



NONPOINT SOURCE SUCCESS STORY

Arkansas

Green Infrastructure and Low Impact Development Reduce Pathogens in Clear Creek

Waterbody Protected

The Arkansas Department of Agriculture's Natural Resource Division's Nonpoint Source (NPS) Pollution Program identified the Clear Creek watershed, a sub-watershed of the Illinois River Watershed, as a priority for reducing NPS pollution in the state's 2018-2023 Nonpoint Source Management Plan. The waterbody was added to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2006 for exceeding the state pathogen (*Escherichia coli*) criterion for primary and secondary contact. Many projects have been completed to implement green infrastructure (GI), water quality monitoring, education, and outreach in response to the urban development and *E. coli* pollution in Clear Creek. Several community events and partners have helped implement urban best management practices (BMPs) that continue to educate and decrease nonpoint source pollution. In the EPA-approved 2018 Arkansas CWA section 303(d) list submitted by the Arkansas Department of Energy and Environment's Division of Environmental Quality (DEQ), Clear Creek showed attainment of the *E. coli* criterion and supported primary and secondary contact beneficial uses for the first time since being listed as impaired in 2006.

Water Quality Challenge

The Clear Creek watershed begins in the urbanized area of southeast Springdale and northeast Fayetteville, is then impounded to form Lake Fayetteville, and then flows west nearly 12 miles to the Illinois River (Figure 1). This waterbody runs through mostly residential neighborhoods and commercial developments but also contains rural and agricultural lands which all contributed to the non-attainment of Clear Creek. The DEQ assessed 13.5 miles of Clear Creek as exceeding the state criterion for *E. coli* and listed the cause as urban sources. While *E. coli* levels were the main cause of Clear Creek's impairment listing, nutrients, sediments, trash, and eroding streambanks were also impacting the waterbody. According to the U.S. Census, Fayetteville has seen an 83% population increase since 2000, with the most dramatic increase happening between 2000 and 2008 (75%). In 2009, the University of Arkansas Cooperative Extension Service (Cooperative Extension) found an estimated 54% depletion of functional riparian areas throughout the watershed.

Clear Creek 1111010302



Clear Creek watershed map.

Project Highlights

In 2008 the Illinois River Watershed Partnership (IRWP), oversaw a volunteer water quality monitoring project to educate the public and gain data in Clear Creek. Cooperative Extension conducted 61 outreach events including 17 creek clean-ups, 15 riparian buffer demonstration sites, rain barrel workshops, and presentations on NPS pollution (Table 1). The IRWP installed 31 rain gardens throughout the watershed from 2011 to 2014 with the help of volunteers and local partners. These rain gardens were installed with 7,426 native plants and work to not only slow down the stormwater in the urban areas but also as outdoor classrooms for schools and the public to learn the importance of native vegetation in a watershed (Table 1). In 2013, IRWP installed three bioswales, three rain gardens, and held two community events as public outreach to highlight the unified approach to water quality and GI education in their urban areas. Cooperative Extension held 4 litter events, from 2013-2015, that removed an estimated 3 tons of litter from the watershed (Table 1). This project also held three rain barrel workshops in the catchment area needing the most runoff reduction (Table 1). Beginning in 2015, IRWP with local partners, installed eight rain gardens, four bioswales, and created mitigation for over seven acres of impervious area across the watershed (Table 1). These BMPs have improved the water quality in Clear Creek by removing NPS and encouraging the public to make decisions that maintain the improvement of the watershed.



LID Project

| Best Management Practice | Number Installed | Units | Comments |
|--------------------------------|------------------|-------------|--|
| Vegetated Swales | 52500 | SQUARE FEET | Projects 13_300 & 15_800 |
| Porous Pavement | 14025.5 | SQUARE FEET | Projects 13_300 & 15_800 |
| Raingarden/ bioretention basin | 78548 | SQUARE FEET | Projects 13_300, 15_800, 11_300 & 11_400 |
| Riparian Forest Buffer | 4892.05 | ACRES | Projects 13-300, 13_1400, & 09_1200 |

Results

IRWP worked with volunteers to collect grab samples in 2008, it was found that there was a positive correlation in increased urban areas with increased nutrient and sediment levels in Clear Creek. Although Clear Creek was listed for *E. Coli*, the urban nonpoint source pollution was also negatively impacting the stream. By 2014, after many of the rain gardens and bioswales had been implemented, IRWP and the Beaver Water District (BWD) found there was 99% retention rate compared to their initial projection of 82%. The amount of stormwater being slowed down correlated to nonpoint sources such as bacteria, nitrogen, and sediment being reduced from the Clear Creek Watershed. The Arkansas Water Resources Center (AWRC) sampled five different sites along Clear Creek from 2012-2014 for *E. coli*. In 2012, AWRC found that two sites (sites CC029A and CC029B) had a primary contact *E. coli* exceedance in 12.5% of their samples (Table 2). Although, by 2013 and 2014 CC029A and CC029B both dropped to 0% exceedance. In 2023 and 2024 AWRC resumed sampling of reach CC029, returning to three of the previous sites and adding two new ones for better accessibility. One site (CC-265, which overlaps with the original CC029A) was found to have an exceedance of 11%, though by 2024 it had returned to 0% exceedance (Table 2). The GI and urban best management practices implemented will continue to help reduce the amount of *E. Coli* entering the watershed as well as other important NPS pollutants (Table 3). Since 2008 there have been over 4,000 volunteers from the Northwest Arkansas region that helped install rain gardens, bioswales, clean-up events, and more to help alleviate the problems in the Clear Creek Watershed. The introduction of the urban BMPs has decreased the amount of sediment, nutrients, and other NPS pollution entering the watershed. The education events will also prove valuable in continuing the stewardship of this watershed in the future.

Table 1. Summary of 319(h) projects funded in the Clear Creek watershed, sub-awardee information, funding amount, and project type.

| Project # | Year | Partner | Grant \$ | Match \$ | BMPs/Events | Category |
|-----------|------|---------------------------------|-----------|-----------|--|--------------------------------|
| 08-300 | 2008 | Cooperative Extension | \$169,106 | \$127,571 | N/A | SWAT model |
| 08-400 | 2008 | IRWP | \$25,650 | \$19,350 | N/A | Water Quality Monitoring |
| 08-1200 | 2008 | IRWP | \$75,000 | \$56,850 | N/A | Watershed Management Plan |
| 09-1200 | 2009 | Cooperative Extension | \$250,000 | \$188,598 | 15 Riparian Buffers, 17 Creek Cleanups, 61 Education Programs | Demonstration & Education |
| 11-200 | 2011 | Botanical Gardens of the Ozarks | \$38,680 | \$33,403 | Riparian | Streambank Restoration |
| 11-300 | 2011 | IRWP | \$139,702 | \$105,537 | 31 Rain Gardens, 7 Rain Garden Academies | LID, Demonstration & Education |
| 11-400 | 2011 | IRWP | \$210,288 | \$160,627 | 64 Rain Gardens, 17 Education Events | LID, Demonstration & Education |
| 11-500 | 2011 | AWRC | \$728,000 | \$621,197 | N/A | Water Quality Monitoring |
| 13-300 | 2013 | IRWP | \$300,000 | \$226,315 | 3 Rain Gardens, 5 Bioswales, 2 Parking Lot BMPs, 84 Education Events | LID, Demonstration & Education |
| 13-1400 | 2013 | Cooperative Extension | \$275,782 | \$208,046 | 9 Litter Cleanup Events, 9 Education Events, 2 Riparian Plantings, 3 Invasive Species Removal Events | Education & Outreach |
| 15-800 | 2015 | IRWP | \$213,722 | \$160,772 | 180 Education Events, 15 LID projects (raingardens and bioswales) | LID, Demonstration & Education |

Table 1. Projects, Partners, & Funding

Partners and Funding

| Partner Type | Agency | Funding | Notes |
|-----------------------|---|-------------|---|
| Federal | Clean Water Act Section 319 | \$2,285,793 | CWA 319(h) Grants |
| State | ARKANSAS DEPARTMENT OF AGRICULTURE NATURAL RESOURCES DIVISION | - | CWA 319(h) Grant Program Administrators |
| State | ARKANSAS FORESTRY COMMISSION | \$50,000 | Grant |
| State | ARKANSAS GAME AND FISH STREAM TEAM | - | |
| City | CITY OF FAYETTEVILLE | - | |
| City | CITY OF SPRINGDALE | - | |
| Conservation District | Washington County Conservation District | - | |
| County | WASHINGTON COUNTY ENVIRONMENTAL AFFAIRS | - | |
| County | WASHINGTON COUNTY NATURAL RESOURCES CONSERVATION SERVICE | - | |
| Other | ILLINOIS RIVER WATERSHED PARTNERSHIP | \$623,914 | In-kind Match |
| Other | FAYETTEVILLE ENVIRONMENTAL ACTION COMMISSION | - | |
| Other | FAYETTEVILLE NATURAL HERITAGE ASSOCIATION | - | |
| Other | VOLUNTEERS AND STAKEHOLDERS | - | In-kind Match |
| Other | BEAVER WATER DISTRICT | - | |
| Private Sector | BOTANICAL GARDEN OF THE OZARKS | \$33,403 | In-kind Match |
| University/College | UNIVERSITY OF ARKANSAS CROP SOIL AND | - | |

| | | | |
|--------------------|--|-----------|---------------|
| | ENVIRONMENTAL SCIENCE CLUB | | |
| University/College | ARKANSAS WATER RESOURCE CENTER | \$621,197 | In-kind Match |
| University/College | UNIVERSITY OF ARKANSAS MONTICELLO – FORESTRY RESOURCE CENTER | - | |
| University/College | UNIVERSITY OF ARKANSAS COOPERATIVE EXTENSION SERVICE | \$524,215 | In-kind Match |
| University/College | UNIVERSITY OF ARKANSAS MASTERS GARDENERS | - | |
| Other | WATERSHED CONSERVATION RESOURCE CENTER | - | |
| Other | ARKANSAS WATERSHED ADVISORY GROUP | - | |
| Other | LAKE FAYETTEVILLE WATERSHED PARTNERSHIP | - | |

Table 2. Summary statistics for E. coli numbers for the reach and individual sites on Clear Creek for each primary contact season (May-September). The table includes the number of samples collected (N), the geometric (Geo.), minimum (Min.), median (Med.), and maximum (Max.) E. coli as the most probable number (MPN) of colonies (col/100 mL). The percentage of E. coli measurements exceeding the limit of 410 col/100 mL (% Exc.) is also shown. Bold values for % Exc. represent a reach or stream that violated the applicable WQS in a given year (E. coli numbers exceeded 410 col/100 mL for more than 25% of the samples collected during the primary contact season; APCEC Regulation 2). Sites CC-B71 and CC-112 were new testing sites added in 2023 chosen for accessibility and proximity, but uncorrelated to previous sites. Data collection completed by the Arkansas Water Resources Center funded by 319 federal dollars.

| Site ID | Year | N | Geo. | Min. | 25th | Med. | 75th | Max. | % Exc. |
|---------|------|---|------|------|------|------|------|------|--------|
| CC029A | 2012 | 8 | 33 | 3 | 9 | 39 | 133 | 411 | 12.5 |
| | 2013 | 8 | 87 | 33 | 57 | 87 | 160 | 172 | 0 |
| | 2014 | 9 | 80 | 26 | 34 | 66 | 208 | 308 | 0 |
| CC-265 | 2023 | 9 | 222 | 69.7 | 148 | 172 | 204 | 579 | 11 |
| | 2024 | 9 | 127 | 40.8 | 87 | 126 | 147 | 236 | 0 |
| CC029B | 2012 | 8 | 187 | 45 | 116 | 184 | 297 | 921 | 12.5 |
| | 2013 | 8 | 67 | 36 | 41 | 73 | 92 | 148 | 0 |
| | 2014 | 9 | 116 | 48 | 68 | 99 | 243 | 378 | 0 |
| CC-WST | 2023 | 9 | 78.7 | 32.7 | 54 | 66.3 | 91 | 178 | 0 |
| | 2024 | 9 | 88 | 49.6 | 75 | 75.9 | 109 | 146 | 0 |
| CC029C | 2012 | 8 | 80 | 21 | 29 | 93 | 210 | 222 | 0 |
| | 2013 | 8 | 30 | 12 | 24 | 30 | 39 | 75 | 0 |
| | 2014 | 9 | 47 | 19 | 32 | 37 | 64 | 167 | 0 |
| CC-WRD | 2023 | 9 | 38.7 | 18.3 | 21 | 30.5 | 34 | 130 | 0 |
| | 2024 | 9 | 74.7 | 25 | 34 | 75.9 | 78 | 146 | 0 |
| CC029D | 2012 | 8 | 125 | 32 | 68 | 142 | 241 | 387 | 0 |
| | 2013 | 8 | 51 | 34 | 36 | 49 | 74 | 87 | 0 |
| | 2014 | 9 | 80 | 20 | 29 | 113 | 170 | 206 | 0 |
| CC-B71 | 2023 | 9 | 58 | 38.1 | 42 | 46.5 | 72 | 96 | 0 |
| | 2024 | 9 | 101 | 25.6 | 41 | 81.6 | 183 | 236 | 0 |
| CC029E | 2012 | 8 | 38 | 19 | 19 | 27 | 53 | 345 | 0 |
| | 2013 | 8 | 38 | 10 | 16 | 41 | 100 | 178 | 0 |
| | 2014 | 9 | 151 | 20 | 63 | 101 | 543 | 2420 | 22.2 |
| CC-112 | 2023 | 9 | 45.1 | 9.6 | 22 | 37.7 | 43 | 163 | 0 |
| | 2024 | 9 | 48.3 | 25.6 | 33 | 42.8 | 65 | 85.7 | 0 |

Table 2. Summary Stats for E.Coli

Table 3. Estimated load reductions per acre for urban best management practices using PLET modeling. Estimates are likely lower than actual values due to limited data in earlier projects.

| Pollutant | Estimated Reduction |
|----------------------------|---------------------|
| Phosphorus Effect (lbs/yr) | 724 |
| Sediment Effect (tons/yr) | 53 |
| Nitrogen Effect (lbs/yr) | 6,851 |

Table 3. Load Reductions



Raingarden Project



U.S. Environmental Protection Agency
Office of Water
Washington, DC

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