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Prepared in cooperation with the Johnson County Stormwater Management Program

Effects of Contaminant Sources on Stream-Water Quality in Johnson County, Northeastern Kansas, October 2002 Through June 2004

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The U.S. Geological Survey (USGS), in cooperation with the Johnson County Stormwater Management Program, investigated selected streams in Johnson County, northeast Kansas, to determine the effects of point- and nonpoint-source contamination on stream-water quality and their relation to varying land use. Johnson County streams are an important resource for irrigation, drinking water, aquatic life, and recreation. Water-quality conditions were determined by collection and analysis of stream-water and streambed-sediment samples. The streams studied were located in urban areas of the county (Brush, Dykes Branch, Indian, Tomahawk, and Turkey Creeks), developing areas of the county (Blue River and Mill Creek), and in more rural areas of the county (Big Bull, Captain, Cedar, Kill, and Little Bull Creeks). The information from this study can be used by Johnson County officials to evaluate existing water-quality conditions, identify areas of potential point- and nonpoint-source contamination, and develop strategies to improve water-quality conditions.

This fact sheet summarizes the results of a water-quality investigation conducted in Johnson County from October 2002 through June 2004 (Lee and others, 2005). The complete report is available on the World Wide Web at: http://ks.water.usgs.gov/Kansas/studies/qw/joco

Introduction

Johnson County, located in northeast Kansas, is the most populous and fastest growing county in the State (U.S. Census Bureau, 2004). Increasing population has caused changes in land use, resulting in more residential, commercial, and industrial developments and increased impervious surface area (such as roads, houses, businesses, and parking lots), which may have a substantial effect on stream-water quality. This contamination may come from point sources (such as wastewater-treatment effluent) and nonpoint sources (such as stormwater runoff, leaky sewage lines, septic tanks, and atmospheric deposition). Stormwater runoff may contain contaminants as diverse as fecal contamination from pets, livestock, and wildlife to dissolved solids, hydrocarbons, and trace elements from roads and parking lots. These contaminants may remain dissolved in stream water, adsorb to streambed or suspended sediment, or accumulate in aquatic life.

Stream segments in five Johnson County watersheds (Blue River, Cedar Creek, Indian Creek, Kill Creek, and Mill Creek) have been designated as water-quality impaired, and the Kansas Department of Health and Environment (KDHE) has estab-

Base-flow condition

Stormflow condition

Photographs showing Indian Creek at State Line Road (site IN6, fig. 1) during base-flow and stormflow conditions.

lished section 303(d) listing and total maximum daily loads (TMDLs) for these stream segments (Kansas Department of Health and Environment, 2004b). TMDLs are quantitative objectives and strategies used to achieve water-quality standards. The water-quality standards constitute goals to fully support the designated uses of streams, lakes, and wetlands.

Johnson County municipalities are subject to the U.S. Environmental Protection Agency (USEPA) National Pollutant Discharge and Elimination System (NPDES) Phase II stormwater program designed to reduce the effects of stormwater runoff on surface-water quality. These regulations include establishing best management practices (BMPs) to curtail surface-water contamination from urban and suburban stormwater runoff.

Water-Quality Contaminants Studied

Several types of contaminants were analyzed that can affect the health and use of streams. Suspended sediment can destroy stream habitat and transport many other water-quality contaminants. Large concentrations of nutrients (nitrogen and phosphorus species) encourage excessive growth of algae and aquatic plants, which may produce taste-and-odor problems in drinking water, reduce dissolved oxygen concentrations, and potentially lead to fish kills. USEPA and KDHE have established recreational water-quality criteria that are based on the densities of fecal coliform, *Escherichia coli (E. coli)*, and enterococci bacteria in water that correlate to human illness (U.S. Environmental Protection Agency, 1986; Kansas Department of Health and Environment, 2004a). Trace metals and pesticides can persist in the environment, accumulate in streambed sediment and aquatic life, and may be toxic to humans and aquatic life. Organic wastewater compounds (chemicals used in and around the home, which typically are associated with wastewater effluent) and pharmaceutical compounds (prescription and nonprescription drugs, also associated with wastewater effluent) are potential environmental concerns because of possible physiological effects on aquatic life and as indicators of human-waste contamination.

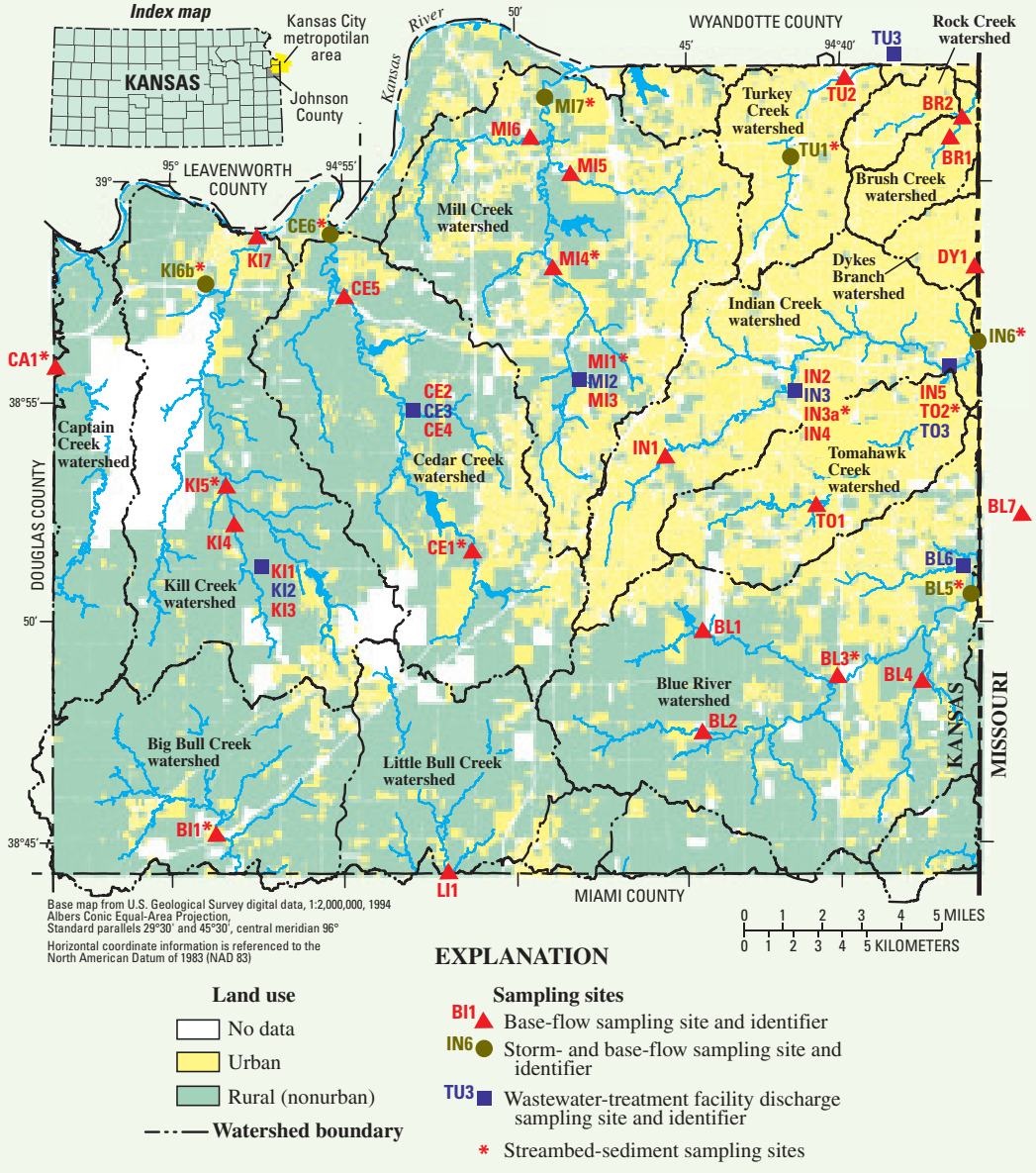

Figure 1. Urban and rural land use in Johnson County, northeast Kansas, 2003. Land use from Johnson County Automated Information Mapping System (written commun., 2003).

Watershed Descriptions

Urban development has changed the landscape of many Johnson County watersheds (fig. 1). Between 1990 and 2003, land parcels devoted to residential, business, and industrial uses have increased by 45 percent and in many of these watersheds constitute more than one-half of land uses (U.S. Census Bureau, 2004; Kevin Skridulis, Johnson County Appraiser's Office, written commun., 2004). In the five most urban watersheds, more than 20 percent of the total area is covered by impervious surfaces (roads, houses, businesses) (Shannon Porter, Johnson County Automated Information Mapping System, written commun., 2003). In addition to the changing landscape, 9 of 13 watersheds contain wastewater-treatment discharges. Seven of these discharges were sampled during this study.

Sample Collection

Base-flow samples were collected by USGS during sustained fair-weather streamflow conditions from 31 stream sites during November 4–7, 2002, and

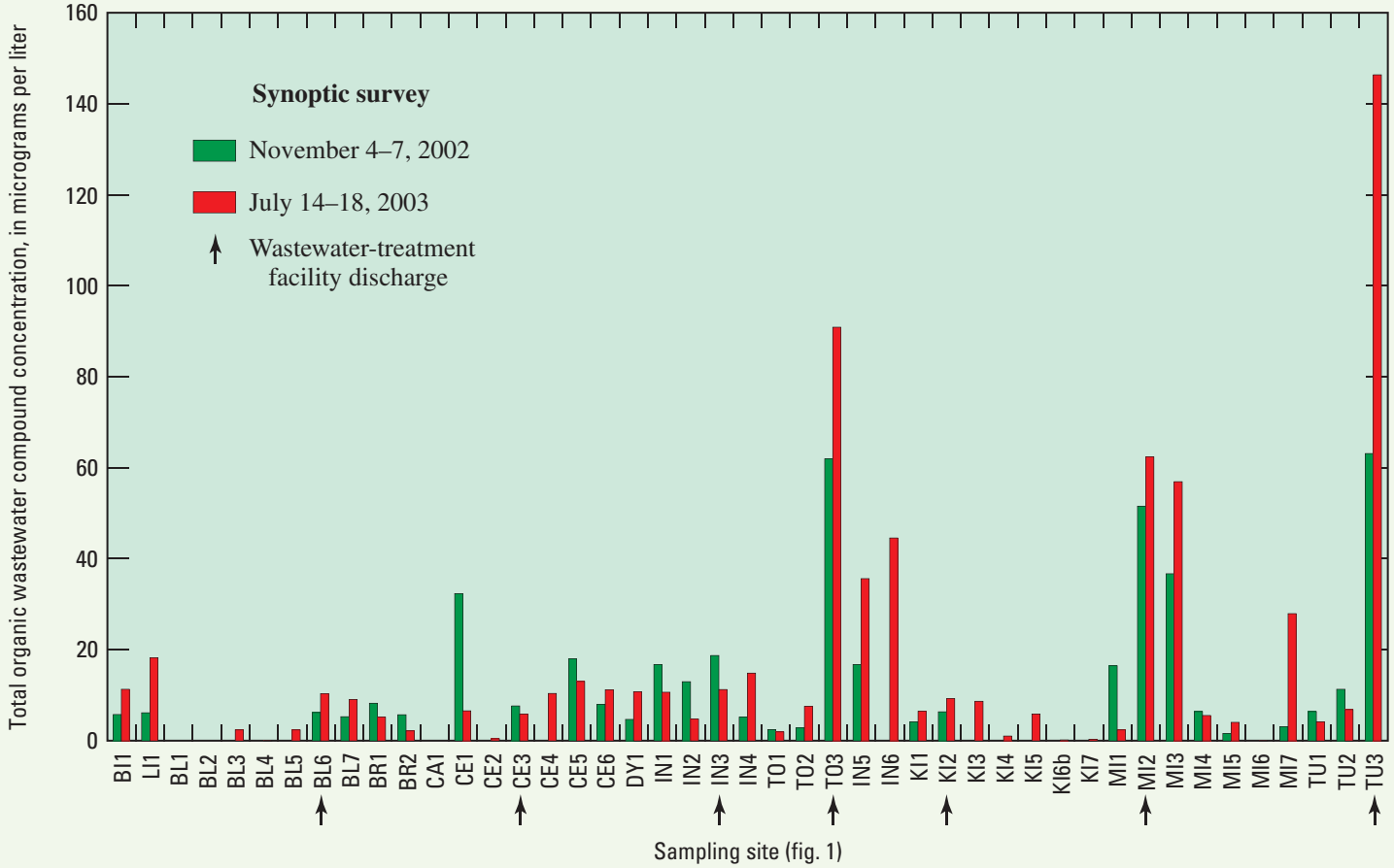

Figure 2. The largest concentrations of organic wastewater compounds were detected in samples from wastewater-treatment discharges with trickling-filter secondary treatment processes (sites MI2, TO3, and TU3).

from 42 sites during July 14–18, 2003 (fig. 1). A minimum of three stormflow samples were collected from six sites located in the Blue River, Cedar Creek, Indian Creek, Kill Creek, Mill Creek, and Turkey Creek watersheds from October 2002 through June 2004. Fifteen streambed-sediment samples were collected from nine watersheds from March 31 through April 3, 2003. Samples were analyzed for suspended sediment, dissolved solids and major ions, nutrients, fecal indicator bacteria, pesticides, and wastewater compounds. Selected samples also were analyzed for pharmaceutical compounds.

Point Sources of Water-Quality Contaminants

Wastewater-treatment facilities (WWTFs) were the major source of streamflow during base-flow sampling. Nutrients, wastewater, and pharmaceutical compound concentrations were largest during base flow at sites immediately downstream from WWTFs. Concentrations of these contaminants decreased in samples collected from sites farther downstream from WWTF discharges because of potential degradation, adsorption to streambed sediment, or consumption by aquatic biota.

Secondary treatment processes used by WWTFs appeared to affect the concentrations of many water-quality contaminants during base flow. Samples of discharge from two WWTFs with trickling-filter secondary treatment processes (sites TO3 and TU3) exceeded KDHE chronic aquatic-life use criteria for ammonia in surface water during the July 2003 base-flow synoptic survey (Kansas Department of Health and Environment, 2004a). Samples of discharge from trickling-filter facilities generally had the largest concentrations of wastewater compounds of all Johnson County stream-water samples (fig. 2). Concentrations of caffeine (stimulant), nonylphenol-diethoxylate (detergent surfactant), and tris(2-butoxyethyl) phosphate (flame retardant and plasticizer) in Johnson County WWTF discharges from sites TO3 and TU3 were larger than maximum concentrations in a comparable study in Minnesota (Lee and others, 2004). Concentrations of nutrients, silver, and most wastewater compounds were largest in streambed-sediment samples collected immediately downstream from WWTF discharges, indicating point-source contamination.

Nonpoint Sources of Water-Quality Contaminants

Land use and time of year affected the occurrence and magnitude of many water-quality contaminants originating from nonpoint sources. Samples collected during stormflow contained the largest suspended-sediment concentrations and fecal indicator bacteria densities, which may indicate that nonpoint sources were the primary sources of these constituents. Base-flow samples from sites located upstream from WWTF discharges in urban areas contained larger fecal indicator bacteria densities and wastewater compound concentrations than samples collected from sites upstream from WWTF discharges in rural areas. Dissolved-solids concentrations were largest in winter stormflow samples collected from urban sites likely because of runoff. A sample collected from site IN6 (Indian Creek at State Line Road) on January 26, 2004, had a chloride concentration of 1,000 milligrams per liter, which exceeded the

KDHE acute aquatic-life use criterion (860 milligrams per liter) likely due to effects from road-salt application (Kansas Department of Health and Environment, 2004a). Pesticide concentrations were the largest in spring stormflow samples collected in rural watersheds, likely because of agricultural pesticide application. 9,10-Anthraquinone (bird repellent), caffeine (stimulant), carbazole (component of coal tar and petroleum products), nonylphenol-diethoxylate (detergent surfactant), and tris(2-butoxyethyl) phosphate (flame retardant and plasticizer) also were detected at the largest concentrations (greater than 1 microgram per liter) of all wastewater compounds analyzed in stormflow samples at sites downstream from urban watersheds. Relatively large concentrations of wastewater compounds in stormflow samples indicate that these water-quality contaminants have nonpoint sources.

Streambed-sediment samples contained many water-quality contaminants that may have adverse effects on humans and aquatic life. Trace elements, total chlordane, total dichlorodiphenyl-trichloroethane (DDT), polyaromatic hydrocarbons (PAHs), and selected wastewater compounds were not as linked to WWTF discharges and had the largest concentrations in streambed-sediment samples collected from watersheds with primarily urban land uses.

Information to Protect Johnson County Streams

The information from this study can be used by Johnson County officials to evaluate the condition of Johnson County streams, identify potential source areas of contamination, and develop practices to reduce contaminant effects on Johnson County streams.

References

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USGS scientist measuring water-quality conditions at Mill Creek at Johnson Drive (site MI7).

For additional information on Johnson County water quality, visit the USGS Web site at:

http://ks.water.usgs.gov/Kansas/studies/qw/joco

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