



NONPOINT SOURCE SUCCESS STORY

Michigan

Implementing Stormwater Management Practices Reduces Phosphorus and Sediment Loads to Arcadia Creek

Waterbody Improved

Nutrients transported in urban runoff from the Arcadia Creek and other upstream tributaries led to the eutrophication of Lake Allegan. Implementing best management practices (BMPs) to reduce nutrient loading led to dramatically decreased nutrient loads and runoff from the Arcadia Creek subwatershed. Over time, with continued support and BMP implementation in the larger Lake Allegan drainage area, these load reductions are expected to contribute to improved conditions in Lake Allegan.

Problem

Arcadia Creek, a small tributary to the Kalamazoo River in the city of Kalamazoo, Michigan (assessment unit 040500030606-04), flows into Lake Allegan, a 1,375-acre impoundment on the Kalamazoo River (Figure 1). Lake Allegan was added to Michigan's Clean Water Act (CWA) section 303(d) list of impaired waterbodies in 1996 because excess algal growth fueled by high phosphorus loads caused the lake to fail to support its aquatic life designated use. Arcadia Creek (drainage area of 17 square miles) is not listed as impaired for phosphorus; however, an assessment showed that it ranked 5th out of 75 subwatersheds for the highest total phosphorus loading per unit area, and is a significant contributor of phosphorus to Lake Allegan (drainage area of 1,550 square miles). Arcadia Creek flows through an urban area and is listed as impaired for bacteria, mercury, polychlorinated biphenyls and dioxin.

The Michigan Department of Environmental Quality developed a total maximum daily load (TMDL) for phosphorus for Lake Allegan/Kalamazoo River in 2001. The TMDL called for a 50 percent reduction of total phosphorus stormwater loads within the Lake Allegan/Kalamazoo River watershed.

Project Highlights

Two watershed management plans were developed that helped guide efforts to reduce nutrients and other nonpoint source pollutants. In 2006 stakeholders developed an EPA-approved, nine-element subwatershed plan for Portage and Arcadia creeks. In 2011 a plan was developed for the larger Kalamazoo River watershed above Lake Allegan, which also encompasses Arcadia Creek.



Figure 1. Arcadia Creek is in the Kalamazoo River watershed in southern Michigan.

Multiple stormwater best management practices have been implemented in the Arcadia Creek subwatershed since the mid-2000s, especially on the campus of Western Michigan University. Two Clean Michigan Initiative grants and a Clean Water Act (CWA) section 319 grant funded the following BMPs between 2007 and 2011:

- Three stormwater detention basins, totaling 141 acres in size
- A 395-foot grassed waterway
- A 6.5-acre infiltration/retention basin
- A 0.8-acre infiltration trench
- 3,115 feet of stream bank stabilization (Figure 2)
- 6 acres of vegetated buffers
- 1.6 acres of reconnected floodplain
- 5,900 native vegetation plugs

Additional stormwater BMPs were installed in the subwatershed using other grants and local funds.



Figure 2. Project partners reshaped the streambank and added rock to stabilize this eroding area of Arcadia Creek along Stadium Drive on the Western Michigan University campus.

Results

To assess BMP performance, post-BMP wet weather and dry weather water sampling for total phosphorus and total suspended solids was conducted in 2013–2014 and compared to pre-BMP data collected in 2002–2003.

Post-BMP monitoring results demonstrated substantial improvements in phosphorus and suspended solids loadings, and stream hydrology:

- Average wet weather event mean concentrations (EMCs) for total phosphorus declined from 0.414 milligrams per liter (mg/L) in 2002–2003 to 0.254 mg/L in 2013–2014 (39 percent decline; Table 1).
- Annual loadings of total phosphorus declined from 2,023 pounds in 2002 to 1,234 pounds in 2013–2014 (39 percent decline; Table 1).
- Average wet weather EMCs for total suspended solids declined from 137.7 mg/L in 2002–2003 to 89.6 mg/L in 2013–2014 (35 percent decline; Table 1).
- Annual loadings of total suspended solids declined from 403 tons in 2002–2003 to 262 tons in 2013–2014 (35 percent decline; Table 1).
- Average wet weather flows and peak flows were substantially reduced after BMPs were installed, despite larger rain events in 2013 and 2014.
- BMP performance studies of two stormwater detention BMPs demonstrated 85 percent to 99 percent removals of total phosphorus and total suspended solids.
- Anecdotal reports indicated reduced flooding throughout the Arcadia Creek watershed after the BMPs were installed.

Table 1. Pre- and post-stormwater BMP total phosphorus and total suspended solids annual loadings and event mean concentrations

Years	Annual Loading		Event Mean Concentration	
	Total phosphorus (tons/year)	Total suspended solids (tons/year)	Total phosphorus ($\mu\text{g/L}$) ¹	Total suspended solids (mg/L)
2002–2003 (Pre)	2,023	403	414	138
2013–2014 (Post)	1,234	262	254	90

¹ $\mu\text{g/L}$ = micrograms per liter

In addition, Western Michigan University reduced its annual total phosphorus load to Arcadia Creek by 50 percent, and has committed to infiltrating 100 percent of the stormwater from any redevelopment or new development.

Overall, total phosphorus loadings in Arcadia Creek declined significantly after BMPs were implemented, indicating that headway is being made toward water quality improvements. Phosphorus concentrations in Lake Allegan have also decreased, although interannual variability is significant. More work remains, and will need to focus on sources in other areas of the larger Kalamazoo River watershed upstream of Lake Allegan.

Partners and Funding

The improvement in water quality in Arcadia Creek was supported by two Clean Michigan Initiative implementation grants to The FORUM of Greater Kalamazoo, as well as a CWA section 319 implementation grant to Western Michigan University (these three funding sources totaled \$1,737,363, including \$536,958 in matching funds). Post-BMP monitoring was funded by a Clean Michigan Initiative grant to Western Michigan University totaling \$73,554 (including \$19,154 in matching funds). Partners in the implementation grants were Kalamazoo Christian High School, Western Michigan University, Wildtype Nursery, Geum Services, WildOnes Natural Landscapers, Kalamazoo River Watershed Council, the Gun Lake Tribe, Quantum Construction, and the city of Kalamazoo. Partners in the post-BMP monitoring project were the Portage/Arcadia Watershed Steering Committee, the Kalamazoo Water Reclamation Plant, the city of Allegan's Wastewater Treatment Plant, and Kieser & Associates.



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