KANSAS WATER QUALITY MONITORING AND ASSESSMENT STRATEGY, 2011–2015

Kansas Department of Health and Environment

Bureau of Environmental Field Services

Cover photograph: Kansas River, northwestern Shawnee County, Kansas
Photographer: Steve Cringan, Kansas Department of Health and Environment

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Final Report

December 21, 2010

Kansas Department of Health and Environment
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EXECUTIVE SUMMARY

Water quality monitoring and assessment operations in Kansas are administered primarily by the Kansas Department of Health and Environment. The department maintains several ongoing programs that collectively fulfill the environmental surveillance and reporting requirements of the Clean Water Act and provide the technical data needed to identify and respond to existing and emerging water pollution problems. This report summarizes the current scope and developmental status of these programs and presents recommendations for improving monitoring and assessment operations in the state during the upcoming planning period, 2011–2015.

Overview of Water Quality Monitoring Programs

Departmental monitoring operations currently focus on the condition of the state's surface water resources and involve two different but complementary conceptual approaches. The first approach involves a targeted survey design that focuses on selected stream reaches, lakes, and wetlands. The second approach involves a probabilistic survey design that assesses randomly chosen representatives from a given class of water bodies (e.g., wadeable streams, small lakes) and extrapolates the monitoring results to the entire population of water bodies in that class.

The targeted stream chemistry monitoring network consists of 329 sampling stations and generates physical, chemical, radiological, and microbiological data useful in the characterization of pollutant loadings from more than 97 percent of the state's contributing drainage area. Information derived from this network is applied in the development of total maximum daily loads (TMDLs) for water quality-limited streams and in the formulation of water quality-based permit limits for facilities discharging treated effluent to the waters of the state. Another targeted program, the stream biological monitoring program, evaluates the pollution-tolerance of benthic macroinvertebrate assemblages at approximately 180 locations in Kansas. Information from this program enhances the department's ability to detect water pollution problems, identify contaminants of concern, and develop defensible TMDLs and wastewater treatment plant permits.

The department also routinely surveys 119 publicly owned (or publicly accessible) lakes and wetlands. Physicochemical and biological data generated by this program are applied in the development of TMDLs and water quality-based permit limits, the resolution of toxic algal blooms and algal-related taste and odor problems, the characterization of lake trophic condition, and the tracking and prediction of long-term trends in surface water quality. Working with other state and federal agencies, the department also collects and analyzes fish tissue samples from streams and lakes throughout Kansas. Targeted monitoring efforts are limited annually to about 28 water bodies, including heavily fished reservoirs and certain streams with known water quality problems and existing fish consumption advisories.

The department also maintains a compliance monitoring program for evaluating the performance of discharging wastewater treatment facilities within the state. Samples of treated effluent are collected from about 20 facilities in any given year and subsequently analyzed to assess compliance with permit requirements. As needed, this program also conducts use attainability analyses (UAAs) to determine the classification status and attainable uses of individual water body segments receiving wastewater discharges.

The stream probabilistic monitoring network is predicated on a random, but spatially balanced, site selection process. Data on surface water chemistry, macroinvertebrate community composition, phytoplankton community composition, and in-stream physical habitat are obtained from 35 to 50 randomly selected sites annually, and a new set of sites is selected for monitoring each year. A similar approach is used to assess contaminant levels in fish inhabiting wadeable streams and small (but publicly managed) lakes. On average, fish tissue samples are obtained annually from about 15 randomly selected stream reaches and 15 randomly selected lakes. Data from the various probabilistic monitoring programs are applied by the department in statewide water quality assessments (discussed below) and in the screening of the entire state for water bodies warranting inclusion in targeted sampling activities.

The department also engages in a variety of short-term water quality investigations supportive of special regulatory initiatives or implemented in response to water quality emergencies such as contaminant spills, sewage bypasses, toxic algal blooms, or major fish kills. Additionally, the department works with other state and federal agencies and private organizations to support volunteer water quality monitoring programs, largely through the provision of grants and technical expertise. Although these programs serve an important educational function, volunteer monitoring data currently are not applied by the department in a formal diagnostic or regulatory context owing to quality assurance limitations.

Overview of Water Quality Assessment Programs

An updated version of the Kansas Integrated Water Quality Assessment (IWQA) is published by the department every two years, pursuant to the reporting requirements of the federal Clean Water Act. Sections 305(b) and 314(a) of the Act require a biennial assessment of surface water quality conditions, whereas section 303(d) calls for the development and maintenance of a list of water bodies failing to meet established water quality standards. Such water bodies are regarded collectively as "impaired waters." States are required under the Clean Water Act to take actions that improve the condition of impaired waters. These actions often include the development and implementation of TMDLs, water quality-based permit requirements, and/or nonpoint source (NPS) pollution control measures. The IWQA also contains information on upcoming water quality planning, monitoring, permitting, and pollution abatement initiatives in Kansas.

Data applied in the 305(b)- and 314(a)-related assessments are derived from the previously described departmental monitoring programs. Assessment criteria vary among sampling locations depending on the designated uses of the monitored water bodies. Measured water quality conditions are compared with applicable numeric and narrative criteria set forth in the Kansas surface water quality standards or in federal guidance documents. Water bodies are classified by the department as either fully supportive, partially supportive, or non-supportive of each designated use. The overall level of use support is calculated for the state's entire population of monitored streams, lakes, and wetlands and presented along with other relevant information in the IWQA. In the most recent (2010) IWQA, the monitored water body population accounted for nearly 70 percent of the state's total classified stream mileage and 90 percent of the state's total classified lake and wetland acreage.

Pursuant to section 303(d) of the Clean Water Act, the department maintains an inventory of all monitored streams, lakes, and wetlands within its borders failing to comply with applicable surface water quality standards. The aforementioned monitoring programs provide most of the data applied

in these 303(d)-based assessments. Supplemental sources of information include special water quality investigations, nonpoint source pollution surveys, drinking water source assessments, contaminant dilution calculations, trend analyses, predictive modeling, fish/shellfish consumption advisories, and information provided by other governmental agencies, academic institutions, and the general public. The most recently approved 303(d) list identifies 76 lake-related water quality impairments and 1,311 stream-related water quality impairments in Kansas. Waters listed on the 303(d) list are individually targeted for TMDL development according to a priority ranking established by the department and approved by the United States Environmental Protection Agency.

The department routinely engages in a number of other water quality assessment activities. For example, prior to the issuance of any permit that authorizes a facility to discharge treated effluent to the waters of the state, the department must certify, in writing, that the planned release of effluent will not result in violations of the Kansas surface water quality standards, other applicable state laws, or any federally promulgated water quality standards. The facility's probable impact on the quality of the receiving surface water is evaluated by the department. Limits on the release of certain pollutants are incorporated into the facility's discharge permit based on the receiving surface water's designated uses, estimated assimilative capacity, measured background (upstream) pollutant concentrations, and the projected mean and maximum rates of effluent discharge. Currently, about 1,040 municipal, industrial, commercial, and federal facilities in Kansas are authorized by the department to release treated effluent to the waters of the state.

The department also prepares a report each year describing the state's nonpoint source pollution control objectives, projects implemented during the previous year in support of these objectives, and documented improvements in water quality attributable to nonpoint source pollution control efforts. A variety of additional reports, special publications, and peer-reviewed journal articles are generated by the department to disseminate water quality information to the broader scientific community, elected officials, regulated entities, and the general public.

Gaps in Monitoring and Assessment Programs

Declining State General Fund allocations have led to the suspension of routine groundwater quality monitoring operations, to a steep reduction in compliance monitoring activities, and to a marked decrease in the number of departmental employees engaged in surface water quality monitoring and assessment. Current funding levels preclude the collection of representative water quality data from the state's largest stream, the Missouri River. The department also lacks the resources needed to analyze water, sediment, and fish tissue samples for certain industrial contaminants, agricultural chemicals, pharmaceutical products, algal toxins, and other substances believed to be widely present in the ambient environment. Budgetary enhancements needed to resume historical levels of groundwater and surface water quality monitoring are considered unlikely in the near future. The department has looked increasingly to federal sources of funding for program support.

Recommended Improvements

The department will endeavor to implement a number of improvements in its surface water quality monitoring and assessment programs during the upcoming five-year planning period. Specifically, it will attempt to:

(1) work with other natural resource agencies in Kansas (and with counterpart agencies in adjoining states) to develop a comprehensive water quality monitoring program for the lower Missouri River;

(2) enhance monitoring efforts within watersheds specifically slated for TMDL development, primarily by establishing additional stream monitoring locations at the sub-watershed level;

(3) add several more synthetic organic compounds and naturally occurring algal toxins to the department's list of core and supplemental water chemistry parameters;

(4) maintain the recently implemented geometric mean-based monitoring program for the bacterium *Escherichia coli*, adhering to a five-year (basin-by-basin) rotational schedule consistent with TMDL and National Pollutant Discharge Elimination System (NPDES) permit development activities;

(5) confirm the status of all candidate reference streams in Kansas while working concurrently with other governmental agencies and private stakeholders to protect and maintain the ecological integrity of these streams;

(6) begin assessing stream biological communities on the basis of taxonomic completeness (defined as the proportion of expected taxa actually observed during monitoring activities, or O/E) and also begin applying O/E modeling approaches in statewide (305(b)-based) water quality assessments;

(7) publish a comprehensive report, for the public at large, addressing the current status of the state's surface water and groundwater resources and emphasizing documented improvements in water quality and remaining/emerging challenges in the field of water pollution control;

(8) complete quality control evaluations of all departmental water quality databases as a precursor to uploading this information and related metadata to the modernized federal (STORET WQX) water quality database;

(9) train additional employees in specific sampling, analytical, and taxonomic skills to foster redundant capabilities in the event of retirement, injury, illness, or other factors leading to the loss or temporary absence of monitoring staff; and

(10) implement measures needed to recruit and retain qualified analytical chemists, in support of the department's surface water quality monitoring and assessment programs.

The successful implementation of these recommendations will depend, in large part, on the maintenance of current levels of funding for water quality surveillance and reporting activities. Other needed improvements are unlikely to be implemented during the upcoming planning period owing to budgetary constraints at both the state and federal level. These improvements include the reinstatement of the groundwater quality monitoring program and the procurement of additional and/or more stable sources of funding for water quality monitoring and reporting operations.

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INTRODUCTION

The Clean Water Act provides the overarching federal mandate and statutory context for state water quality monitoring and assessment programs. Pursuant to this law, all states are required to monitor the physical, chemical, and biological condition of their surface water resources and strongly encouraged to monitor groundwater quality. States also are required to update water quality information annually, to comprehensively report on water quality conditions on a biennial basis, to develop and maintain a list and priority ranking of water quality-limited surface waters, and to report each year on improvements in water quality resulting from nonpoint source pollution control efforts. The Clean Water Act prohibits the transfer of certain federal funds to any state failing to comply with these basic monitoring and reporting requirements (Appendix A).

In Kansas, water quality monitoring and assessment responsibilities rest primarily with the Kansas Department of Health and Environment (KDHE). State law compels the department to "investigate and report upon all matters relating to water supply and sewerage and the pollution of the waters of the state" (Kansas Statutes Annotated (K.S.A.) 65-170). Waters of the state are legally defined as "all streams and springs and all bodies of surface and subsurface water within the boundaries of the state" (K.S.A. 65-161(a)). Water pollution is defined, in part, as "contamination or other alteration of the physical, chemical or biological properties of any waters of the state...likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, or to the plant, animal or aquatic life of the state or to other designated beneficial uses" (K.S.A. 65-171d(c)).

This report evaluates the current status of water quality monitoring and assessment programs administered by KDHE and presents recommendations for improving these programs during the upcoming planning period, 2011–2015. Administrative and environmental benefits potentially derivable from the adoption of these recommendations include, but are not necessarily limited to, an enhanced departmental eligibility for federal funds, improved interagency collaboration, more cost effective scrutiny of natural resource conditions, and more expeditious targeting, prioritization, and resolution of water quality problems. In developing this report, KDHE has considered and incorporated the most recent federal guidance for state water quality monitoring and assessment programs (EPA 2003a).

The remainder of this document is presented in three major sections. The first provides a general overview of the state's surface water and groundwater resources. The second describes water quality monitoring and assessment programs currently administered by KDHE in terms of overall programmatic objectives, monitoring network design, core and supplemental water quality parameters, quality assurance features, requirements for data management, analysis and reporting, and administrative mechanisms for program evaluation and infrastructure planning. The final section of this report discusses (a) preferred options for improving the department's water quality monitoring and assessment programs during the upcoming five-year planning period and (b) emerging issues less likely to be resolved during this time frame but meriting consideration in the department's longer term planning efforts.

KANSAS WATER RESOURCES

Statewide Water Budget

More than 98 percent of all water entering Kansas arrives in the form of precipitation. Although the total amount of precipitation varies from year to year, the running average computed over several decades remains nearly constant (Sophocleous 1998). Annual precipitation across the state averages 27 inches (69 cm) but ranges geographically from about 15 inches (38 cm) along the Colorado border to more than 40 inches (102 cm) in several southeastern counties (Goodin *et al.* 1995). Evapotranspiration returns about 86 percent of the state's precipitation back to the atmosphere, with most of the remainder entering streams as surface runoff (10 percent) or groundwater aquifers as natural recharge (3 percent). Streams flowing into Kansas from Colorado and Nebraska provide a statewide annual rainfall equivalent of less than 0.4 inches (1.0 cm), whereas streams flowing from Kansas into Missouri and Oklahoma export a rainfall equivalent of nearly 3 inches (7.6 cm). In years of average flow, the Missouri River carries an additional 32 million acre-feet (40 billion m^3) of water, or a statewide rainfall equivalent of 7.3 inches (18.5 cm), past the northeastern border of Kansas into western Missouri (Sophocleous and Wilson 2000).

Kansans divert approximately 6.8 million acre-feet (8.4 billion m^3) of water per year, on average. Groundwater diversions comprise about 72 percent of this total and are dominated strongly by irrigation withdrawals. Surface water diversions account for the remaining 28 percent and are dominated by cooling water withdrawals for electrical power generation (Sophocleous 1998; Sophocleous and Wilson 2000). Water usage varies from year to year depending on weather conditions, market and regulatory forces, and other factors. The following table itemizes water usage in Kansas during calendar year 2005 based on the most recently compiled information.

Table 1. Estimated water withdrawals in Kansas during calendar year 2005 by water use category (adapted from Kenny et al. 2009; Joan Kenny, U.S. Geological Survey, pers. comm. 2010). Values are expressed in units of thousand acre-feet (and million m^3) and may not add precisely to totals owing to independent rounding.

Water	Water Use Category								
Source:	Public	Domestic	Commercial	Irrigation	Livestock	Industrial	Mining	Thermoelectric	Total
Surface water	272 (335)	< 0.1 (< 0.1)	0.1 (0.2)	128 (158)	30.3 (37.3)	7.1 (8.8)	5.2 (6.4)	1,474 (1,817)	1,916 (2,363)
Ground-water	179 (221)	16.7 (20.6)	4.5 (5.6)	2,941 (3,626)	96.7 (119)	39.8 (49.1)	11.3 (14.0)	15.0 (18.5)	3,305 (4,075)
Total	451 (556)	16.7 (20.6)	4.7 (5.8)	3,069 (3,784)	127 (157)	46.9 (57.9)	16.5 (20.4)	1,489 (1,835)	5,221 (6,437)

Surface Waters

Streams and springs

Kansas surface water quality regulations (K.A.R. 28-16-28b *et seq*.) define streams as "rivers, creeks, brooks, sloughs, draws, arroyos, canals, springs, seeps, and cavern streams, and any alluvial aquifers associated with these surface waters...." The state contains an estimated 24,000 miles (38,600 km) of perennially flowing streams, 110,000 miles (177,000 km) of intermittent streams, and 400 miles (640 km) of agricultural canals and ditches (USGS 2005). Average annual runoff ranges from less than 0.1 inch (0.26 cm) in some western counties to 10 inches (27 cm) in extreme eastern Kansas (Wetter 1987); consequently, perennial streams are much more prevalent in the eastern half of the state (Figure 1). Throughout much of western Kansas, intensive irrigation has contributed to a progressive lowering of the groundwater table and a concomitant decline in stream flow and perennial stream mileage (*e.g.*, Jordan 1982; Cross *et al.*1985; Angelo 1994; Schloss *et al.* 2000). The Kansas surface water register lists nearly 28,000 miles (45,000 km) of streams as classified waters subject to the application of numeric water quality criteria (KDHE 2009b). Recent legislation (K.S.A. 82a-2001 *et seq.*) has shifted regulatory focus away from streams with estimated median flows of less than 1.0 cfs (< 2,450 m^3 day^{-1}) (Perry *et al.* 2004).

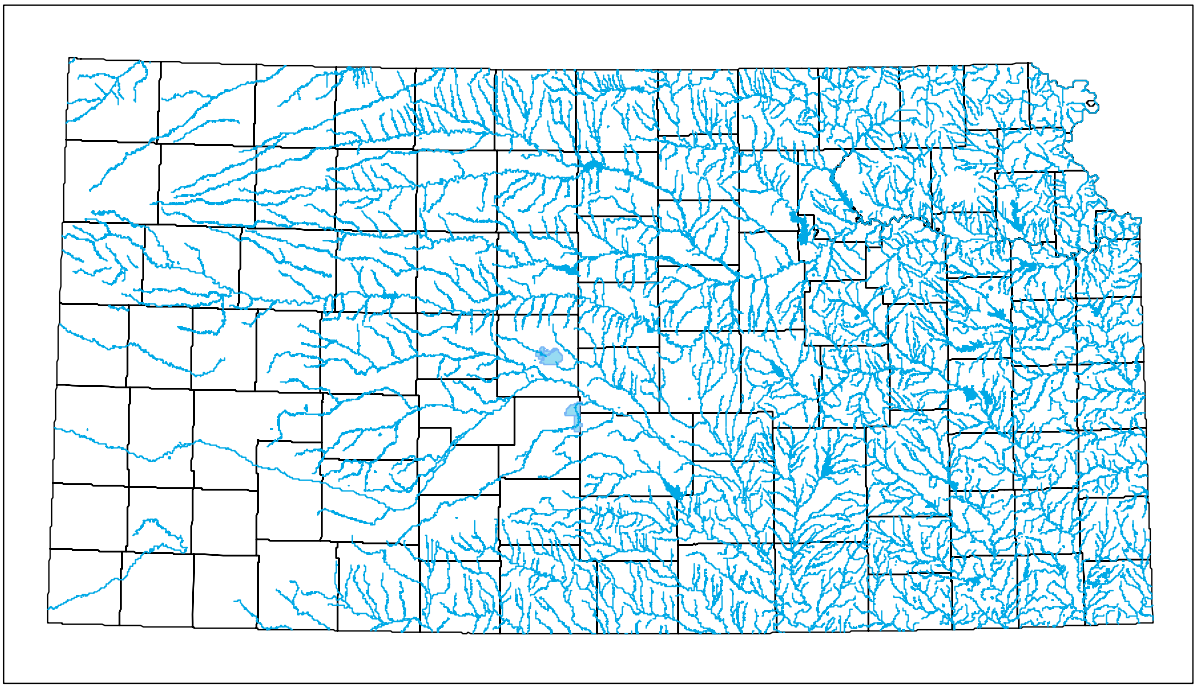

Figure 1. Major classified streams, lakes, and wetlands in Kansas (KDHE 2009, 2010).

Springs comprise an important category of flowing waters, often supporting unique assemblages of plants and animals, sustaining stream flow during periods of limited precipitation, and serving as sources of water for communities and farmsteads. For the purposes of this report, springs are defined as "places where [groundwater] flows naturally from the earth into a body of surface water or onto the land surface, at a rate sufficient to form a current" (Buchanan *et al.* 1998). Sawin *et al*. (2002) have compiled water quality data and other descriptive information for 249 "significant and representative" Kansas springs with flows ranging from less than 1.0 to 1,800 gpm (< 5 to 9,800 m^3 day^{-1}). To date, property access limitations and other factors have precluded a more comprehensive inventory of springs in Kansas.

Lakes and reservoirs

Kansas water quality regulations define lakes as all "oxbow lakes and other natural lakes and man-made reservoirs, lakes, and ponds." Although natural lakes are relatively uncommon in Kansas, the state's total number of dams (registered and unregistered) and associated impoundments has been estimated conservatively at 120,000 (KSBA 1992). This figure is dominated overwhelmingly by water bodies smaller than two acres (0.8 ha) and includes privately owned farm ponds and other smaller impoundments. According to the National Inventory of Dams (USACE 2005), Kansas contains approximately 5,900 larger earthen dams and associated impoundments, most located in the eastern third of the state. Twenty-nine reservoirs in Kansas exceed one square mile (2.6 km^2) in surface area and 32 feet (~10 meters) in maximum depth. Many of the state's larger reservoirs were developed originally for a combination of flood control, water supply, and recreational purposes, and nearly 100 are utilized currently as public drinking water sources. The majority of these reservoirs were developed 40 to 50 years ago, and several have experienced a significant decline in water storage capacity as a result of sediment accumulation (KWA 2010). The Kansas surface water register currently identifies 326 classified (publicly owned or publicly accessible) lakes with a combined surface area of about 190,000 acres (76,900 ha) (KDHE 2009b, 2010d).

Wetlands

The term "wetland" is defined by the Kansas standards as any water body "meeting the technical definition for jurisdictional wetlands given in the corps of engineers wetlands delineation manual...." Based on a somewhat less restrictive definition considering hydrological, soil, and/or biological criteria, the United States Fish and Wildlife Service has estimated the total wetland acreage for the state at 435,400 acres (176,200 ha) or approximately one-half the estimated pre-settlement coverage of 841,000 acres (340,400 ha) (Dahl 1990). Despite this historical loss of wetland resources, the state continues to maintain a number of major wetland complexes of regional and even international importance. The largest include Cheyenne Bottoms, a 14,000 acre (5,700 ha) freshwater marsh in Barton County, and the Quivira Big and Little Salt Marshes, covering a combined area of about 22,000 acres (8,900 ha) in neighboring Stafford, Rice, and Reno counties. These water bodies and several other major wetlands in Kansas are critical stopover points for migratory waterfowl and attract thousands of tourists each year (*e.g.*, Zimmerman 1990). The Kansas surface water register currently identifies 35 classified (publicly owned or publicly accessible) wetlands with a combined surface area of about 56,000 acres (22,700 ha) (Carney 2002; KDHE 2009b, 2010d).

Groundwater

Kansas regulations broadly define groundwater as "water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers or the soil profile" (K.A.R. 28-16-28b(dd)). Although the state has no formal groundwater quality standards, application of the groundwater recharge use to many classified streams is intended to prevent "statistically significant increase[s] in the concentration of any chemical or radiological contaminant or infectious microorganism in groundwater resulting from surface water infiltration or injection" (K.A.R. 28-26-28d(b)(5) and 28-16-28e(c)(5)). Groundwater resources are extensive in the western two-thirds of the state but less common and more localized in the eastern third (Figure 2). This disparity has contributed to a greater agricultural utilization and dependence on irrigation in western Kansas. Much of this region has experienced a significant decline in groundwater levels since the advent of center pivot irrigation in the late 1950s and early 1960s (*e.g.*, Jordan 1982; Cross *et al.*1985; Schloss *et al.* 2000). The total amount of freshwater storage in the state's major aquifers has been estimated at 590 million acre-feet (730 billion m^3), more than 90 percent of which is held in the High Plains/Great Plains aquifer complex of western and central Kansas (Hansen 1991).

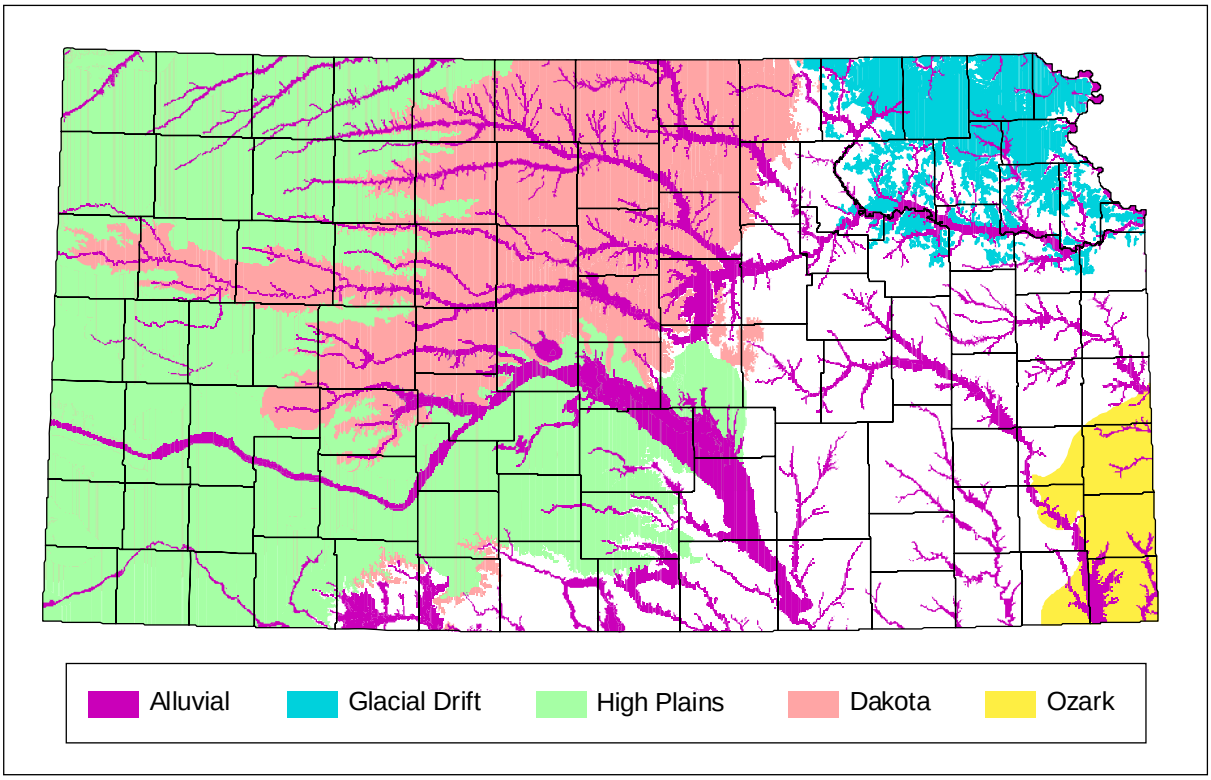

Figure 2. Major groundwater aquifers in Kansas (adapted from Buchanan and Buddemeier 1993).

STATUS OF KANSAS WATER QUALITY MONITORING AND ASSESSMENT PROGRAMS

Allocation of Duties

Water quality monitoring and assessment programs within KDHE are administered by the Division of Environment's Bureau of Environmental Field Services (BEFS) and Bureau of Water (BOW), with analytical support from the Kansas Health and Environmental Laboratories, computer programming and networking assistance from the Office of Information Technology, and consultative input from the Division of Health (Figure 3). The department also works cooperatively with various other agencies and organizations in the acquisition and interpretation of water quality data (discussed below). Routine monitoring operations are implemented by the BEFS Technical Services Section, which maintains offices in downtown Topeka and employs 11 full-time environmental scientists and one full-time environmental technician. Six district offices are maintained by BEFS, and two of these, located in Dodge City and Hays, assist with the collection of water quality samples from sites in far western Kansas. The district offices work cooperatively with the Technical Services Section in the planning and performance of special water quality investigations, such as those occurring in the aftermath of major pollutant spills, toxic algal blooms, and fish kills.

Assessment duties associated with the development of the 305(b)-related portion of the IWQA are implemented by the BEFS central office with input from BOW. The BEFS Technical Services Section is responsible for coordinating this effort and editing the final 305(b) assessment. Conversely, duties associated with the review and revision of the Kansas list of water quality-limited surface waters (*i.e.*, 303(d) list) and development of total maximum daily loads (TMDLs) are implemented by BOW with input from BEFS. Within BOW, the Watershed Planning Section is responsible for formulating the 303(d) list, assigning priority rankings to listed surface waters, and developing TMDLs for these waters. Other units engaged in assessment activities include the BOW Technical Services Section, which analyzes stream flow and water quality data in the derivation of National Pollutant Discharge Elimination System (NPDES) permit limits for wastewater treatment plants and other discharging facilities, and the BOW Watershed Management Section, which evaluates improvements in water quality resulting from the implementation of nonpoint source (NPS) pollution control programs.

Overview of Current Monitoring Operations

The Division of Environment traditionally has endeavored to maintain a comprehensive water quality monitoring program addressing the physicochemical and biological properties of all waters of the state. However, budgetary shortfalls in recent years have led to the suspension of routine groundwater quality monitoring operations (discussed below). Divisional monitoring efforts now focus almost exclusively on the major inland surface water categories: streams, lakes, and wetlands.

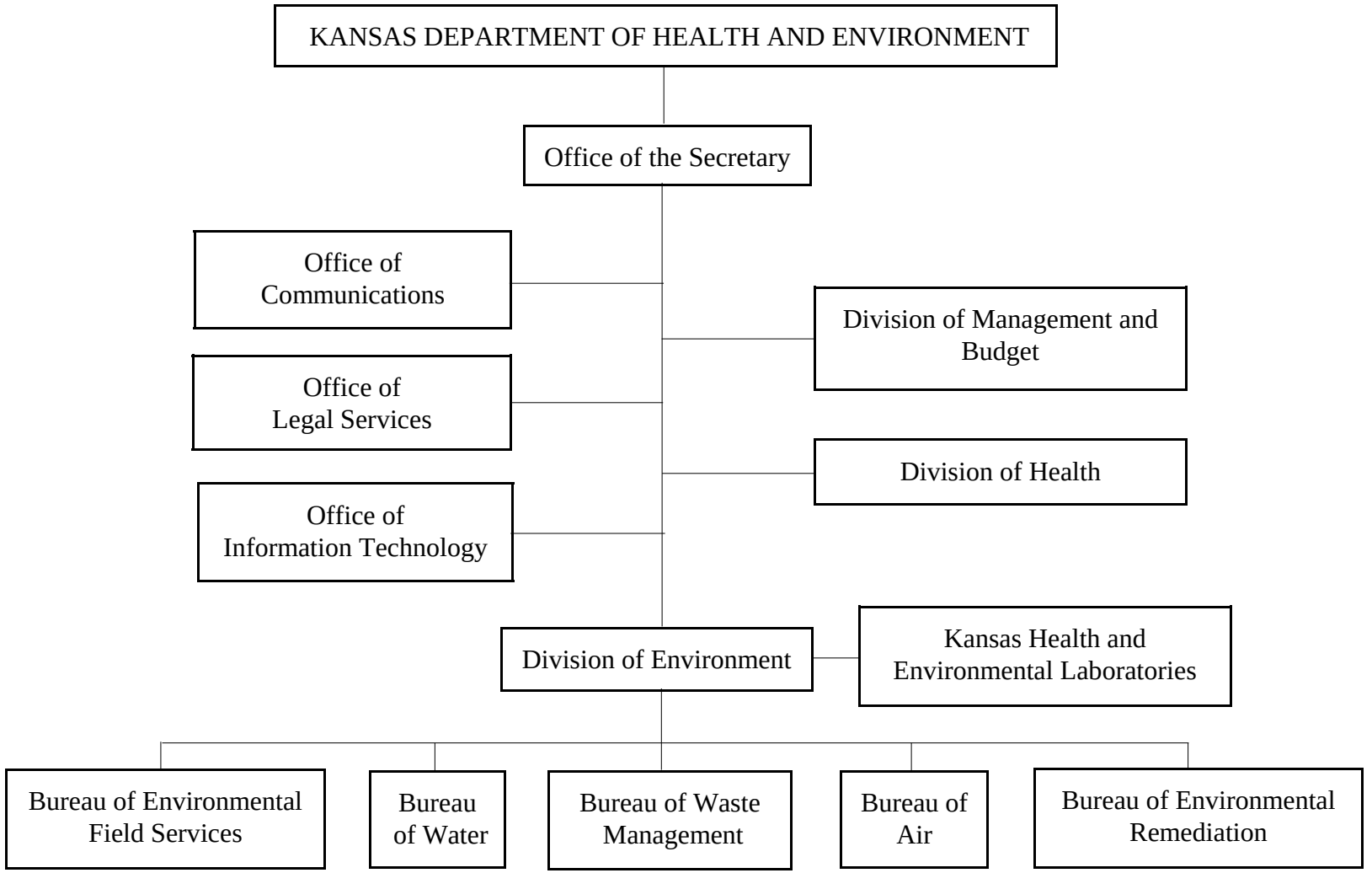

Figure 3. Major organizational subunits within the Kansas Department of Health and Environment. Water quality monitoring and assessment duties within the Division of Environment are implemented primarily by the Bureau of Environmental Field Services and Bureau of Water. See text for details.

The following paragraphs briefly describe the department's major water quality monitoring programs as well as cooperative monitoring efforts involving other governmental agencies, academic institutions, and private organizations. For additional information on the developmental history and current status of these monitoring programs, the reader is referred to the applicable quality assurance program plans (QAPPs) and standard operating procedures (SOPs) posted on the departmental quality assurance website (http://www.kdhe.state.ks.us/environment/index.html).

Monitoring Goals and Objectives

The Kansas Department of Health and Environment relies on timely, accurate, and properly interpreted water quality data to guide the efforts of its various water pollution control programs and, ultimately, to protect and restore the physical, chemical, and biological integrity of the waters of the state. Although each monitoring program is designed around its own unique set of objectives (as set forth in a written QAPP), essentially all monitoring programs lend themselves to the performance of the following tasks:

(1) fulfilling the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1), 303(d), 305(b), 314(a), and 319(h) of the Clean Water Act;

(2) evaluating compliance with the provisions of the Kansas surface water quality standards (K.A.R. 28-16-28b *et seq.*);

(3) identifying point and nonpoint sources of pollution contributing most significantly to documented water use impairments;

(4) documenting spatial and temporal trends in water quality resulting from changes in prevailing climatological conditions, land use/land cover, natural resource management practices, wastewater treatment plant operations, and other factors;

(5) developing scientifically defensible environmental standards, wastewater treatment plant permits, and water body-specific (or watershed-specific) pollution control plans; and

(6) evaluating the effectiveness of pollution control efforts and water body remediation and restoration initiatives implemented by the department and other natural resource agencies.

Stream Chemistry Monitoring Program

The stream chemistry monitoring program is the largest and longest running environmental monitoring operation administered by the BEFS Technical Services Section. Water samples are obtained routinely from streams throughout Kansas (Figure 4) and analyzed for a large suite of physical, organic, inorganic, radionuclide, and bacteriological parameters (Appendix B). The program database currently comprises over 2.3 million records representing nearly 400 active and inactive monitoring locations and approximately 100 different analytical parameters. Some records in the database date to the late 1960s, and several monitoring sites have a continuous period-of-record extending from that time to the present (KDHE 2010g).

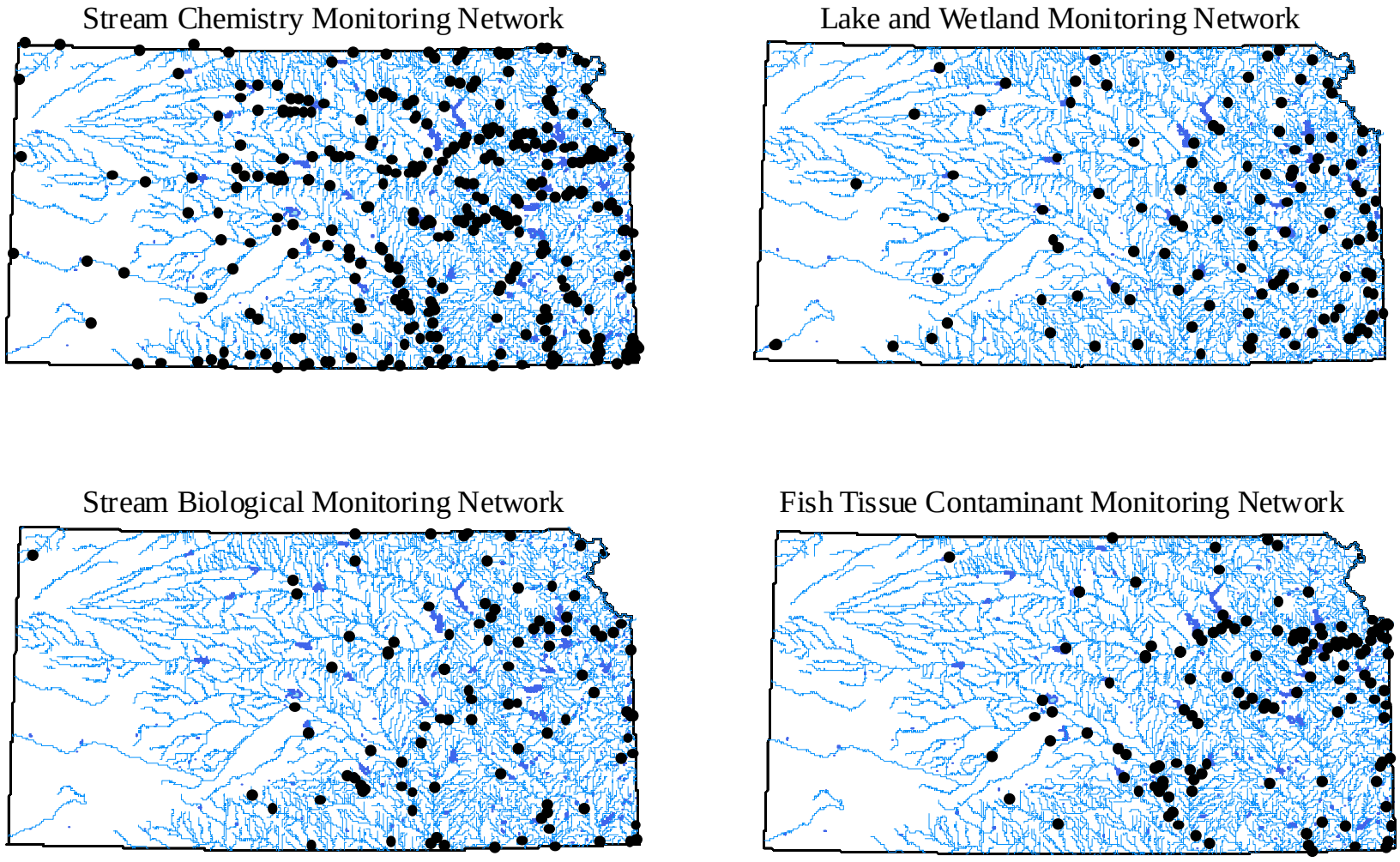

Figure 4. Location of targeted monitoring sites currently included in surface water quality surveillance networks administered by the Kansas Department of Health and Environment.

Currently, the stream chemistry sampling network is comprised of 329 monitoring sites spanning all the major river basins and physiographic regions of Kansas. About 167 core sites are visited by staff on a quarterly basis every year, whereas the remaining 162 sites are monitored using a four-year rotational approach; *i.e.*, samples are collected quarterly from approximately 25 percent of these sites each year. Sampling stations have been chosen to represent water quality conditions in specifically targeted watersheds or stream reaches. For example, some sites reflect water quality conditions in streams as they enter or exit Kansas, others represent conditions above or below major discharging facilities, urban areas, or reservoirs, and still others reflect water quality conditions in predominantly rural watersheds. Several "least impacted" reference streams have been included in the network to gain a better understanding of baseline water quality conditions in the various ecoregions of Kansas (*cf.*, Chapman *et al.* 2001; Angelo *et al.* 2010). Stream reaches hosting monitoring sites range in size from first to eighth order on the Strahler scale (Strahler 1957). As currently configured, the network provides water quality information useful in the characterization of pollutant loadings from more than 97 percent of the state's contributing drainage area. Many monitoring sites are located near the lower terminus of eight-digit hydrological unit code (HUC) watersheds and play an important role in the development and refinement of TMDLs for 303(d)-listed streams (discussed below).

Stream Biological Monitoring Program

This program examines the structural attributes of aquatic macroinvertebrate assemblages and utilizes this information to provide a more refined picture of the ecological status of streams in Kansas. Unlike water chemistry measurements alone, which reflect conditions occurring at the moment of sample collection, biological monitoring provides an integrated measure of environmental condition over time frames ranging from weeks to years, depending on the biological assemblage of interest. The KDHE aquatic macroinvertebrate database currently contains 65,000 high resolution (predominantly genus/species level) records, and a separate freshwater mussel database contains about 14,000 high resolution records. For taxonomic confirmation and training purposes, mussel shell specimens represented in the database are archived permanently by BEFS, and all general macroinvertebrate samples are retained in storage for a minimum of five years (KDHE 2010f).

The macroinvertebrate sampling network includes 180 monitoring sites distributed throughout the state (Figure 4). Samples normally are obtained from 35–50 sites each year, including 35 core stations and 15–20 rotational stations sampled three consecutive years per rotation. The remaining sites in the sampling network represent short-term monitoring stations that are visited by staff on a sporadic basis as dictated by TMDL development needs or other regulatory considerations. As weather conditions allow, monitoring activities at all sites adhere to a seasonal rotation to reduce statistical bias and provide a more comprehensive picture of the resident macroinvertebrate communities; *i.e.*, samples are collected during the spring of one year, the summer of the next, and the fall of the next, a cycle that is repeated every three years (core sites) or every rotational sequence. Streams hosting core or rotational monitoring sites range in size from second to eighth order on the Strahler scale; approximately 50 percent of these sites are located on fifth or sixth order streams and 80 percent are located on fourth to seventh order streams. The sampling network incorporates a targeted monitoring strategy comparable to that employed in the stream chemistry monitoring program (KDHE 2010f).

Lake and Wetland Monitoring Program

This program surveys water quality conditions in publicly owned and publicly accessible lakes and wetlands throughout Kansas. Individual water bodies are visited by staff on a 3–5 year rotational schedule, and field measurements and subsequent laboratory analyses provide data on a large suite of physical, organic, inorganic, and biological (phytoplankton, macrophyte) parameters (Appendix B). The program's primary database now contains more than 260,000 analytical records representing more than 300 water bodies. Watersheds associated with many of these monitored lakes and wetlands are periodically surveyed with respect to prevailing land use/land cover and the location and size of any discrete pollutant sources (wastewater treatment plants, feedlots, etc.). Macrophyte community composition and aerial macrophyte coverage also are evaluated in selected water bodies smaller than 250 acres (~100 ha). Information derived from these ancillary activities improves the department's ability to estimate contaminant fluxes, characterize lake trophic conditions, predict future changes in these conditions, and assess the need for regulatory intervention (KDHE 2010e).

Water quality information currently is obtained from 119 lakes and wetlands distributed throughout the state (Figure 4). These include all 24 federal reservoirs, most state-administered fishing lakes (those retaining open water in most years), various other state, county, or locally owned lakes, several privately owned but publicly accessible lakes, and seven state or federally owned marshes. Because only a few of these water bodies are naturally occurring, an effort has been made to identify reservoirs in least disturbed watersheds to serve the function of reference ecosystems (Carney 1989–2010, 2002; Dodds *et al.* 2006). This program routinely shares a large amount of data and expertise with other agencies and organizations involved in lake and wetland management, environmental restoration, water quality monitoring, and environmental education. Additional collaborative efforts have addressed the abatement of toxic algal blooms and taste/odor problems in public drinking water supply reservoirs (Pope *et al.* 1985; Arruda and Fromm 1989; Carney 1989–2010, 1993a–b, 1994, 1996, 1998a–c; KDHE 1996a–e).

Fish Tissue Contaminant Monitoring Program

This program generates information on contaminant levels in fish obtained from Kansas streams and lakes. Whole-fish samples (composite samples of 3–6 individuals) are obtained every other year from eight long-term monitoring sites, transferred to the EPA Region 7 laboratory in Kansas City, and analyzed for organochlorine pesticides, polychlorinated biphenyls, toxic metals, and other bioaccumulative contaminants. The resulting database allows the department to track the prevalence of these contaminants within the ecological food web and to ascertain temporal and spatial trends in environmental condition. Composite fillet samples also are obtained annually from a variable number of targeted and randomly selected sites and analyzed for contaminants of human health concern. In recent years, such samples have been obtained annually from 11 targeted and 15 randomly selected stream sites, 17 targeted Class A lakes (primarily large federal reservoirs), and 15 randomly selected Class B lakes (smaller lakes supporting managed fisheries) (Figures 4–5).

The Kansas fish tissue database currently contains nearly 19,000 records, representing more than 200 sites and about 200 (83 detected) contaminant parameters (KDHE 1987, 1988a–b, 2010c; Cringan 1989, 1991) (Appendix B). In consultation with the Kansas Department of Wildlife and Parks (KDWP), KDHE staff annually evaluate the available data to determine the need for issuing, rescinding, or modifying local fish consumption advisories. Although chlordane traditionally has

been viewed as the contaminant of greatest concern (Arruda *et al.* 1987a–b; KDHE 1988a–b), chlordane concentrations in fish have declined dramatically in recent years and attention has shifted gradually to mercury, polychlorinated biphenyls, and a few other persistent contaminants. The department has begun to devote a greater proportion of its monitoring resources and laboratory sample allocation to the collection and analysis of larger predatory fish from recreational reservoirs. This initiative acknowledges national concerns with mercury levels in freshwater fish and the potential for mercury-related health problems, especially in more vulnerable segments of the human population (*e.g.*, children and women of child bearing age) (EPA 2000a).

On January 4, 2010, consumption advisories were issued for nine water bodies in eastern and central Kansas owing to elevated levels of mercury, polychlorinated biphenyls (PCBs), or other contaminants in fish and shellfish. Citizens also were advised against consuming fish parts other than fillets owing to elevated levels of PCBs in skin and organ meats (http://www.kdheks.gov/befs/index.html). Advisories related to mercury were based on (a) average levels of this metal measured in fish (fillet) samples collected over a three-year period and/or (b) the documentation of increasing trends in mercury concentrations in fish samples. Future advisories and press releases on this subject likely will include additional precautionary statements, reflecting the fact that fish from some randomly sampled streams and lakes contain elevated mercury concentrations. The department currently lacks the resources needed to conduct follow-up investigations on all randomly selected (single year) sites yielding fish with mercury levels above the advisory threshold. However, follow-up studies are being conducted and will be conducted at locations where preliminary data indicate unusually high concentrations of mercury in fish.

Stream Probabilistic Monitoring Program

Probabilistic sampling may be used to obtain representative data on the condition of a given class of natural resources. It differs from conventional sampling in that (a) monitoring stations are a randomly selected subset of the resource as a whole, and (b) an emphasis is placed on the assessment of the total resource rather than the individual monitoring locations. Water quality monitoring programs implemented by KDHE traditionally have employed a targeted network design that positions stations in a deliberate and strategic manner. Targeted designs are of critical importance in determining site- and watershed-specific water quality conditions. However, funding realities generally limit the number of targeted sites that can be sampled on an ongoing basis. Given these considerations, the department recommended the initiation of a probabilistic stream sampling program in its previous five-year monitoring and assessment strategy (KDHE 2005b).

In 2004, KDHE participated in the National Wadeable Streams Assessment and gained a familiarity with the application of probabilistic sampling designs and associated field methods (EPA 2004). In 2005, the availability of supplemental monitoring funds under section 106(b) of the Clean Water Act provided an opportunity for BEFS to: (1) develop a quality assurance management plan and accompanying set of standard operating procedures for a similar statewide probabilistic program (KDHE 2007); (2) hire and train two environmental scientists to assist with the implementation of field and taxonomic duties; (3) develop a list of randomly selected (candidate) stream reaches; (4) obtain landowner permission to perform evaluations on these stream reaches; (5) initiate probabilistic monitoring operations; and (6) develop a methodology for applying probabilistic data in 305(b)-based water quality assessments. Probabilistic monitoring was implemented in June 2006 under the auspices of the newly created Kansas stream probabilistic monitoring program (SPMP).

From its inception, the SPMP was designed to complement (rather than supplant) the department's traditional monitoring programs. Targeted monitoring continues to serve as the primary basis for 303(d) list development, TMDL formulation, and NPDES permit review and certification. Although site selection procedures for the probabilistic and targeted monitoring programs differ substantially, field methodologies developed for the targeted efforts have been integrated with little alteration into the probabilistic program. This decision has maintained methodological continuity across programs and facilitated inter-program data comparisons. Chemistry and biological data generated by the SPMP and targeted monitoring programs are uploaded to the same electronic databases (discussed below). Staff of the targeted monitoring programs have contributed to the development of the SPMP and continue to play an important role in the implementation of this program.

The stream probabilistic monitoring network is predicated on a random, but spatially balanced, site selection process (Urquhart *et al.*, 1998; Herlihy *et al.*, 1998, 2000). Site coordinates are based on the random selection of points from the universe of classified streams identified in the most recently approved version of the Kansas surface water register (KSWR) (KDHE 2009b). The KSWR represents all potential probabilistic sampling locations or "the sampling frame." An infinite number of potential sites can be selected from the KSWR, allowing a manageable subset of about 30–50 newly chosen sites to be sampled each year (Figure 5). Results generated through the probabilistic monitoring program can be extrapolated with known statistical confidence to the state's entire population of streams, including hundreds of smaller water bodies largely outside the historical and current purview of the targeted monitoring programs.

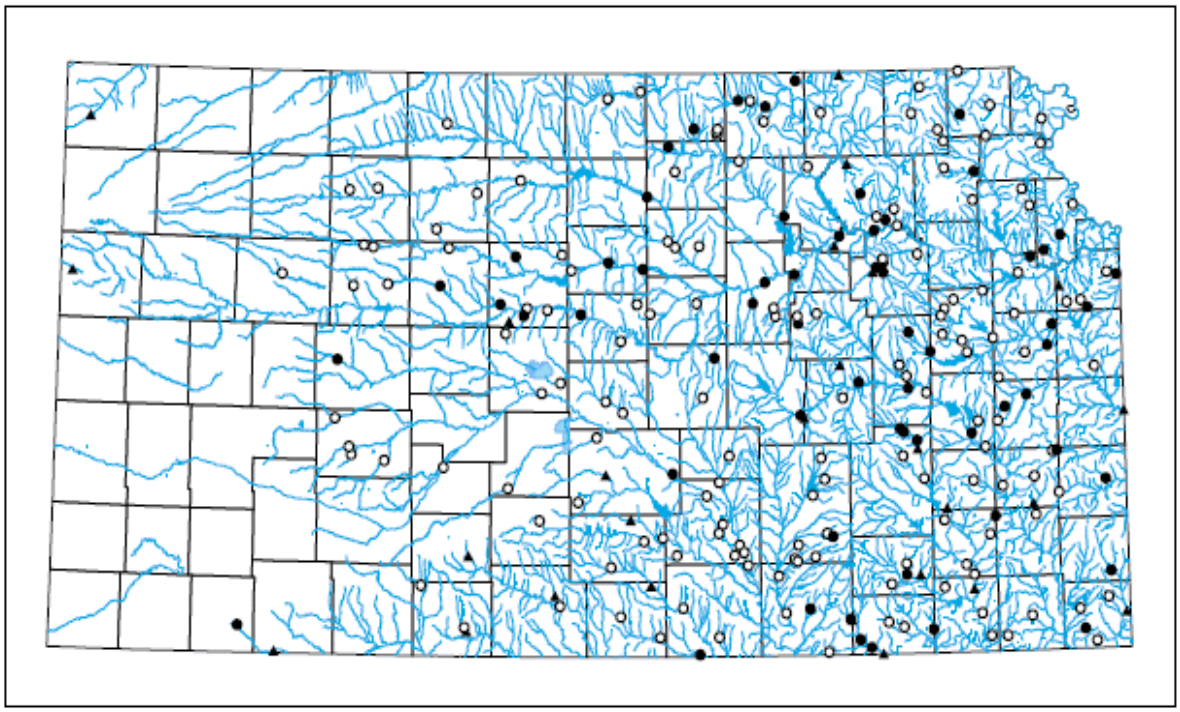

Figure 5. Sites sampled as part of the Kansas stream probabilistic monitoring network, 2006–2010. Sites depicted as open circles were assessed for water chemistry, macroinvertebrate and phytoplankton community composition, and biological habitat. Sites depicted as closed circles were monitored for the same environmental indicators plus fish tissue chemistry. Closed triangles represent least impacted reference sites (KDHE 2010d).

Groundwater Quality Monitoring Program

Kansas no longer maintains a statewide groundwater quality monitoring program, and funding for the renewal of such an enterprise appears unlikely in the near future. However, an earlier monitoring program (suspended in 2002 owing to budgetary constraints) evaluated groundwater quality at more than 200 sites in Kansas. Individual wells in the monitoring network were sampled on a two-year rotational basis, with approximately half these wells being sampled in any given year. All wells in the network adhered to specific siting, depth, and construction criteria, and the network as a whole was deemed representative of the state's major aquifer systems. The program's surviving electronic database contains roughly 150,000 records spanning 120 different physical, chemical, and radiological parameters and 327 groundwater quality monitoring locations. Additional background information is presented in the program's QAPP and accompanying set of SOPs, last revised in December 2000 (KDHE 2000b).

Some groundwater quality data continues to be gathered by KDHE through the efforts of its major regulatory bureaus. For example, groundwater is sampled routinely by the Bureau of Environmental Remediation from the vicinity of nearly 200 abandoned landfills and groundwater remedial sites, 1,500 storage tank cleanup sites, and a few active surface mining operations. The Bureau of Waste Management obtains groundwater quality information from a few dozen active landfills and hazardous waste sites across the state. The Bureau of Water requires a number of major NPDES permit holders to periodically submit data on groundwater quality; examples include larger confined animal feeding operations, certain industrial operations (*e.g.*, meat processing facilities, power plants, injection wells), and a few municipal wastewater treatment plants. All of these monitoring activities focus on surficial groundwater and/or a very limited set of analytical parameters. Although public water supply systems are monitored for a wide range of parameters pursuant to the federal Safe Drinking Water Act, samples are collected after treatment and do not reliably reflect the condition of the raw water source. These assorted monitoring operations are not intended to provide representative information on the state's major aquifer systems or to serve as a coordinated and comprehensive ambient groundwater quality monitoring program.

Compliance Monitoring Program

This program evaluates the quality of treated effluent released into the environment by wastewater treatment plants and other discharging facilities. It also provides an independent means of evaluating the accuracy and completeness of self-monitoring and reporting information provided by holders of NPDES permits. Parameters selected for analysis vary from one discharging facility to the next in accordance with effluent limitations and monitoring requirements specified in individual discharge permits. Supplemental parameters also are sometimes included in these compliance analyses for regulatory planning purposes. The scope of this program is statewide. All NPDES facilities in the state potentially are subject to unannounced compliance monitoring visitations (40 CFR 123.26(b); K.S.A. 65-170b; KDHE 2010b). Traditionally, the agency has visited about 60 NPDES facilities each year for compliance monitoring purposes. However, only 20 facilities were monitored in 2010 and only 13 were monitored in 2009. These numbers reflected an overall decline in the funding allocated to the compliance monitoring program.

As needed, the employees of this program also perform use attainability analyses (UAAs) to obtain geographical, geomorphological, hydrological, chemical, and/or biological data valuable for

determining the attainable uses of individual water bodies (KDHE 2005a). The results of these surveys undergo formal in-house review, public comment, and, ultimately, EPA review and approval. Approved use designations are codified in the Kansas surface water register (KDHE 2009b) and adopted by reference in the Kansas surface water quality standards (K.A.R. 28-16-28g). The level of water quality protection afforded by the standards varies among classified water bodies in accordance with these use designations and associated water quality criteria (K.A.R. 28-16-28d and -28e).

The attainable uses of essentially all classified surface waters in Kansas were systematically reevaluated by BEFS during 2003–2007. In 2004 alone, more than 650 streams segments were surveyed to determine their classification status and capacity to support several newly defined recreational uses (*cf.*, K.S.A. 82a-2001 *et seq.*; K.S.A. 82a-2004). Programmatic efforts in 2006 and 2007 shifted to the assessment of other beneficial uses such as aquatic life support, food procurement, water supply, and groundwater recharge. By December 31, 2007, UAAs had been completed for nearly all water bodies identified in the Kansas surface water register. Only a few additional UAAs were performed by BEFS during 2008–2010. These surveys were requested by BOW and supported NPDES permit development functions.

Special Water Quality Investigations

On average, KDHE receives about 40 fishkill reports each year. Most originate from landowners or other concerned citizens, and nearly all prompt field investigations by the BEFS district offices and/or the regional KDWP offices. Because the BEFS central office employs a number of experienced aquatic biologists, maintains several boats, and has access to specialized sampling and diagnostic equipment, it is sometimes requested by the district environmental administrators to participate in large or unusual fishkill investigations. Other emergency situations that generally elicit investigative responses include contaminant spills, sewage bypasses, toxic algal blooms, and taste and odor problems in drinking water supply reservoirs. Central office staff also perform special water quality investigations in support of TMDL studies (*e.g.*, Hillsdale Lake Nutrient Loading Study, 1992–1993), special administrative initiatives (*e.g.*, Governor's Water Quality Initiative, 1996–1998), interstate water pollution studies (*e.g.*, Spring River Water Quality Assessment, 2001–2002), Natural Resource Damage Assessment (NRDA) projects (*e.g.*, Tri-State Mining Area Study, 2001–2007), multi-state water quality surveys (*e.g.*, National Wadeable Streams Assessment, 2004–2005; National Rivers and Streams Assessment, 2008–2009), or other monitoring/assessment initiatives (*e.g.*, Kansas Reference Stream Study, 2009–2010). In most years, BEFS central office employees are engaged in at least one or two investigations of this kind.

Collaborative Monitoring Programs

Some outside organizations routinely lend monitoring assistance to KDHE or otherwise generate data suitable for inclusion in the agency's water quality assessment reports. For example, EPA Region 7 and KDWP routinely assist KDHE with the collection of fish tissue samples from some of the state's larger streams and reservoirs (KDHE 2010c). The United States Army Corps of Engineers obtains and shares information on fecal bacteria concentrations in federal reservoirs maintaining public swimming beaches. Recipients of NPDES permits submit discharge monitoring reports to KDHE on a regular basis; these reports convey information regarding the amount of effluent discharged to the waters of the state, measured levels of selected contaminants, and, in some

cases, the risk posed by the treated effluent to aquatic organisms (as determined by standardized laboratory toxicity tests). The United States Geological Survey (USGS), the Kansas Geological Survey, and the Kansas Biological Survey sometimes are commissioned by KDHE to perform special water quality, sediment quality, or biological studies, often in support of TMDL development initiatives. Under contractual agreements with the department and the Kansas Water Office, the USGS also monitors stream flow at 178 locations in the state (http://waterdata.usgs.gov/ks/nwis/current/?type=flow). This flow gauging network plays a critical role in the establishment of water quality-based permit limits and development of TMDLs for water quality-impaired streams.

Volunteer Monitoring Programs

Most volunteer water quality monitoring programs in Kansas support broad environmental education objectives. Owing primarily to quality control constraints, the information obtained through these programs generally is not applied by KDHE in a formal diagnostic or regulatory context. Financial support for volunteer monitoring programs is derived largely from Clean Water Act section 319 grants (administered by the BOW Watershed Management Section). Some recent recipients of this funding have included Kansas State University (Office of Research and Extension) and the Kansas Watershed Restoration and Protection Strategy (WRAPS) program. The Kansas State University initiative promotes participation in voluntary monitoring efforts and is geared primarily toward farmers, ranchers, and high school youth in rural areas of the state (Janke 2004). The Kansas WRAPS program provides a multi-agency framework for addressing a variety of water resource issues, such as the achievement of TMDLs, protection of public water supply reservoirs, restoration of wetland and riparian habitats, and ongoing support of volunteer water quality monitoring programs and other environmental education initiatives (http://www.kwo.org/).

Data Management

Formerly, most physicochemical water quality records generated by the department were stored in an electronic repository (the Kansas Water Database) maintained on an IBM AS-400 mainframe computer. This information and related metadata were uploaded electronically to EPA's Storage and Retrieval (STORET) database at least annually. In contrast, most macroinvertebrate, macrophyte, fish tissue, fishkill, and other biological data were maintained by KDHE on personal computers and/or the AS-400 system. Irrespective of the primary storage medium, all databases were backed up at regular intervals and multiple copies were maintained both electronically and as hard copy versions (KDHE 2000a).

In 1999, EPA replaced its original STORET system with a newer version (STORETX) that required data migration software to be installed on all uploading computers. A refined version of this software became available in 2001 for use in an ORACLE operating environment. In 2002, KDHE switched from the AS-400 mainframe to a Xiotech storage area network (SAN) and Hewlett Packard server-based system with ORACLE operating software. This change was needed to better harmonize with STORETX and other federal databases operating on an ORACLE database platform. In 2003, KDHE's Office of Information Systems (later renamed Office of Information Technology) successfully migrated a portion of the stream chemistry database (1986–2002) to ORACLE.

During 2005 and early 2006, four years of stream chemistry data and five years of lake chemistry data were uploaded to STORETX. However, in the spring of 2006, EPA announced that STORETX

would be replaced by a newer federal database known as the Water Quality Exchange (WQX). Kansas and most other states ceased transferring data to STORETX and waited instead for the EPA WQX to become fully operational, a process that required nearly three years. By the fall of 2009, KDHE had developed a state-oriented version of WQX for database transfer purposes and had begun uploading data from this system to the EPA WQX. By August 2010, essentially all surface water chemistry data obtained by KDHE during 1999–2009 had been transferred to EPA WQX.

During the upcoming (2011–2015) planning period, KDHE will endeavor to review and validate all surface water chemistry data collected from 1967 through 1998. The validated data and related metadata will be uploaded to EPA WQX. An effort also will be made to upload the department's large stream biological (macroinvertebrate) database to EPA WQX. The department's in-house ORACLE and WQX-compatible databases will be maintained for back-up purposes and to facilitate data transfers to EPA WQX.

Quality Assurance/Quality Control

The foremost goal of the Division of Environment (DOE) quality management system is to ensure that all environmental monitoring programs and projects administered by the division produce data of known and acceptable quality and support, in a scientifically defensible manner, the informational needs and regulatory functions of KDHE. Part I of the DOE Quality Management Plan (QMP) establishes the general framework for this quality assurance management program (KDHE 2010a). Quality assurance goals, policies, procedures, organizational responsibilities, and evaluation and reporting requirements are specifically addressed in this document, and the foundation is laid for the bureau- and program-level quality assurance plans presented in Part II and Part III of the QMP. Written quality assurance plans have been developed for all routine environmental monitoring programs administered by the BEFS Technical Services Section and district offices. Each plan describes:

(1) the objectives and goals of a particular program, along with historical background information;

(2) programmatic quality assurance goals and expectations;

(3) organizational (staff/supervisor/administrator) responsibilities;

(4) quality assurance procedures for monitoring site selection, sample collection, chain-of-custody, field and laboratory analyses, internal and external quality control assessments, corrective actions, data management, equipment/supply purchasing, and quality assurance reporting;

(5) standard operating procedures (step-by-step instructions for sample collection, preservation, transport and analysis, equipment maintenance/calibration, related safety procedures, and other routine programmatic activities); and

(6) additional information such as field and laboratory equipment checklists, standardized field sheets, sample submission and chain-of-custody forms, a glossary of applicable technical terms, and bibliographical citations for further reading and information.

Quality assurance documents for all departmental programs generating environmental data are posted on the DOE quality assurance website (http://www.kdhe.state.ks.us/environment/index.htm).

Evaluation of Monitoring Programs

Water quality monitoring programs administered by the department are subjected periodically to both internal and external quality assurance evaluations. These generally take the form of data quality assessments, performance audits, or management system reviews. Data quality assessments address whether the type, quantity and/or quality of environmental data collected by a given monitoring program support the informational needs of the administering bureau and the division. These assessments focus largely on sampling design and monitoring frequency and the general adequacy of the collected data relative to the stated purpose of the monitoring effort. The EPA document *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (EPA 2000b) serves as the principal written guidance for data quality assessments. Evaluations of this kind are performed by the BEFS QA representative or chief of the BEFS Technical Services Section based on perceived need or according to schedules set forth in the bureau-level QA management plan or applicable programmatic QAPPs. Corrective actions stemming from these assessments are addressed by the section chief and program managers in end-of-year program evaluation reports.

Individual monitoring programs are audited annually by the section chief and may be audited from time to time by the divisional QA officer, bureau QA representative, federal oversight agency, or an independent third party contracted by the division or oversight agency. Most programmatic audits are performed by the section chief or bureau QA representative based on perceived need or according to schedules set forth in the bureau QA management plan or applicable QAPPs. These audits consider the adequacy of physical facilities, equipment, personnel, training, field and laboratory procedures, record keeping, data validation and management, and other aspects of the monitoring program. The EPA document *Guidance on Technical Audits and Related Assessments for Environmental Data Operations* (EPA 2000d) serves as the principal written guidance for planning and implementing internal audits. Corrective actions stemming from audits are approved and implemented pursuant to procedures addressed in the divisional QMP and are summarized by the section chief and program managers in annual program evaluation reports.

Management system reviews are implemented at the divisional level to determine whether environmental monitoring operations and the supporting management infrastructure comply with the stated goals and requirements of the QMP. To date, all management system reviews have been performed by auditors from EPA under the direction of the EPA regional QA manager. Evaluations of this kind are implemented with the prior knowledge and consent of the DOE QA officer and division director. Management system reviews normally follow the guidelines set forth in the EPA document *Guidance on Assessing Quality Systems* (EPA 2003b). These reviews help identify needed corrective actions and other opportunities for improving QA performance. The results of these assessments are summarized by EPA in writing, then distributed to the division director, divisional QA officer, and participating bureau directors, bureau QA representatives, section chiefs, and program managers.

Infrastructure Planning

Departmental operations involving the generation and analysis of environmental monitoring data are systematically planned and documented pursuant to the requirements of the QMP (KDHE 2010a). Planning tools include, but are not limited to, the departmental budget, the performance partnership agreement with EPA, work plans associated with other federal grants and agreements, the continuing planning process (KDHE 1998a), and this document — the five year monitoring and assessment strategy. End-of-year program reports and DOE's annual QA report to EPA also serve in a planning capacity by addressing staff training needs, pending corrective actions, and upcoming QA initiatives and assessments. The QAPPs contained in Part III of the QMP likewise constitute formal planning tools for both intramural and extramural environmental monitoring programs. In developing a QAPP, the program manager (or outside contractor) is expected to obtain input from persons or organizations requesting the monitoring data or representing the ultimate users of the data. The program manager also is expected to solicit comments from field, analytical, data management, supervisory, and other personnel participating in the monitoring program. Prior to implementation, each QAPP must be reviewed and approved by the section chief for conformity with organizational practices, policies, and priorities and by the bureau QA representative for conformity with applicable QA requirements. The EPA document *Guidance for the Data Quality Objectives Process* (EPA 2000c) is used as a tool in the QAPP planning and development process.

Overview of Current Assessment Operations

Water Quality Assessment (305(b)) Report

Since 2008, the biennial 305(b) report has been incorporated within a larger document known as the Kansas Integrated Water Quality Assessment (IWQA). The 305(b)-related portion of the IWQA assesses the state's overall water quality condition using information obtained from the aforementioned monitoring programs. Reporting efforts have focused primarily on the condition of classified streams, lakes, and wetlands in Kansas (KDHE 2010d). Earlier 305(b) reports, predating the suspension of the groundwater quality monitoring program, also evaluated the condition of the state's major aquifer systems (*e.g.*, KDHE 1996a, 1998b, 2000c). In general, only the data obtained from a program's most recently completed monitoring (rotational) cycle are considered during document development (*e.g.*, four consecutive years of stream probabilistic monitoring data).

Assessment criteria vary from one monitoring location to another depending on the designated uses of individual stream reaches, lakes, and wetlands. Measured water quality conditions are compared with applicable narrative or numeric criteria presented in the Kansas surface water quality standards or in guidance documents published by EPA (*e.g.*, EPA 2000a). In the translation of narrative biological criteria, the agency applies a suite of biological assessment indices that include, for example, the macroinvertebrate biotic index (MBI), Kansas biotic index (KBI), Ephemeroptera-Plecoptera-Trichoptera (EPT) index, mussel taxa loss index, and Carlson trophic state index (KDHE 2007, 2010d, 2010f). Monitored water bodies are evaluated and classified as either fully supportive, partially supportive, or non-supportive of each designated use. The overall level of use support then is calculated for the entire population of monitored streams, lakes, and wetlands and presented along with other relevant information in the 305(b)-related portion of the IWQA (http://www.kdhe.state.ks.us/befs/index.html).

The department's most recent 305(b) assessment evaluated the condition of 19,300 stream miles (~31,000 km or 70% of the state's total classified stream length). Severe drought conditions and dry creek channels precluded the evaluation of another 8,500 stream miles. The 305(b) assessment also evaluated 222,000 lake and wetland acres (~90,000 ha or 90% of the state's classified lake/wetland area). The condition of an additional 25,300 lake and wetland acres (~10,200 ha or 10% of the state's classified lake/wetland area) was assessed in a less rigorous manner using information from short-term investigations. Classified waters that were not well represented in the 305(b) assessment included a few hundred publicly owned or publicly accessible lakes and wetlands, most smaller than 10 acres (4.0 ha). Moreover, the Missouri River was not considered in the 305(b) assessment owing to logistical and budgetary constraints that precluded the collection of representative physicochemical and biological data from this large interstate stream (KDHE 2010d).

Water Quality-Limited Surface Waters and TMDLs

Pursuant to section 303(d) of the Clean Water Act, each state must maintain an inventory of all streams, lakes, and wetlands within its borders failing to comply with applicable surface water quality standards. States also must consider "all existing and readily available water quality data and information" during the development and periodic revision of this inventory (40 CFR 130.7(b)(5)). In the identification of water quality-impaired surface waters in Kansas, KDHE relies primarily on information obtained through the previously mentioned (targeted) water quality monitoring programs. Secondary sources of information include special water quality investigations, nonpoint source pollution surveys, drinking water source assessments, contaminant dilution calculations, trend analyses, predictive modeling, fish/shellfish consumption advisories, and information provided by other governmental agencies, academic institutions, and the general public.

Proposed modifications to the 303(d) list undergo internal, interagency, and public review and ultimately must be approved by EPA. Because water bodies identified on the 303(d) list are assigned a priority ranking for TMDL development (discussed below), this document significantly influences KDHE's day-to-day regulatory operations and its long-term targeting of watersheds and water bodies for environmental restoration. The department's most recent 303(d) list identifies 1,311 stream-related water quality impairments and 76 lake/wetland water quality impairments distributed among 57 HUC-8 watersheds (KDHE 2010h). This list has undergone extensive internal and public review and has been approved by EPA (http://www.kdheks.gov/tmdl/2010_Approval_Leter. pdf).

Total maximum daily loads constitute established limits on the release of pollutants to the waters of the state. Waters listed on the 303(d) list are targeted for TMDL development according to a priority ranking proposed by KDHE and approved by EPA. In developing a TMDL, the department specifies (1) the water body in question, (2) the pollutant causing the water quality impairment, (3) the degree of deviation from applicable water quality standards, (4) the level of pollution reduction needed for regulatory compliance, (5) corrective actions needed to achieve this reduction, (6) monitoring strategies needed to assess the impact of the corrective actions, and (7) provisions for modifying the TMDLs, if needed, based on future monitoring and assessment information.

In 1999, under the direction of a court decree, Kansas began using a basin-by-basin rotational approach to develop TMDLs for water quality-limited streams, lakes, and wetlands. The schedule under the court decree concluded in 2006, at which time KDHE adopted a five-year rotational cycle for developing future TMDLs in each basin. To date, this effort has addressed impairments in each

of the state's twelve major river basins, and TMDLs have been finalized and approved for 410 stream-related impairments and 274 lake- and wetland-related impairments. Future TMDL development and revision cycles are projected to continue in each basin on a five-year rotational basis (http://www.kdheks.gov/tmdl/index.htm).

Water Quality-Based Effluent Limits

Prior to the issuance of any permit that authorizes a facility to discharge effluent to the waters of the state, KDHE must certify, in writing, that the planned release of effluent will not result in violations of the Kansas surface water quality standards, other applicable state laws, or any federally promulgated water quality standards (CWA §401(a)(1); 40 CFR 124.53). A review of the discharge's potential impact on the quality of the receiving surface water is conducted by the department. This review generally involves the use of desktop computer models and the application of certain standard assumptions related to mixing zone dimensions, pollutant decay rates, stream re-aeration coefficients, and other instream features and processes. Limits on allowable concentrations (or loadings) of certain pollutants may be established by the department based on the receiving surface water's designated use(s), estimated assimilative capacity, measured background (upstream) pollutant concentrations, and the projected mean and maximum rates of effluent discharge. Any approved TMDLs for the receiving surface water (or other, downstream waters) are considered during this review. The department may require permit holders to monitor actual discharge rates and levels of selected contaminants in the treated effluent. Additional requirements may be imposed depending on the degree of uncertainty inherent in the certification analysis and other factors (KDHE 2004b).

Approximately 1,040 municipal, industrial, commercial, and federal facilities in Kansas are authorized by KDHE to release treated effluent to the waters of the state. Discharge permits normally are reviewed and renewed on a five-year cycle; hence, about 200 permits are issued each year, on average. The Bureau of Water currently reviews these permits on a basin-by-basin rotational basis consistent with the aforementioned TMDL schedule. This coordinated approach allows wasteload allocations generated through the TMDL process to be incorporated more rapidly and more comprehensively into permits issued by the department (KDHE 2004b; http://www.kdhe.state.ks.us/tmdl/basic.htm# Implementation).

Nonpoint Source Pollution Report

Pursuant to subsection 319(h)(11) of the Clean Water Act, the BOW Watershed Management Section prepares a report each year describing the state's NPS pollution control objectives, source water assessments and protection plans, watershed restoration/protection strategies, projects implemented during the previous year in support of these objectives, plans, and strategies, and any noted improvements in water quality attributable to NPS pollution control efforts. This annual report also presents a basin-by-basin summary of known water quality impairments attributable to NPS pollution and addresses the status of TMDL development efforts within each basin. Additional technical materials and professional contact information are included in this report for the benefit of other agencies, organizations, and individuals engaged in the study and control of NPS pollution (KDHE 2009a).

Special Water Quality Reports and Presentations

In addition to the major assessment reports considered already, the agency generates a large variety of in-house reports, special publications, invited articles and commentaries, and peer-reviewed journal articles addressing the integrity of the state's surface water and groundwater resources (Haslouer 1979, 1983, 2003; Cringan and Haslouer 1984; Arruda *et al.* 1987a–b, 1988; Haslouer *et al.* 1987, 2005; KDHE 1987, 1988a–b, 1996b–d; Arruda and Fromm 1989; Carney 1989–2010, 1993a–b, 1994, 1996, 1998a–c, 2002, 2009; Cringan 1989, 1991; Angelo 1991, 1991–1992, 1994, 2001; Bain 1992, 1994, 1996; Carney *et al.* 1991, 1995; Angelo *et al.* 2002, 2003, 2007, 2009, 2010; Angelo and Cringan 2002, 2003; Banner *et al.* 2009; Wang *et al.* 2009). Departmental water quality data also are sometimes included in the reports and publications of other agencies, organizations, and academic institutions (Cross *et al.* 1983, 1985; Cross and Haslouer 1984; Pope *et al.* 1985; Collins *et al.* 1987, 1988, 1991; Jordon and Stamer 1991; Davis and Schumacher 1992; Yu *et al.* 1993; Tanner 1995; Allen *et al.* 1999; Sophocleous and Wilson 2000; Chapman *et al.* 2001; Mulhern *et al.* 2002; Dodds and Oakes 2004; KWO 2004; Pope 2005; Dodds *et al.* 2006). Most scientists and engineers employed by BEFS and BOW belong to at least one professional organization and regularly attend meetings for the purpose of sharing and acquiring information relevant to their work at KDHE. From time to time, many are invited to give presentations to school groups, university classes, professional associations, or technical workgroups or to participate in public meetings, news interviews, or televised documentaries. Collectively, these informational outlets play an important role in maintaining and improving the public's knowledge of the water quality issues facing Kansas (KDHE 2004a).

Planning and Evaluation of Assessment Programs

This document, the five-year monitoring and assessment strategy, constitutes one of the department's primary planning tools for water quality assessment operations. Other major planning tools include the departmental budget, the performance partnership agreement with EPA, work plans associated with other federal grants and agreements (*e.g.*, Clean Water Act §604(b) grant), the divisional QMP (KDHE 2010a), and the continuing planning process (KDHE 1998a). Water quality assessment programs within KDHE are evaluated largely on the basis of written work products (*e.g.*, IWQA; annual NPS report; reports stemming from special water quality monitoring initiatives). All such products undergo some level of in-house review, and many are submitted to other governmental agencies and/or the general public for additional review and comment. Modifications to the Kansas surface water register, revised 303(d) lists, and proposed TMDLs are subjected to a particularly high level of public scrutiny and ultimately require the review and approval of EPA. Most papers submitted to scientific journals undergo independent peer-review and, upon publication, may prompt additional comments and constructive criticisms from the broader scientific community. These comments and criticisms are considered carefully by program managers and other supervisory personnel and often lead to further improvements in the department's water quality monitoring and assessment programs.

PROPOSED IMPROVEMENTS IN KANSAS WATER QUALITY MONITORING AND ASSESSMENT PROGRAMS

Short-Term Recommendations

The following paragraphs discuss several preferred options for improving the department's water quality monitoring and assessment programs during the upcoming five-year planning period. Barring any unforseen budgetary crises or similar contingencies, projected state and federal funding levels should accommodate the implementation of each of these recommendations.

Recommendation #1: Add Missouri River to stream monitoring coverages

Funding and logistical constraints have prevented the department from routinely monitoring the condition of the Missouri River, the largest stream in Kansas. However, in 2008, staff collected physical, chemical, and biological data from this water body as part of the National Rivers and Streams Assessment (http://water.epa.gov/type/rsl/monitoring/riverssurvey/riverssurvey_index.cfm). Capitalizing on the training, experience, and information acquired as part of this effort, the department will reconsider the feasibility of including the Missouri River in its ongoing stream chemistry and biological monitoring programs. Some of the funding currently devoted to the sampling of other streams may need to be reapportioned to accommodate this hypothetical monitoring initiative. KDHE also will consider the potential advantages of pooling its assets with those of other agencies and neighboring states to enhance the quality and scope of this effort.

Recommendation #2: Expand intra-watershed monitoring operations

As discussed previously, the department's stream chemistry monitoring program obtains water quality data from about 97 percent of the HUC-8 watersheds in Kansas. To date, TMDLs have been developed largely on the basis of these watersheds and their associated (integrator) monitoring stations. Because a majority of the reported water quality impairments in Kansas are wholly or partly attributable to nonpoint source pollution, this TMDL-watershed orientation melds neatly with watershed management activities supported by the State Water Plan Fund and Clean Water Act section 319 grants. The Watershed Restoration and Protection Strategy (WRAPS) has emerged from the 319 program as the preferred vehicle for implementing nonpoint source pollution abatement in Kansas. However, this approach would benefit from the availability of additional information on water quality conditions within designated HUC-8 watersheds (*i.e.*, from an enhanced capacity to identify the geographical locations responsible for the pollutant loadings and beneficial use impairments documented at the watershed outlets).

Recently, BEFS, BOW, and the KDHE laboratory agreed to allocate their respective resources in a manner supportive of the study of smaller (*e.g.*, HUC-12) watersheds identified by WRAPS groups as high priority areas for TMDL implementation. Monitoring already has been implemented in a select group of these "sub-watersheds" and will continue for five years to (a) determine baseline conditions and (b) document initial improvements in water quality stemming from the application of agricultural best management practices and other environmental improvement actions. During the upcoming planning period, the department will endeavor to increase the number of sub-watersheds included in this new monitoring initiative.

Recommendation #3: Incorporate additional parameters in monitoring programs

During the next planning period, the department will evaluate the merit and feasibility of expanding its list of core and supplemental water chemistry parameters to include various additional volatile organic compounds (*e.g.*, trihalomethanes), biocides (*e.g.*, glyphosate), antibiotics (*e.g.*, triclosan), synthetic hormones (*e.g.*, estradiols), and algal toxins (*e.g.*, microcystin). Although many of these compounds have been documented in the waters of Kansas and surrounding states (*e.g.*, Carney 1989–2010; Kolpin *et al.* 2002), their prevalence and distribution in the ambient environment remain poorly understood. The KDHE laboratory currently lacks the equipment and staff needed to test routinely for many of these compounds. However, BEFS plans to continue a dialogue with the laboratory, BOW, and departmental administrators to identify possible sources of funding for these needed analytical services.

Recommendation #4: Continue stream bacteriological monitoring initiative

In response to recent State legislation (K.S.A. 82a-2001 *et seq.* and 82a-2004), the department has promulgated revised water quality criteria for primary and secondary contact recreation in classified streams (K.A.R. 28-16-28e(c)(7) and 28-16-28e(d)). These criteria are expressed as maximum allowable geometric mean concentrations of *Escherichia coli*, an enteric bacterium commonly employed as an indicator of fecal contamination. Calculation of the geometric mean at a given monitoring site requires the collection of surface water samples on five or more days during the course of a 30-day assessment period. If implemented at all monitoring sites in the state on a quarterly basis, this stipulated sampling frequency would correspond to an overwhelming increase in the department's environmental monitoring and analytical workload. Therefore, KDHE currently limits geometric mean-based (GMB) monitoring to 20–25 sites per year. Sites are distributed among a few selected river basins in anticipation of future 303(d) listings and a corresponding need to develop and implement TMDLs within these basins.

During the upcoming five-year planning period, the department plans to continue a statewide GMB monitoring program for *E. coli* that adheres to a five-year (basin-by-basin) rotational schedule, consistent with TMDL development activities. This program will target stream reaches that exhibit elevated levels of *E. coli* during routine (single-sample) monitoring operations or special studies conducted or commissioned by the department. Geometric mean-based monitoring will be performed in the identified stream reaches on a seasonal basis (*i.e.*, four times annually).

Recommendation #5: Identify and protect reference-caliber stream reaches

Reference streams, or the highest quality streams in a given region, play a critical role in modern water pollution control programs. Knowledge obtained through their study is applied in the characterization of the baseline ecological condition, the development of surface water quality criteria, the identification of water quality-impaired streams, the performance of statewide water quality assessments, and the formulation of restoration goals for environmentally degraded water bodies. With these considerations in mind, KDHE recently undertook a systematic inventory of candidate reference streams in Kansas. In July 2009, the department began to assemble a large suite of existing geographical databases, each relevant to the identification and study of reference ecosystems. A human disturbance index was developed using these databases and subsequently applied in the evaluation and ranking of the state's nearly 100,000 (NHDPlus) watersheds and

corresponding stream reaches. Predictive computer models also were developed relating watershed disturbance scores to the prevailing diversity of native fishes, freshwater mussels, and aquatic insects. Results were summarized and interpreted for the state as a whole and for five quantitative ecoregions delineated as part of this study (Angelo *et al.* 2010).

Given the regulatory and scientific importance of reference streams, the protection of these water bodies should be included among the shared goals of all natural resource agencies. Protective measures now being considered in Kansas include (a) the enhanced monitoring of reference streams; (b) designation of reference streams as either exceptional state waters or outstanding national resource waters; (c) development of total maximum daily loads (TMDLs) for selected reference streams based on the antidegradation provisions of the Kansas surface water quality standards; (d) establishment of minimum desirable stream flows for reference streams pursuant to existing state water allocation laws; (e) wider utilization of conservation easements and other incentive-based programs for protecting and improving the condition of these waters; (f) more complete integration of reference streams within the Kansas WRAPS program; and (g) incorporation of the preceding goals in the Kansas Water Plan.

In December 2010, the department was awarded a Clean Water Act section 104(b)(3) grant to facilitate the implementation of the above recommendations on a pilot basis. This one-year project will culminate in a detailed, well illustrated report, presenting and interpreting the acquired monitoring and assessment data and describing any notable successes or failures with respect to stakeholder support for reference stream protection. Another anticipated outcome of this effort is an increase in the capacity of local stakeholders (*e.g.*, WRAPS groups) to implement protective measures in high quality watersheds and reference stream reaches. This project also is expected to result in an enhanced level of communication and cooperation among agencies tasked with the protection and management of aquatic resources in Kansas.

Recommendation #6: Develop more sensitive biological assessment models

The department has amassed a large quantity of stream biological monitoring data during the past three decades, but methods employed in the analysis and interpretation of this information have progressed less rapidly and require a greater level of attention. The emergence of modeling techniques for estimating taxonomic completeness (defined as the proportion of expected taxa actually observed during monitoring activities, or O/E) has enhanced the ability of scientists and regulators in several other regions to quantify human-induced changes in aquatic biological condition (Moss *et al.* 1987; Hawkins *et al.* 2000; Clarke *et al.* 2003; Hawkins 2006). Using its historical body of biological monitoring data and the initial findings of the stream probabilistic monitoring program, the department will begin to evaluate the potential application of the O/E modeling approach in statewide water quality assessments performed under section 305(b) of the Clean Water Act.

Recommendation #7: Publish comprehensive Kansas water quality report

From the late 1970s through the mid 1990s, KDHE produced biennial 305(b) reports containing significant narrative content and numerous figures and photographs to better explain to the public the water quality issues facing the state. This practice ceased in the late 1990s, as emphasis shifted instead to supplying EPA with the tabular data summaries stipulated in newer 305(b) guidance

documents. During the upcoming planning period, BEFS will endeavor to develop the first in a continuing series of comprehensive reports on the status of the state's surface water and groundwater resources. This report will be updated at approximately five-year intervals to track changes in water quality over time and address any major accomplishments or remaining challenges in the field of water pollution control. The projected completion date for the first of these reports is December 31, 2015.

Recommendation #8: Improve water quality data management capabilities

During the next two years, the department plans to complete its quality assurance evaluation of all water chemistry data collected during the period 1967–1998 and to upload this data and related metadata to the EPA WQX database. An effort also will be made to upload the department's large stream biological (macroinvertebrate) database to EPA WQX. In-house ORACLE and WQX-compatible databases will be maintained by KDHE for back-up purposes and also used to facilitate the transfer of water quality data to EPA WQX. Moreover, as time and resources allow, program managers and data management personnel will attempt to retrieve, review, and electronically enter and upload information contained in the agency's older paper files and archived publications (dating from approximately 1900). After January 1, 2013, the department will refer most individuals and organizations requesting large data retrievals to EPA WQX, which is readily accessible via the world wide web (see http://www.epa.gov/storet/wqx/index.html).

Recommendation #9: Provide additional monitoring and assessment training

During the upcoming planning period, monitoring personnel will be encouraged to participate in national and regional water quality monitoring conferences and in any formal training that addresses recent advances in monitoring network design, sample collection methods, analytical and taxonomic techniques, quality control, or other related subjects. Moreover, the department will train additional employees in specific sampling, analytical, and taxonomic skills to foster redundant capabilities in the event of retirement, injury, illness, or other factors leading to the loss or temporary absence of monitoring staff. Employees engaged in data analysis also will be encouraged to participate in specialized training (*e.g.*, statistical analysis and modeling workshops) offered sporadically by EPA and cooperating academic institutions.

Recommendation #10: Improve recruitment and retention of qualified chemists

Analytical chemists employed by KDHE generally receive less pay than the department's microbiologists, environmental scientists, environmental geologists, and environmental engineers, even though all such job classifications require comparable levels of education and training (http://www.da.ks.gov/ps/specs/specs/default.htm). This disparity has contributed to a comparatively rapid turnover rate among laboratory staff. Today, the KDHE laboratory frequently serves as a stepping stone to better paying positions in DOE and the Division of Health. Ongoing losses of more experienced laboratory personnel have led to sporadic delays in the analysis of water quality samples and reporting of water quality data. On occasion, these losses have resulted in more serious quality control complications. During the upcoming planning period, the department will explore available options for reducing disparities in pay among scientific job classifications, with the goal of reducing the turnover rate among laboratory employees.

Long-Term Recommendations

The following additional actions should be taken to ensure the maintenance of a comprehensive water quality monitoring and assessment program in Kansas. These actions are unlikely to be implemented during the upcoming planning period owing to budgetary constraints at both the state and federal level. However, it is hoped that by acknowledging these issues at this time, an attempt will be made to secure the necessary resources in the months and years ahead.

Recommendation #11: Reinstate groundwater quality monitoring program

Given the overall importance of groundwater to the societal and ecological well being of Kansas, the department should endeavor to resume ambient (aquifer-based) groundwater quality monitoring operations as soon as practicable. The surviving groundwater quality database, associated metadata, and related quality assurance documentation (KDHE 2000b) should provide the information needed by the department to recommence groundwater monitoring operations with minimal developmental cost and delay. Based on historical expenditures and inflationary considerations, an annual budgetary allocation of about $300,000 would be needed to fully restore this program. This level of funding would support the hiring of an environmental geologist (program manager) and the collection and analysis of groundwater samples from approximately 125 sites annually or 250 sites every two-year rotation (*cf.*, http://www.kdhe.state.ks.us/environment/qmp2000/download/GQMP_QAMP.pdf).

Recommendation #12: Secure stable funding for monitoring and assessment programs

The department's water quality monitoring programs depend heavily on allocations from the State General Fund (SGF). In response to recent reductions in SGF funding, certain monitoring operations have been suspended or greatly reduced in scope, several monitoring and laboratory positions have been eliminated, water chemistry and fish tissue samples are being collected from fewer locations (or at a significantly reduced frequency), and several relevant water chemistry parameters are no longer being considered in water quality assessments performed by KDHE. Future changes of this kind could be prevented, in part, by reserving a greater portion of the state's annual funding from EPA (*e.g.*, Clean Water Act §106 and §319 allotments) for water quality monitoring and assessment purposes. Fee-based options and other alternative sources of funding also could be systematically explored by the department. In lieu of an actual increase in the level of financial support, a greater diversity of funding sources and a more balanced mix of state and federal monies would provide a modicum of protection against recurring fluctuations in available resources, the loss of additional monitoring staff, and the suspension of additional water quality monitoring programs.

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APPENDIX A

Major Federal and State Statutes and Regulations Addressing Water Quality Monitoring and Assessment

Clean Water Act

Section 104(a): The [EPA] Administrator shall establish national programs for the prevention, reduction, and elimination of pollution and as part of such programs shall...in cooperation with the States, and their political subdivisions, and other Federal agencies establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters and ground waters....

Section 106(e): [The] Administrator shall not make any grant under this section to any State which has not provided or is not carrying out as part of its program...the establishment and operation of appropriate devices, methods, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition), the quality of navigable waters and to the extent practicable, ground waters including biological monitoring; and provision for annually updating such data and including it in the report required under section 305 of this Act....

Section 303(d): Each State shall identify those waters within its boundaries for which the effluent limitations required by section 301(b)(1)(A) and section 301(b)(1)(B) are not stringent enough to implement any water quality standard applicable to such waters. The State shall establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters.

Section 305(b): Each State shall prepare and submit to the Administrator...a [biennial] report which shall include...(A) a description of the water quality of all navigable waters in such State...; (B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water; (C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows for recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to the additional action necessary to achieve such objectives and for what waters such additional action is necessary...; (E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources....

Section 314(a): Each State on a biennial basis shall prepare and submit to the Administrator for his approval...an identification and classification according to eutrophic condition of all publicly owned lakes in such State...[and] an assessment of the status and trends of water quality in lakes in such State, including but not limited to, the nature and extent of pollution loading from point and nonpoint sources and the extent to which the use of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

Section 319(h): Each State shall report to the Administrator on an annual basis concerning...to the extent that appropriate information is available, reductions in nonpoint source pollution loading and improvements in water quality for those navigable waters or watersheds within the State...resulting from implementation of the [nonpoint source pollution control] program.

Code of Federal Regulations

40 CFR 35.168(a): The Regional Administrator may award section 106 funds to a State only if...the State monitors and compiles, analyzes, and reports water quality data as described in section 106(e)(1) of the Clean Water Act....

40 CFR 123.26(b): State programs shall have inspection and surveillance procedures to determine, independent of information supplied by regulated persons, compliance or noncompliance with applicable program requirements. The State shall maintain...a program for periodic inspections of the facilities and activities subject to regulation. These inspections shall be conducted in a manner designed to:

(i) Determine compliance or noncompliance with issued permit conditions and other program requirements;

(ii) Verify the accuracy of information submitted by permittees and other regulated persons in reporting forms and other forms supplying monitoring data; and

(iii) Verify the adequacy of sampling, monitoring, and other methods used by permittees and other regulated persons to develop that information....

40 CFR 130.4(a): In accordance with section 106(e)(1), States must establish appropriate monitoring methods and procedures (including biological monitoring) necessary to compile and analyze data on the quality of the waters of the United States and, to the extent practicable, ground-waters....

40 CFR 130.4(b): The State's water monitoring program shall include collection and analysis of physical, chemical and biological data and quality assurance and control programs to assure scientifically valid data. The uses of these data include determining abatement and control priorities; developing and reviewing water quality standards, total maximum daily loads, wasteload allocations and load allocations; assessing compliance with National Pollutant Discharge Elimination System (NPDES) permits by dischargers; reporting information to the public through the section 305(b) report and reviewing site-specific monitoring efforts.

40 CFR 130.6(c)(9): Identification and development of programs for control of ground-water pollution including the provisions of section 208(b)(2)(K) of the Act. States are not required to develop ground-water WQM plan elements beyond the requirements of section 208(b)(2)(K) of the Act, but may develop a ground-water plan element if they determine it is necessary to address a ground-water quality problem. If a State chooses to develop a ground-water plan element, it should describe the essentials of a State program...[including] monitoring and resource assessment programs in accordance with section 106(e)(1) of the Act.

Kansas Statutes Annotated

K.S.A. 65-161a: "Waters of the state" means all streams and springs, and all bodies of surface and subsurface water within the boundaries of the state....

K.S.A. 65-170: For the purpose of carrying out the provisions of this act it shall be the duty of the director of the division of environment to investigate and report upon all matters relating to water supply and sewerage and the pollution of the waters of the state that may come before the secretary of health and environment for investigation or action, and to make such recommendations in relation thereto as the director may deem wise and proper, and to make such special investigations in relation to methods of sewage disposal and public water supply and the purification of water as may be necessary in order to make proper recommendations in regard thereto, or as may be required by the secretary of health and environment.

K.S.A. 65-170b: In performing investigations or administrative functions relating to water pollution or a public water supply system...the secretary of health and environment or the secretary's duly authorized representatives upon presenting appropriate credentials, may enter any property or facility which is subject to the provisions of [this act], or any amendments thereto, for the purpose of observing, monitoring, collecting samples, examining records and facilities to determine compliance or noncompliance with state laws and rules and regulations relating to water pollution or public water supply.

The secretary of health and environment or the secretary's duly authorized representative shall make such requirements as they deem necessary relating to the inspection, monitoring, recording, and reporting by any holder of a sewage discharge permit...or any holder of a public water supply system permit....

K.S.A. 65-171a: The authority of the secretary of health and environment in matters of stream pollution is hereby supplemented to include stream pollution found to be detrimental to public health or detrimental to the animal or aquatic life of the state.

K.S.A. 65-171d(c): For the purposes of this act...and any amendments thereto, pollution means: (1) Such contamination or other alteration of the physical, chemical or biological properties of any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, or to the plant, animal or aquatic life of the state or to other designated beneficial uses; or (2) such discharge as will or is likely to exceed state effluent standards predicated upon technologically based effluent limitations.

APPENDIX B

Core and Supplemental Physicochemical Parameters: KDHE Surface Water and Fish Tissue Monitoring Programs

Stream Chemistry and Stream Probabilistic Monitoring Programs

Core Composite and Inorganic Parameters

Alkalinity, total (as $CaCO_3$)
Aluminum, total recoverable
Ammonia, total (as N)
Antimony, total recoverable
Arsenic, total recoverable
Barium, total recoverable
Beryllium, total recoverable
Boron, total recoverable
Bromide
Cadmium, total recoverable
Calcium, total recoverable
Carbon, total organic
Chloride
Chromium, total recoverable
Cobalt, total recoverable
Copper, total recoverable
Dissolved oxygen
Fluoride
Hardness, total (as $CaCO_3$)
Iron, total recoverable
Kjeldahl nitrogen
Lead, total recoverable
Magnesium, total recoverable
Manganese, total recoverable
Mercury, total
Molybdenum, total recoverable
Nickel, total recoverable
Nitrate (as N)
Nitrite (as N)
pH (field)
Phosphate, ortho- (as P)
Phosphorus, total (as P)
Potassium, total recoverable
Selenium, total recoverable
Silica, total recoverable (as SiO_2)
Silver, total recoverable
Sodium, total recoverable
Specific conductance
Strontium, total recoverable
Sulfate
Thallium, total recoverable
Total dissolved solids (calculated)
Total suspended solids
Turbidity
Vanadium, total recoverable
Zinc, total recoverable
Temperature (field)

Core Organic Parameters

Acetochlor
Alachlor
Aldrin
Atrazine (Aatrex)
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Butachlor
Carbofuran (Furadan)
Chlordane
Cyanazine (Bladex)
DCPA (Dacthal)
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Methoxychlor
Metolachlor (Dual)
Metribuzin (Sencor)
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
Propachlor (Ramrod)
Propazine (Milogard)
Simazine
Toxaphene

Supplemental Organic Parameters

Chlorophyll-a
Chlorpyrifos (Dursban)
Deethylatrazine
Desethylated atrazine
Diazinon
Pentachlorophenol
Pheophytin-a
Prometon (Pramitol)

Supplemental Radiological Parameters

Actinium-228
Americium-241
Antimony-125
Barium-140
Beryllium-7
Cerium-141
Cerium-144
Cesium-134
Cesium-136
Cesium-137
Chromium-51
Cobalt-57
Cobalt-58
Cobalt-60
Gallium-67
Gross alpha
Gross beta
Gross uranium
Indium-111
Iodine-123
Iodine-131
Iodine-132
Iodine-133
Iron-59
Lanthanum-140
Lead-212
Lead-214
Manganese-54
Molybdenum-99
Neodymium-147
Neptunium-239
Niobium-95
Potassium-40
Radium-226
Radium-228
Ruthenium-103
Ruthenium-106
Silver-110m
Technetium-99m
Thorium-228
Total Solid
Tritium
Ytterbium-169
Zinc-65
Zirconium-95

Lake and Wetland Water Quality Monitoring Program

Core Composite and Inorganic Parameters

Alkalinity, total (as $CaCO_3$)
Aluminum, total recoverable
Ammonia, total (as N)
Antimony, total recoverable
Arsenic, total recoverable
Barium, total recoverable
Beryllium, total recoverable
Boron, total recoverable
Bromide
Cadmium, total recoverable
Calcium, total recoverable
Carbon, total organic
Chloride
Chromium, total recoverable
Cobalt, total recoverable
Copper, total recoverable
Dissolved oxygen (field profile)
Fluoride
Hardness, total (as $CaCO_3$)
Iron, total recoverable
Kjeldahl nitrogen
Lead, total recoverable
Light (PAR) (field profile)
Magnesium, total recoverable
Manganese, total recoverable
Mercury, total
Molybdenum, total recoverable
Nickel, total recoverable
Nitrate (as N)
Nitrite (as N)
pH (field)
Phosphate, ortho- (as P)
Phosphorus, total (as P)
Potassium, total recoverable
Selenium, total recoverable
Silica, total recoverable (as SiO_2)
Silver, total recoverable
Sodium, total recoverable
Specific conductance
Strontium, total recoverable
Sulfate
Temperature (field profile)
Thallium, total recoverable
Total dissolved solids (calculated)
Total suspended solids
Turbidity
Vanadium, total recoverable

Core Organic Parameters

Acetochlor
Alachlor
Aldrin
Atrazine (Aatrex)
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Butachlor
Carbofuran (Furadan)
Chlordane
Chloropyll-a
Cyanazine (Bladex)
DCPA (Dacthal)
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Methoxychlor
Metolachlor (Dual)
Metribuzin (Sencor)
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
Pheophytin-a
Picloram (Tordon)
Propachlor (Ramrod)
Propazine (Milogard)
Simazine
Toxaphene
2,4-D as acid
2,4,5-T as acid (Silvex)

Supplemental Organic Parameters

Microcystins
Perchlorate

Fish Tissue Contaminant Monitoring Program

Core Organic and Inorganic Parameters

gamma-BHC (Lindane)
Cadmium
Chlordane, technical
cis-Chlordane
trans-Chlordane
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Lead
Mercury
Mirex
cis-Nonachlor
trans-Nonachlor
Oxychlordane
PCB-1248
PCB-1254
PCB-1260
Pentachloroanisole
Pentachlorobenzene
Selenium
1,2,4,5-Tetrachlorobenzene
Trifluralin (Treflan)

Supplemental Organic and Inorganic Parameters

Acenaphthene
Acenaphthylene
Acrolein
Acrylonitrile
Alachlor (Lasso)
Aldrin
Aluminum
Aniline
Anthracene
Antimony
Aroclor-1248
Aroclor-1254
Aroclor-1260
Arsenic
Atrazine (Aatrex)
Azinphosmethyl (Guthion)
Barium
Benzene
Benzidine
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzoic acid
Benzo(g,h,i)perylene
Benzo(a)pyrene
Benzylalcohol
Beryllium
alpha-BHC
beta-BHC
delta-BHC
Bromoform
4-Bromophenyl phenyl ether
Butylbenzylphthalate
Calcium
Carbon tetrachloride
Chlorobenzene
Chlordene
alpha-Chlordene
beta-Chlordene
gamma-Chlordene
Chlorodibromomethane
Chloroethane
bis(2-Chloroethoxy)methane
4-Chloroethoxy phenyl ether
bis(2-Chloroethyl)ether
2-Chloroethyl vinyl ether
Chloroform
bis(2-Chloroisopropyl)ether
p-Chloro-m-cresol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chlorpyrifos (Dursban)
Chromium
Chrysene
Cobalt
Copper
Demeton (Systox)
Dibenzo(a,h)anthracene
o,p'-DDE
o,p'-DDD
o,p'-DDT
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3-Dichlorobenzidine
Dichlorobromomethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,1-Dichloroethylene
1,2,-trans-Dichloroethylene
2,4-Dichlorophenol
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Diethylphthalate
2,4-Dimethylphenol
Dimethylphthalate
Di-n-butylphthalate
4,6-Dinitro-o-cresol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphthalate
1,2-Diphenylhydrazine
alpha-Endosulfan
beta-Endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Ethylbenzene
bis(2-Ethylhexyl)phthalate
Ethyl parathion
Fluorene
Fluoranthene
Fonofos (Dyfonate)
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
Hexachlorobutadiene
Hexachlorocyclopentadiene
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
Hexachloroethane
Indeno(1,2,3-c,d)pyrene
Iron
Isophorone
Lipids, total (%)
Malathion
Manganese
Magnesium
Methoxychlor
Methyl bromide
Methyl chloride
Methylene chloride
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Metolachlor
Metribuzin (Sencor)
Molybdenum
Naphthalene
Nickel
2-Nitroanaline
3-Nitroanaline
4-Nitroanaline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodi-n-propylamine
N-Nitrosodiphenylamine
PCB-1016
PCB-1221
PCB-1232
PCB-1242
Penoxalin (Prowl)
Pentachloroanisole
1,2,3,7,8-Pentachlorodibenzo-p-dioxin
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
Pentachlorophenol
cis-Permethrin
trans-Permethrin
Phenanthrene
Phenol
Potassium
Prometon (Pramitol)
Propazine (Milogard)
Pyrene
Simazine (Princep)
Silver
Sodium
Styrene
2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,3,7,8-Tetrachlorodibenzofuran
1,1,2,2-Tetrachloroethane
1,1,2,2-Tetrachloroethene
Tetrachloroethylene
Thallium
Titanium
Toluene
Toxaphene
1,2,4-Trichlorobenzene
Trichloroethane
Trichloroethylene
Trichlorfon (Dylox)
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Vanadium
Vinyl chloride
Zinc