NONPOINT SOURCE SUCCESS STORY

Oklahoma

Local, Regional and State Partners' Efforts Improve Delaware Creek

Waterbody Improved

Oklahoma listed Delaware Creek on the Clean Water Act (CWA) section 303(d) list for total dissolved solids (TDS), *Escherichia coli*, and pH in 2004 and for turbidity and sulfates in 2008. Oil and gas extraction, illegal dumping, development and grazing contributed to these impairments. Remediating active and abandoned oil and gas sites, implementing conservation practices (CPs), and educating citizens and agencies resulted in improved land management practices and reduced illegal dumping, which decreased salt, sediment, bacteria and nutrient loading. As a result, the entire length of Delaware Creek was removed from Oklahoma's CWA section 303(d) list for pH (2006), *E. coli* (2008), TDS (2010), sulfates (2010), and turbidity (2012).

Problem

Delaware Creek is a 26.3-mile stream in Osage and Tulsa counties in northeastern Oklahoma. Land use in the 33,000-acre watershed is approximately 40% pasture and 54% forested. Less than 5% is developed. Oil and gas production is significant in the watershed (Figure 1). Poor management of agricultural and well-drilling areas contributed to degraded water quality, and its location near Tulsa made it a prime spot for illegal dumping at bridge crossings. After data showed violations of water quality standards in Delaware Creek, Oklahoma added the entire length of the creek (OK121300010150_00) to the CWA 303(d) list for numerous parameters: pH (2006), *E. coli* (2008), TDS (2010), sulfates (2010), and turbidity (2012) (Table 1). It is also listed as impaired for chloride (2004), dissolved oxygen (2004), and for nonsupport of benthic macroinvertebrates (2012).

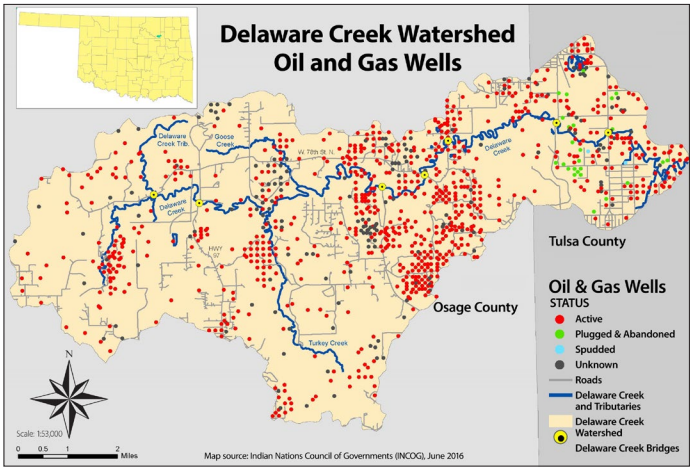

Figure 1. The Delaware Creek watershed is in an oil and gas resource-rich area of eastern Oklahoma, with more than 1,651 known wells drilled in the watershed. Over 80% of those wells remain active; 3% have been plugged.

Table 1. Delaware Creek assessment and CWA section 303(d) listing details.

Impairment	Applicable water quality standard	Listing date and justification	Delisting date and justification
Total dissolved solids	Pre-2010: No more than 396 mg/L; post-2010: No more than 10% may exceed 700 mg/L	2004: 63% samples exceeded WQS (19% exceeded when post-2010 WQS applied)	2010: From 2010 to 2016, 0% exceeded 700 mg/L; met WQS
Pathogens *(E. coli)*	May not exceed a monthly geometric mean (geomean) of 126/100 mL	2004: Geomean of 137/100 mL exceeded WQS	2008: Geomean of 98/100 mL; met WQS
pH	No more than 10% of samples may be outside of 6.5 – 9	2004: 12% of samples exceeded WQS	2008: 10% were outside range; met WQS
Turbidity	No more than 10% of seasonal baseflow samples may be above 50 NTU	2008: 11% of samples exceeded WQS	2012: 5% of samples exceeded 50 NTU; met WQS
Sulfates	Pre-2008, no more than 10% of samples could exceed 65 mg/L; post-2008, sample average cannot exceed 65 mg/L	2008: 24% of samples exceeded WQS	2010: sample average was 56 mg/L; met WQS

Notes: mg/L = milligrams per liter; mL = milliliters; WQS = water quality standards; NTU = nephelometric turbidity units

Project Highlights

Landowners implemented CPs with assistance from the Oklahoma Conservation Commission's (OCC) Locally Led Cost Share (LLCS) program and through the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP). Beginning in 2004, landowners installed 79 acres of prescribed grazing, 41 acres each of forage and biomass planting, 55 acres of nutrient management, seven ponds, 59 acres of upland wildlife habitat management, 1 acre of critical area planting, 2,463 linear feet of cross-fencing, 81 acres of rotation of supplement and feeding areas, and 110 acres of alley cropping. Landowners also implemented modified timing of fertilizer applications on 31 acres, integrated pest management on 186 acres, crop rotation and use of deep-rooted crops and reduced tillage on 17 acres, and improved irrigation efficiency on 13 acres.

The Indian Nations Council of Governments (INCOG) published a 2012 study which characterized the extent of DO problems in the watershed and evaluated contributing factors. In 2016, INCOG summarized oil and gas activity in the watershed to evaluate potential causes of salt contamination and actions that likely contributed to improvements. Although DO concentrations remain impacted by morphology of the stream and the lack of summer flow, DO has improved. INCOG has noted a gradual decrease in illegal dumping, perhaps due to education efforts and increased presence of agency personnel in the watershed.

The Oklahoma Energy Resources Board (OERB) restores abandoned oil and gas sites by removing abandoned equipment and contaminated materials and regrading and revegetating sites. OERB has restored 11 watershed sites since 2006. The Oklahoma Corporation Commission (Corp. Comm.) regulates oil and gas activities, including environmental sampling, permitting and response to complaints. Since the early 2000s, Corp. Comm. has conducted water quality monitoring and has overseen one enforcement and remediation case in the watershed.

The Oklahoma Blue Thumb Program maintained active volunteer monitoring sites on Delaware Creek between 1996 and 2010. Volunteers collect monthly water quality information and educate their communities about the importance of protecting water quality.

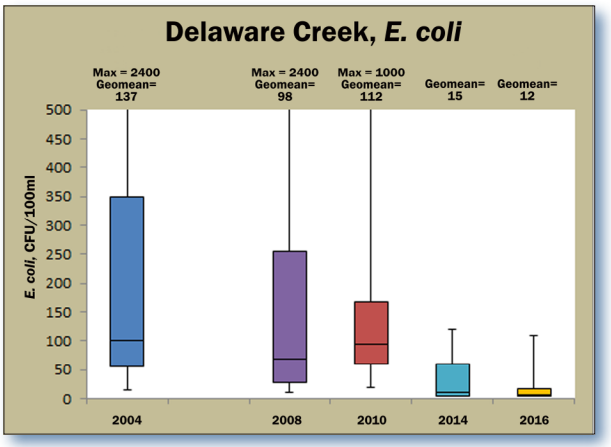

Figure 2. Monitoring data show improved *E. coli* levels.

Results

The OCC documented improved water quality through its monitoring program in turbidity, TDS, pH, sulfates, and *E. coli* (see Table 1, right column). Figure 2 shows *E. coli* levels over time. On the basis of these data, Oklahoma removed the following impairments from the state's CWA section 303(d) list: pH (2006), *E. coli* (2008), TDS (2010), sulfates (2010), and turbidity (2012). Delaware Creek remains listed for chloride, dissolved oxygen, and benthic macroinvertebrates.

Partners and Funding

The OCC monitoring program is supported by the U.S. Environmental Protection Agency's (EPA) CWA section 319 funds at an average annual statewide cost of $1 million; approximately $500,000 in EPA section 319 funds support statewide Blue Thumb. The OCC LLCS program provided $6,709 in state funding for CPs in this watershed through the Osage and Tulsa county conservation districts; landowners contributed an additional $6,854 in match. Beginning in 2004, NRCS supplied less than $215,000 to implement CPs in the watershed through NRCS EQIP and CSP. A large number of practices were funded by landowners based on recommendations through NRCS general technical assistance and conservation planning. INCOG invested at least $20,000 through an EPA CWA section 604(b) project to characterize the water quality problems in the watershed. OERB invested at least $105,000 to restore abandoned oil and gas sites in the watershed. OCC's activities have also played an important role in the water quality improvement.

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For additional information contact:

Shanon Phillips
Oklahoma Conservation Commission
405-522-4500 • shanon.phillips@conservation.ok.gov