reviewed and evaluated to develop a final CIP for the watershed. Projects are then selected for the CIP that reduce TSS yield in all stream reaches within the watershed below 1,600 lb/ac/yr, the action criterion from the WPP. Highest-ranking headwater or upstream projects are typically selected first, and projects downstream are selected iteratively using the Grid Based TSS model until the TSS yields from all reaches are predicted to be below 1,600 lb/ac/yr based on implementation of the projects. The CIP projects are presented and grouped into two levels of service:

- Regulatory or Watershed CIP: projects that are needed to reduce the HUC 12 (Hydrologic Unit Code) watershed TSS yield below 1,600 lb/ac/yr.

- Reach CIP: projects that are needed to reduce each stream reach segment TSS yield below 1,600 lb/ac/yr.

Projects are selected for the CIP based upon an analysis of several implementation factors with the primary factor being a cost/benefit component. This set of rated projects forms the basis of the first projects to be implemented as funds become available.

WIP Implementation

Actual implementation of these types of projects in metropolitan Atlanta has lagged, due to a host of issues, including: loose commitments to implementation, a lack of available funding, and a wide variation in focus of individual municipal programs. However, Gwinnett County has consistently maintained a strong commitment to implementation. The WIP planning process has provided a basis for maintaining the focus on implementing projects whose primary purpose is watershed protection. Gwinnett County addressed funding watershed improvement projects with the following:

- Passage of a comprehensive stormwater utility
- Obtaining a Georgia Environmental Facilities Act (GEFA) loan
- Development of a stream buffer protection banking program.

This varied set of funding sources provides a firm basis for proceeding with implementing projects identified in the planning process. By implementing projects with the highest predicted benefits for the lowest estimated costs, Gwinnett County is achieving its best value while incrementally reengineering each watershed. A description of the design rationale for three of these projects follows.

PROJECTS SUMMARY

The following WIP implementation projects are presented:

- Lake Marie (BMP retrofit)
- Lake Wethersfield (BMP retrofit)
- Bromolow Creek (Stream restoration)

Lake Marie BMP Retrofit

Lake Marie is an existing wet pond located on Gwinnett County property in a residential area of the Sweetwater Creek Watershed (Gwinnett County 2003). The lake is located near Timbercreek Drive and Rolling Ridge Road vicinity. The lake currently has no outlet structure and storm flow overtops the earthen embankment at a low spot. This can be considered a potential hazard to development downstream. The pond outflow is eroding the downstream face of the embankment and may eventually result in a breach of the dam if no modifications are made. Because of the lack of an effective outlet structure, little if any peak runoff attenuation is achieved in its current configuration.

Project Benefits. The contributing drainage area to Lake Marie is approximately 16.2 acres, approximately 45.8% of which is impervious. Current peak flows from the BMP in a 2-year event are 5.97 cfs. By retrofitting the outlet structure, these flows can be reduced to 0.97 cfs, a significant reduction in channel forming flows, thus providing downstream benefits. Table 1 provides a summary of existing and predicted flows from project implementation. As can be seen from the table, the project also provides flood attenuation (25, 50, and 100-year storm) benefits as well. By providing the required water quality and channel protection volumes of 30,102 ft^3 and 85,582 ft^3 in the storage volumes, an average of 21,278 lbs/year of TSS will not be discharged downstream over existing conditions, providing water quality benefits to reaches downstream of the project.

Project Design. The project includes the following main features:

- Partially draining of the lake to allow for construction, but also save fish species
- Partial dredging of upstream areas below the current water line
- Clearing and grubbing the dam face, including removal of several large trees
- Construction of a new circular outlet structure which includes a 7 inch orifice and a 4 foot diameter overflow
- Construction of a 24-inch culvert through the dam midway up its elevation stepping down to a junction box and thence to its outlet
- An engineered channel designed to accommodate a 10% slope and step down the high energy flows eventually transitioning to a more natural channel

Table 1. Lake Marie Flow Reduction Benefits

Return Frequency (years)	Existing Flow (cfs)	Predicted Project Flow (cfs)
1	2.87	0.78
2	5.97	0.95
5	13.95	2.36
10	21.63	5.24
25	33.10	11.80
50	42.42	18.17
100	48.90	20.97

A simplified representation of the design is presented in Figure 2.

Lake Wethersfield BMP Retrofit

Lake Wethersfield is an existing wet pond located on Gwinnett County property in a residential area of the Up-

per Yellow Creek Watershed (Gwinnett County 2003). The lake is located near Scenic Highway on Wethersfield Road. The drainage area is approximately 49.5 acres, and the surface area of the lake is approximately 2.2 acres. The lake provides recreational use for property owners in the vicinity. The existing outlet consists of a 6 inch Corrugated Metal Pipe (CMP) standpipe riser. Because of the relatively small size of the CMP riser, storm flows routinely overtop the earthen embankment through a naturally formed weir on the north of the dam. Several issues were observed with the dam and appurtenances: 1) a hole in the bottom of the 6-inch CMP was observed discharging water at a continuous rate, and 2) a potential breach in the dam was observed on the northwest corner of the embankment. The outflow is eroding the downstream face of the embankment.

Project Benefits. The contributing drainage area to Lake Wethersfield is approximately 49.5 acres, approximately 39.4 % of which is impervious. This is almost double the amount estimated in the WIP (19%) and is due to new development. Current peak flows from the BMP in a 2-year event are 16.62 cfs. By retrofitting the outlet structure, these flows can be reduced to 6.28 cfs, a significant reduction in channel forming flows, providing downstream stream benefits. Table 2 provides a summary of existing and predicted flows from project implementation. The benefits continue for larger storm events, but their proportional benefit decreases. The water quality and channel protection volumes for this watershed are 87,262 ft^3 and 249,938 ft^3 in the storage volumes, an average of 154,447 lbs/year of TSS will be prevented from discharging down-stream over existing conditions. Actual TSS reductions will probably be larger due to the increase in imperviousness in the contributing watershed. This will provide significant water quality benefits to reaches downstream of the project. This is in addition to a significant benefit of reducing channel forming (2-year) flows, and a modest reduction in 100-year flows.

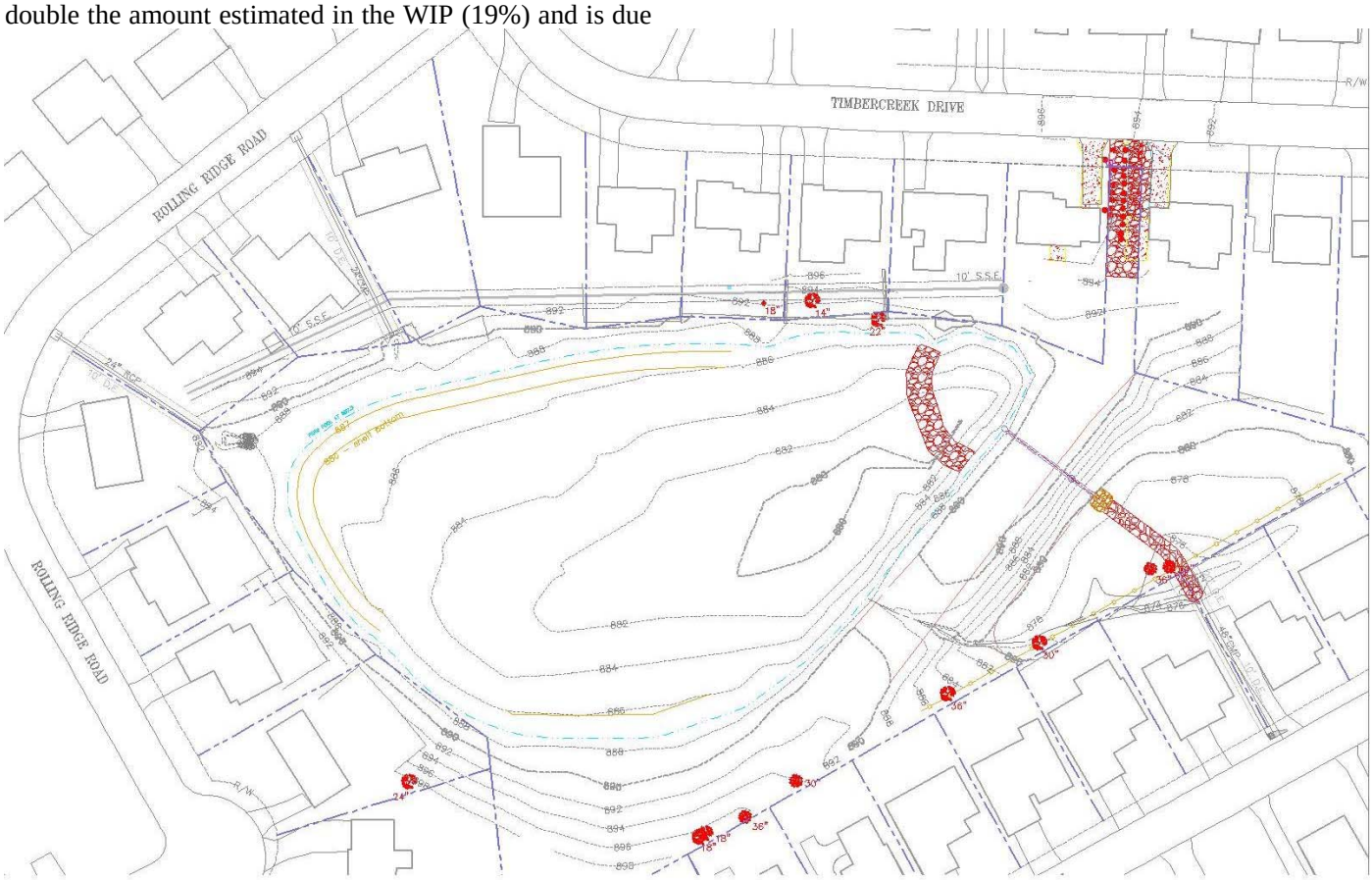

Figure 2: Lake Marie Preliminary Design

Table 2. Lake Wethesfield Flow Reduction Benefits

Return Frequency (years)	Existing Flow (cfs)	Predicted Project Flow (cfs)
1	8.01	3.27
2	16.62	6.28
5	40.27	24.25
10	61.79	46.68
25	93.87	78.04
50	120.48	102.34
100	139.02	123.10

Project Design. The project includes the following main features:

- Partially draining of the lake to allow for construction, but save fish
- Construction of a new 6 foot outlet structure which includes a 9 inch orifice, and an overflow weir
- Construction of a 36-inch culvert through the dam midway up its elevation stepping down to a junction box and thence to its outlet
- Design of a new spillway to pass peak storm events without eroding the dam face
- Possible repairs to the dam, and clearing and grubbing of vegetation on the dam face
- Design of a stilling basin to transition high energy flows from the outlet of the dam prior to discharging to the natural stream channel

A simplified representation of the design is presented in Figure 3.

Bromolow Creek Stream Restoration

Gwinnett County DWR identified an undeveloped parcel on Old Norcross Road as a potential site for stream and wetland restoration based on the aquatic resources present and their existing condition. The undeveloped 7-acre site has two tributaries of Bromolow Creek, with a total on-site length of approximately 1,180 linear feet (LF), which appear to have been channelized. The site also has extensive forested riparian wetlands within the floodplain of Bromolow Creek. The channelized sections have created vertical, unstable creek banks that are poorly vegetated and actively eroding, thus severely impacting the diversity and quality of aquatic habitat conditions. The riparian corridor is intact along these reaches, although the understory is dominated by Chinese privet (i.e., *Ligustrum sinense*).

Project Benefits. The stream restoration measures to improve the water quality and habitat conditions follow a Priority 2 restoration approach, with stabilization of the creek and development of a new floodplain bench at or near the existing creek bed elevation. Figure 4 illustrates the conceptual plan for this project. This approach will restore the creek without sacrificing the flood control requirements of the existing box culvert and bridge crossings for Bromolow Creek at Old Norcross Road. This will be accomplished by recreating a natural riffle/pool channel morphology, stabilizing the eroding stream banks through grading and establishment of native riparian vegetation, connecting the creek to a new floodplain bench where appropriate, and enhancing the aquatic and riparian habitat conditions. Wetland enhancement measures will focus on removal of non-native, invasive species (e.g., Chinese privet), and supplemental planting of native species for forested riparian wetlands. The Bromolow Creek Stream and Wetland Restoration project has the potential to generate up to 11,151 stream mitigation credits and up to 6.63 wetland mitigation credits which is expect to have a significant market value.

SUMMARY AND CONCLUSIONS

Gwinnett County has now completed the full cycle of progress in watershed management, from assessment to planning to implementation. Three projects were presented; numerous others are being implemented. While it is a large and comprehensive program, many aspects of DWR's award winning program may be adaptable to other stormwater management agencies. Implementation of the projects suggested in the myriad planning studies is the only real way watershed improvements can take place.

REFERENCES

Booth, D.B., Hartley, D., and Jackson, R., 2002. Forest cover, impervious-surface area, and the mitigation of storm water impacts. Journal of the American Water Resources Association (38) 835-845.

MNGWPD, 2003. District-wide Watershed Management Plan.

Gwinnett County, 2003. Sweetwater Creek Watershed Improvement Plan.

Gwinnett County, 2003. Lower Yellow River Watershed Improvement Plan.

Atlanta Regional Commission, 2001. Georgia Stormwater Management Manual.

ACKNOWLEDGEMENTS

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Figure 3: Lake Wethersfield Preliminary Design

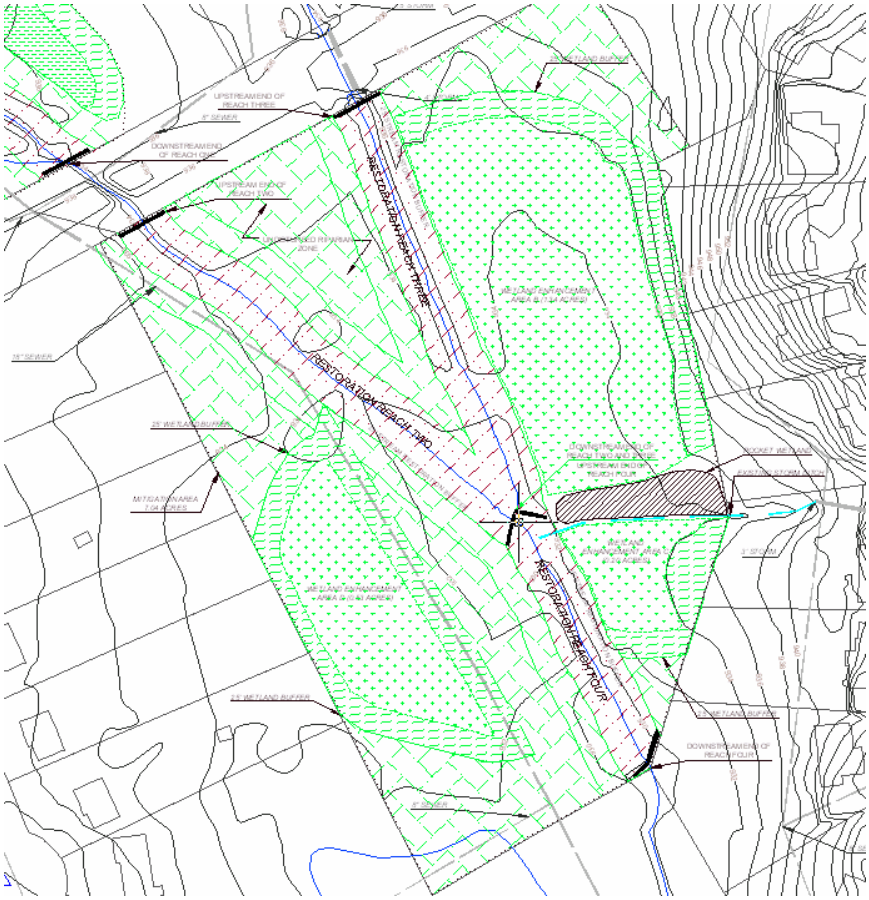

Figure 4: Bromolow Creek Concept Plan