Charlotte-Mecklenburg Storm Water Services

"Charlotte-Mecklenburg Schools – South Park Campus Watershed Enhancement Project"

May 17, 2016

Project Description:

The CMS South Park Watershed Enhancement project is an innovative stormwater BMP retrofit project implemented by Charlotte Storm Water Services (CSWS) at an existing 71 acre school campus site in Charlotte, NC. The project was constructed during 2013 with the ultimate goal of installing on-site structural stormwater BMPs to provide treatment of stormwater runoff pollutants for as much of the site as possible. Additional goals were to 1.) provide an educational opportunity for school students, including using BMPs as outdoor classrooms where possible, 2.) provide a natural amenity for school students as well as neighborhood residents who may access the site after hours, 3.) provide natural habitat for wildlife, 4.) reduce stormwater discharge volumes leaving the site, and 5.) improve downstream water quality and the environment as a whole.

The project originally developed out of a request from members of the Parent Teacher Association (PTA) for the school campus, which actually includes three separate schools – Selwyn Elementary School, Alexander Graham Middle School, and Myers Park High School. The PTA was interested in seeing a stormwater demonstration project implemented on the campus. CSWS evaluated the site and determined there was potential to implement structural BMP retrofits at several locations within the campus. Although the PTA was interested in seeing the project developed, buy-in and approval for the project would ultimately be needed from the Charlotte-Mecklenburg School District. Although the school district had no funding for structural BMPs, they were agreeable to allowing CSWS to conduct a feasibility study to determine the potential for retrofit. The feasibility study originally identified 16 BMP sites that would be potentially suitable; however, a number of sites were eliminated from further consideration due to projected costs, unfavorable cost-benefit, and site constraints. CSWS concluded the most cost effective and beneficial option was to construct five structural BMPs that would strategically provide stormwater treatment for approximately 36 acres of the campus.

Upon receiving approval from the school district, CSWS began planning and design of the project which included developing a detailed projected cost estimate of $1.28 million for construction of the project. The project design utilized green infrastructure and low impact design elements such as infiltration and bio-filtration where possible, which included construction of two bioretention areas, a grass swale with subsurface infiltration trench, a dry detention sand filter basin, and a wet detention pond. The City of Charlotte requires new development and redevelopment to provide stormwater treatment for water quality and flow volume control. Applicable projects are required to design BMPs to treat the runoff volume from the first one-inch of rainfall for water quality and control the volume for the one-year storm for water quantity (aka-the channel protection volume). Although the CMS South Park project did not have to meet these requirements due to it being a retrofit of existing exempt development, every effort was made to design the BMPs to meet these standards. **Figure 1** shows an aerial view of the project site showing the locations of the BMPs.

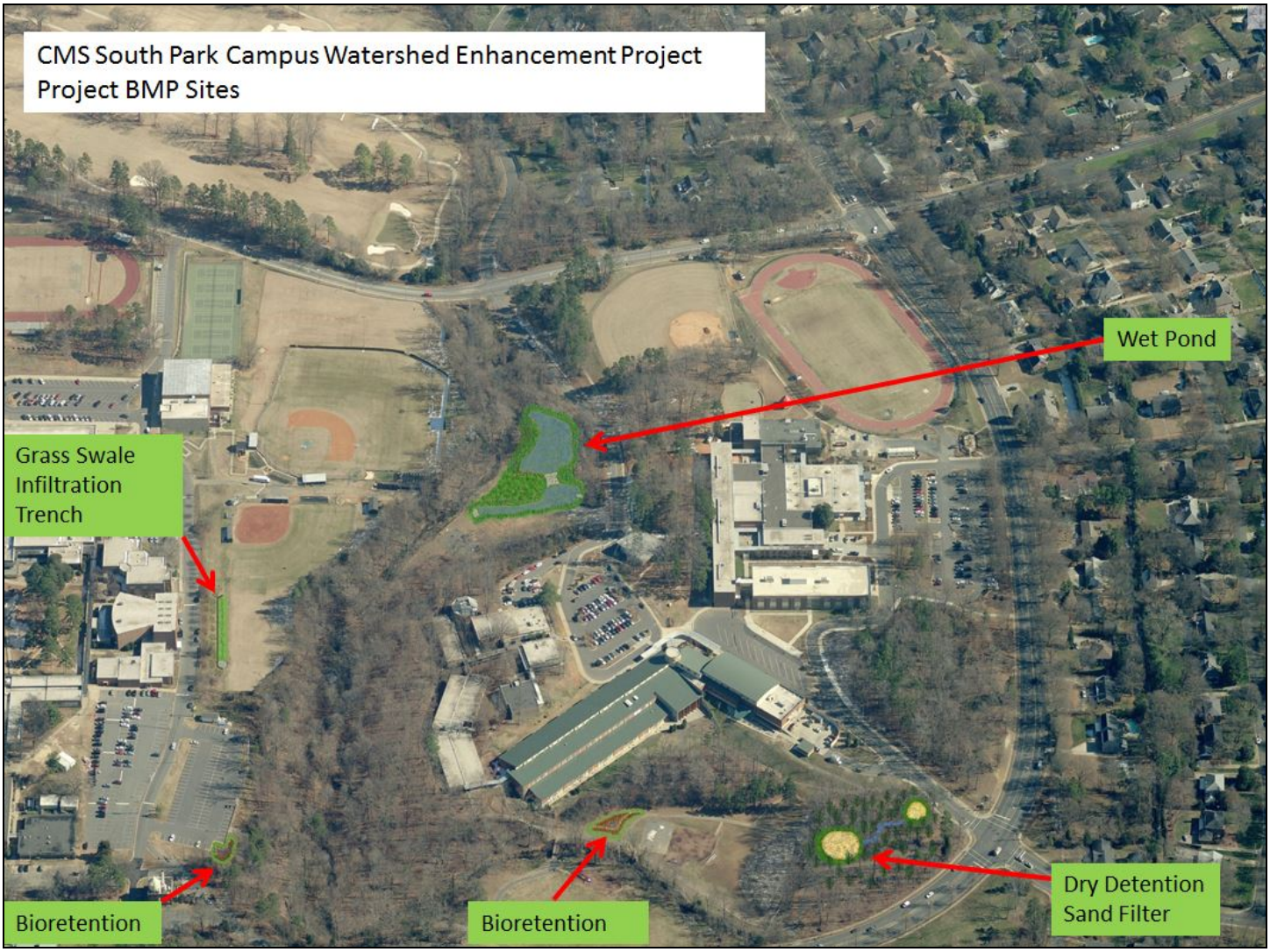

Figure 1: CMS South Park Project BMP Locations.

Environmental Impact:

As discussed above, the primary goal of the project was to provide treatment of stormwater runoff pollutants for as much of the school campus site as possible. The completed project installed five separate BMPs and now treats approximately 36 acres or just over 50% of the entire 71 acre watershed area of the campus. Of the 36 acres treated, over 18 acres are impervious surfaces such as roadways, parking lots, and roof tops. All BMPs are designed to remove 85% of total suspended solids (TSS) coming from the site which will also result in corresponding removal of Total Nitrogen, Total Phosphorus, Fecal Coliform bacteria, and metals that are commonly attached to TSS particles. Without any treatment of stormwater runoff from the 36 acre project area of the campus it is expected that over 18,000 pounds of sediment, 292 pounds of Total Nitrogen, and 46 pounds of Total Phosphorus would enter the receiving stream each year. With the addition of the five retrofit structural BMPs producing an expected TSS removal of 80 percent overall, the sediment discharge is being reduced by approximately 14,500 pounds per year. The corresponding expected reduction for Total Nitrogen and Total Phosphorus is approximately 114 pounds and 25 pounds per year, respectively. The expected load reductions are based on a site evaluation model developed by Tetra Tech, Inc.[1.] Another benefit realized is the protection of receiving stream banks from bank erosion by reducing stormwater volumes and attenuating peak flows from the campus. CSWS also maintains a Pilot BMP Program that focuses on real world storm event field testing of structural BMPs to determine actual pollutant removal efficiencies and load reductions. The BMPs installed at CMS South Park are currently being monitored under this program with testing expected to be complete in 2018.

The project also provides natural open space and aesthetic benefit for teachers and students of the campus as well as neighborhood residents who often use the site's walking trails and playgrounds. The bioretention areas and wet pond are also a resource for use as an outdoor classroom for various science classes. In addition, these BMPs provide additional habitat and a water source for water fowl and other wildlife in the area. Although not currently utilized, the wet pond and infiltration trench offer a water storage resource for use by campus staff for lawn and landscape watering. This potential stormwater resource component offers approximately 150,000 gallons from the wet pond and 112,000 gallons from the infiltration trench water storage, available for stormwater reuse from each one-inch storm event. **Figure 2** shows a hawk visiting the newly constructed wet pond, and **Figure 3** shows the installation of the infiltration trench water storage device.

Figure 2: A hawk surveys the wet pond in search of food.

Figure 3: Installation of the 15,000 cubic foot infiltration water storage device.

Economic Impact:

As stated earlier, the CMS South Park project is a stormwater BMP retrofit of a previously developed school campus facility. As such, several constraints had to be overcome which resulted in additional costs to implement the project. Existing underground utilities including water, sanitary sewer, gas, and electric had to be addressed in the development, design, and construction of the project. In several cases, utility lines were relocated to allow for construction of the BMPs. In addition, existing stormwater infrastructure had to be re-routed and expanded to allow stormwater runoff to enter the structural BMPs at selected locations. Another constraint was that the school district did not want to give up prime playground and parking space to be potentially used for structural BMPs. This meant that BMPs had to be located in other areas that were not as amenable in terms of access and construction.

The cost to plan, design, and construct the project was $1.647 million, and with CSWS internal project staff costs factored in, the overall total cost represented a $1.834 million investment in water quality, the environment and the community as a whole. Funding for the project included a $400,000 grant received from the North Carolina Clean Water Management Trust Fund with the remainder funded by CSWS capital improvement funds. While the exact dollar amount is undetermined, the socioeconomic benefits of providing improved water quality and natural open space amenities are a major positive impact of this project.

Through implementation of this project, CSWS obtained valuable information about costs, requirements, benefits, and challenges associated with stormwater BMP projects. In support of development and redevelopment goals, this information has been and will continue to be used in the development and refinement of Charlotte's land development and stormwater BMP standards and requirements.

Outreach:

In developing the CMS South Park project, a multi-step outreach approach was used to gain support and approval for the project, requiring the project to be presented and sold at each level. The first step was developing a conceptual plan and meeting with school district facilities management staff to gain acceptance and approval for proceeding with the development of the project. Once the proposed project was developed and refined to include the five structural BMPs at the selected locations, additional meetings were conducted with school district staff to address design comments and concerns. Upon receiving agreement and approval from school district staff, CSWS staff presented the project to on-site school principals and listened to their comments and concerns. Once approval and buy-in from the school principals was achieved, the next step was to present the proposed project to students, parents, the PTA, and neighborhood residents adjacent to the campus. This step utilized school e-mail lists and social media where possible, as well as mailers and PTA newsletters to advertise and provide information about the project. In addition, a public meeting was held at the high school auditorium to present the project and address questions and concerns. Outreach evaluation was measured by the positive turn out at the public meeting. The meeting was well-advertised and resulted in over 100 parents and students attending, showing this was the audience most successfully reached.

The project was also presented at the Southeast Stormwater Association (SESWA) annual conference held in Charlotte during October 2013. This conference is attended by many stormwater professionals including engineers, scientists, academia, and municipal government staff. CSWS is also currently developing permanent educational signage to be strategically located at each BMP. The signs will serve as focal points along an educational walking tour that will be developed in collaboration with the schools' teachers. Other future efforts for outreach include publishing reports on BMP monitoring results as well as further presentations to resource professionals. **Figure 4** shows an example of the educational signage that will be placed at the BMP sites.

Figure 4: Educational signage example.

Results:

The project serves as a pilot project not only to treat stormwater runoff but also to determine the benefits, requirements, and constraints of implementing green infrastructure (GI) and low impact development (LID) projects, especially in a retrofit scenario. Charlotte's post construction stormwater control regulations currently allow the use of GI/LID BMPs for development projects. All development projects must execute an operation and maintenance agreement that requires the long-term inspection, operation, and maintenance of structural BMPs, in perpetuity. Project maintenance requirements, frequency, and costs are being tracked to determine what will be required for the implementation and maintenance of GI/LID projects in the future. This information will also be valuable in the further development and refinement of BMP standards and regulations.

Two of the project BMPs were located near the receiving stream and, therefore, required coordination and permitting. Review and approval was required from the US Army Corps of Engineers for stream encroachment as well local agency approval for flood-plain and stream buffer impacts.

The combined capture volume for the project's five structural BMPs was just over 83,000 cubic feet. Four of the five BMPs treated existing development which was constructed prior to stormwater regulations, and therefore provided 100% capture volume above the requirements for those BMP watersheds. Overall, the project provided 88% capture volume above the requirements.

As mentioned above, the overall cost of the project was $1.834 million with the cost per acre treated just over $51,000 and a stormwater volume cost of approximately $22 per cubic foot. The expected pollutant removal in pounds per acre per year is 453 for TSS, 3.5 for Total Nitrogen, and 0.75 for Total Phosphorus. Based on a 30 year BMP life span, the combined cost per pound of pollutant removed per year is approximately $134. **Table 1** shows cost information for the project.

As previously discussed, the project provides an amenity for the community and demonstrated an efficient use of resources by using unused areas of the campus to locate the BMPs. This meant that there was no loss of use for school operations and activities while still providing the additional stormwater treatment for the campus. In addition, there were no land costs as the school district donated permanent easements for the implementation and long-term maintenance access by CSWS.

	Overall Actual Project Cost	Wet Pond	Dry Dt Sand Filter	Infiltration Trench	Bioretention	Bioretention
Total Costs	**$1,834,594**	**$444,181**	**$385,034**	**$449,716**	**$215,739**	**$274,344**
Watershed Acreage Treated	35.72	12.91	10.51	7.35	0.73	4.22
Impervious Acreage Treated	18.60	5.47	4.95	4.84	0.58	2.76
Cost/Watershed Acre	$51,360	$34,406	$36,635	$61,186	$295,533	$65,010
Cost/Impervious Acre	$98,634	$81,203	$77,785	$92,917	$371,964	$99,400
Cost/Cubic foot capture volume	$22	$14	$15	$29	$133	$29

Table 1: Cost and watershed information per BMP.

Maintenance:

BMP maintenance is being conducted by CSWS and typically includes removal of sediment and debris, re-mulching, and vegetation management, as needed. The BMPs are inspected annually at a minimum to determine operational condition and maintenance needs. Inspections include evaluating the condition of inlet structures, fore bays, embankments, outlet riser structures, outfalls, sand filter surface, wet pond surface, mulch, and plantings. Leaves from near-by trees have been an issue in the fall season resulting in surface clogging of the sand filter and bioretention areas. In addition, there has been some vandalism observed with the removal of storm grates located on the riser structures.

CSWS monitors maintenance requirements and costs as part of the pilot BMP program and currently the average cost is $1,800 per BMP per year. In addition, cost and progress reporting was required for the NC Clean Water Management Trust Fund grant mentioned above. CSWS is also conducting stormwater monitoring of the BMPs within the project. Storm event runoff samples are being collected at the inflow and outflow points of the BMPs to determine their pollutant removal efficiency. Stormwater inflows and outflows are also being measured to determine volume reduction and corresponding pollutant load reduction.

Conclusion:

The CMS South Park BMP project has successfully provided a valuable resource for the community and is accomplishing the stated goals of the project. Stormwater runoff is being treated to remove pollutants, reduce volumes and improve water quality. Educational opportunities are available for students and a natural amenity and wildlife habitat have been created. Much knowledge has also been gained related to the challenges, constraints, logistics, requirements and costs of implementing a large BMP retrofit project. Challenges included 1.) working with the school to agree upon locations for the BMPs that would not take away from other school uses; 2.) dealing with concerns from the public regarding safety and mosquitoes; and, 3.) coordinating construction activities to provide minimal disruption during school operating hours.
Finally, while the project shows that the implementation of retrofit BMPs within existing development can be successful, it also shows the considerable monetary and time investment needed to accomplish such projects. **Figure 5** shows a newly constructed bioretention area adjacent to a student parking lot, and **Figure 6** shows a beautiful scene of a reflection in a constructed step pool upstream of the sand filter.

Figure 5: Bioretention area with stormwater inflow monitoring box.

Figure 6: Beautiful scenes creating a natural amenity.

References:

1. Site Evaluation Tool, version 3.3, December 2005.
Developed by Tetra Tech, Inc. for Mecklenburg County, North Carolina, USA.

The Site Evaluation Tool is based in part on the following models:
Simplified Urban Nutrient Output Model (SUNOM):
Caraco, D., R. Claytor, and J. Zielinski. 1998. Nutrient Loading from Conventional and Innovative Site Development. The Center for Watershed Protection, Ellicott City, MD.

SCS Runoff Curve Number method:
US Dept of Agriculture. 1986. Urban Hydrology for Small Watersheds. Technical Release 55. USDA, Soil Conservation Service. Washington, DC.

SCS Hydrograph method:
US Dept of Agriculture. 1972. National Engineering Handbook, Section 4, Hydrology, Chapter 16, Hydrographs. Soil Conservation Service, Washington D.C.