WATER QUALITY AND USE

Beneficial Use Attainment

All streams in the Elk River basin are classified for aquatic life protection, fishing, and livestock/wildlife watering. The permanent flowing reaches of the Elk River, Buffalo Creek, Indian Creek, Big Sugar Creek, and Lost Creek are also classified for whole body contact recreation and boating. The permanently flowing reaches of South Indian Creek are classified for coldwater sport fishery (MDNR 1985).

Section 303(d) of the Clean Water Act requires states to list waters not expected to meet established, state water quality standards even after application of conventional technology-based controls for which total maximum daily load (TMDL) studies have not yet been completed. The list is produced annually by the MDNR and includes waters for which existing required pollution controls are not stringent enough to maintain state water quality standards. The 1998 MDNR list includes: 35 miles of Big Sugar Creek; 9 miles of Buffalo Creek; 21.5 miles of Elk River; 26 miles of Indian Creek; 10.5 miles of North Indian Creek; 9 miles of South Indian Creek; 11 miles of Little Sugar Creek; and 2 miles of Patterson Creek in the Elk River basin (MDNR 1998b). These streams in the Elk River basin are negatively impacted by nutrients from livestock production and are not expected to meet water quality standards through the implementation of any currently required pollution control technology (MDNR 1998b).

Town Branch, a tributary of Little Sugar Creek that originates in the Bentonville area, was monitored by the Arkansas Department of Pollution Control and Ecology (ADPCE) and was found to be non-supporting for drinking water uses and only partially supporting of aquatic life protection. The pollutants causing the problems were nutrients of municipal point source origin (ADPCE 1996). Little Sugar Creek was evaluated as partially supporting protection of aquatic life primarily due to chronic turbidity and elevated nutrients from agricultural and municipal non-point sources. Other sources of pollutants in the area causing non-support of aquatic life use were pasture used for poultry waste application, instream gravel removal, and road construction (ADPCE 1996).

Chemical Quality of Streams

The overall water quality of streams in the Elk River basin historically has been excellent with isolated pollution incidents causing localized problems, usually of short duration. A basin-wide water quality network was started in 1990 to monitor water quality changes because of concern over the large amounts of animal wastes land applied in the basin. A tremendous increase in the number of confined animal operations in this area resulted in increased application of animal wastes. The trend in water quality in the basin as shown by USGS data (intermittently collected from 1967 through 1993) and Crowder College data (1990-1993) was upward for total nitrogen. It was suspected that bacteria (fecal coliform and/or fecal strep) levels in basin streams may be exceeding state water quality standards during the

recreational season and under normal flow conditions.

Water quality investigations are underway to determine the extent of phosphorus contamination, but only preliminary summaries are currently available. In most stream systems phosphorus availability is the factor limiting plant and algae growth. When phosphorus increases, the limiting effect is altered and excessive plant and algae growth often results. The U. S. Environmental Protection Agency (EPA) suggests that phosphorus should be 0.1 mg/L or less to prevent nuisance plant growth in streams (USGS 1999b). The EPA index of watershed indicators report on ambient water quality monitoring of phosphorus, pH, dissolved oxygen, and ammonia in the Elk River basin found phosphorus exceeding established criteria in 45 percent of the observations. Ammonia, dissolved oxygen, and pH exceeded established criteria in less than 5 percent of the observations (U.S. Environmental Protection Agency website 1999).

Contaminants, Fish Kills, and Health Advisories

Groundwater in Lanagan and Noel was found to have radium levels in excess of established drinking water standards (Barnett et al. 1985). Another problem in the Elk River basin is hydrogen sulfide in domestic wells (Barnett et al. 1985). Soil and tank dioxin residue from a defunct wastewater school at Neosho may affect Buffalo Creek (MDNR 1985). The Arkansas Geological Commission (AGC) is recommending deep groundwater wells in northwest Arkansas due to concerns about nitrate contamination of shallow groundwaters (AGC, pers. comm.).

A study was completed on the water quality of 40 wells in the watershed between August 1990 and April 1992. The study was initiated over the growing concern about large numbers of confined animals in McDonald County and the threats they may pose to groundwater quality. The study found that 25% of the wells sampled had unsatisfactory fecal coliform counts. Results from samples collected during this period were compared to similar samples from the 1960s. These comparisons suggest nitrate levels in the Springfield aquifer, underlying McDonald County, have increased (MDNR 1996).

Water quality problems associated with increased urban development are an ongoing concern in the Little Sugar Creek sub-basin (MDNR 1985 and MDNR 1996). Population increases in Benton County, Arkansas (chiefly around the Bentonville area) are suspected as the primary reason for increased nutrification and algal growth in Little Sugar Creek. Other sources of pollutants in the area are pasture used for poultry waste application, instream gravel removal, and road construction (ADPCE 1996). Lakes in the Bella Vista development are fertilized to increase sportfish production. These combined influences probably contribute to the excessive nutrient loading seen in Little Sugar Creek. The Arkansas portion of the watershed has experienced significant urban development (U.S. Census Bureau Home Page 1998), while the Missouri portion of the watershed remains more rural in nature. This may be changing as urbanization expands from northwest Arkansas into southwest Missouri.

Reports of pollution and fish kills has increased over the past 15 years. There may be several reasons including increased pollution events, increased environmental awareness and activism, better monitoring by state and federal agencies, or a combination of these factors. The potential for pollution events from confined agriculture operations has significantly increased since the early 1980s. Recurring spills from poultry processing plants in the basin have caused problems in area streams. Animal feeding operations problems relating to animal waste management and disposal have been publicized in the media from many areas of the United States and in Missouri. There are also vocal citizen groups in the Elk River basin that have been active in pursuing agricultural pollution related issues. These circumstances have

probably sensitized and polarized the residents in the area concerning pollution from agriculture and related industries. Table 6 lists pollution investigations involving MDC from 1977 through 1998. The table is divided into two sections. Before 1982 there was very little confined animal agriculture in the basin. Since 1982 there has been tremendous growth in the confined animal industry. All fish in the Elk River basin are considered safe to eat in any amount (MDOH 1999).

Water Use

Water for domestic use in the Elk River basin is often drawn from groundwater sources. Precipitation and runoff easily percolate through area soils and rapidly recharge groundwater aquifers. The ready infiltration of precipitation and runoff can lead to contamination of groundwater supplies if good watershed stewardship practices are not followed.

There is one public water supply district in the Elk River Basin in Missouri (MDNR 1986). Most communities in the Missouri portion of the basin obtain water from wells (Table 7). Figure 16 shows the location of permitted wells within the Missouri portion of the Elk River basin.

Water use in the Elk River basin in Missouri is about 2.2 trillion gallons per year. Public and domestic use accounts for 1.4 trillion gallons, industrial/commercial use 409 million gallons, and agriculture for 384 million gallons (DuCharme and Miller 1996).

Point Source Pollution

Missouri Clean Water Commission (MCWC 1974) testing of streams in the Elk River basin found very little variation in chemical and bacteriological parameters. A small elevation in coliform bacteria counts was observed in Indian Creek above Highway 71 near Anderson, Missouri. Effluent from a poultry processing plant and cheese plant were indicated as the reason for reduced water quality. A report by the MDNR in 1976 mentioned that these two industries had ceased operation, and an improvement in water quality was expected. Intermittent gravel mining was also mentioned as causing occasional turbidity problems when it was operating in Indian Creek. This was the only site that was described as not having excellent water quality in the Elk River basin in Missouri (MDNR 1976).

Other water quality concerns are nutrient loading from the Arkansas portion of the watershed to Little Sugar Creek and high levels of nitrate in springs and streams with the potential for CAFO related toxic levels of ammonia in the Little Sugar Creek and Big Sugar Creek sub-basins (MDNR 1985).

Water quality concerns associated with point sources were listed in the Missouri Water Quality Basin Plan (MDNR 1996). The problems associated with point source discharges at this time included: exceeding fecal coliform standards from the Anderson wastewater treatment facility (WWTF); 0.6 miles of stream impacted by the Goodman WWTF; 5.5 miles of stream impacted by the Neosho South WWTF; 0.2 miles of stream impacted by the Pineville WWTF; seepage to a road ditch from an unsewered portion of Fairview; foam and odor problems from a Hudson poultry processing plant; lime deposits in a stream from Lanagan Quarry; sludge and erosion problems associated with the Newton-McDonald county landfill; red algae growth and lowered benthic diversity in Cave Spring Branch caused by Simmons poultry processing plant; 0.5 miles of stream impacted by Noel Water Company; over-application of irrigation water by Wheaton WWTF; and 17 recorded incidents associated with corporate farming, including discharge of waste to streams and poor manure spreading practices (MDNR 1985).

The Clean Water Act requires wastewater dischargers to have a permit establishing pollution limits, and

Table 6. Fish kills and water pollution investigations in the Elk River basin, 1970 - 1998.

Date	Stream	County	# of Fish	Est. value	Cause/Source
July 07, 1981	Miser Hollow Branch	McDonald			petroleum
July 29, 1980	Elk River	McDonald			grain
Nov. 20, 1978	Elk River	McDonald			septic tank seepage
Nov. 20, 1978	Little Sugar Creek	McDonald			sewage effluent/silt
Pre-1982 Total			0	0.00	
Oct. 13, 1998	Cave Spring Branch	McDonald	8	$4.02	poultry processing waste
Sep. 3, 1998	Elk River	McDonald			ammonia
Jul. 14, 1998	Elk River	McDonald	250-300 mussels		sewage suspected
Apr. 2, 1998	Honey Creek	McDonald			concrete
Feb. 24, 1998	Cave Spring Branch	McDonald	0		poultry processing waste
Jul. 28, 1997	Elk River	McDonald			high temp./low flow
May 7, 1997	Elk River				unknown
Aug. 9, 1996	Thief Hollow Creek	McDonald			hydraulic fluid
Jul. 26, 1996	Butts Ponds	McDonald			poultry manure
Mar. 29, 1996	Elk River (floodplain)	McDonald			food processing wastes
Sep. 25, 1995	Elk River	McDonald			municipal wastewater

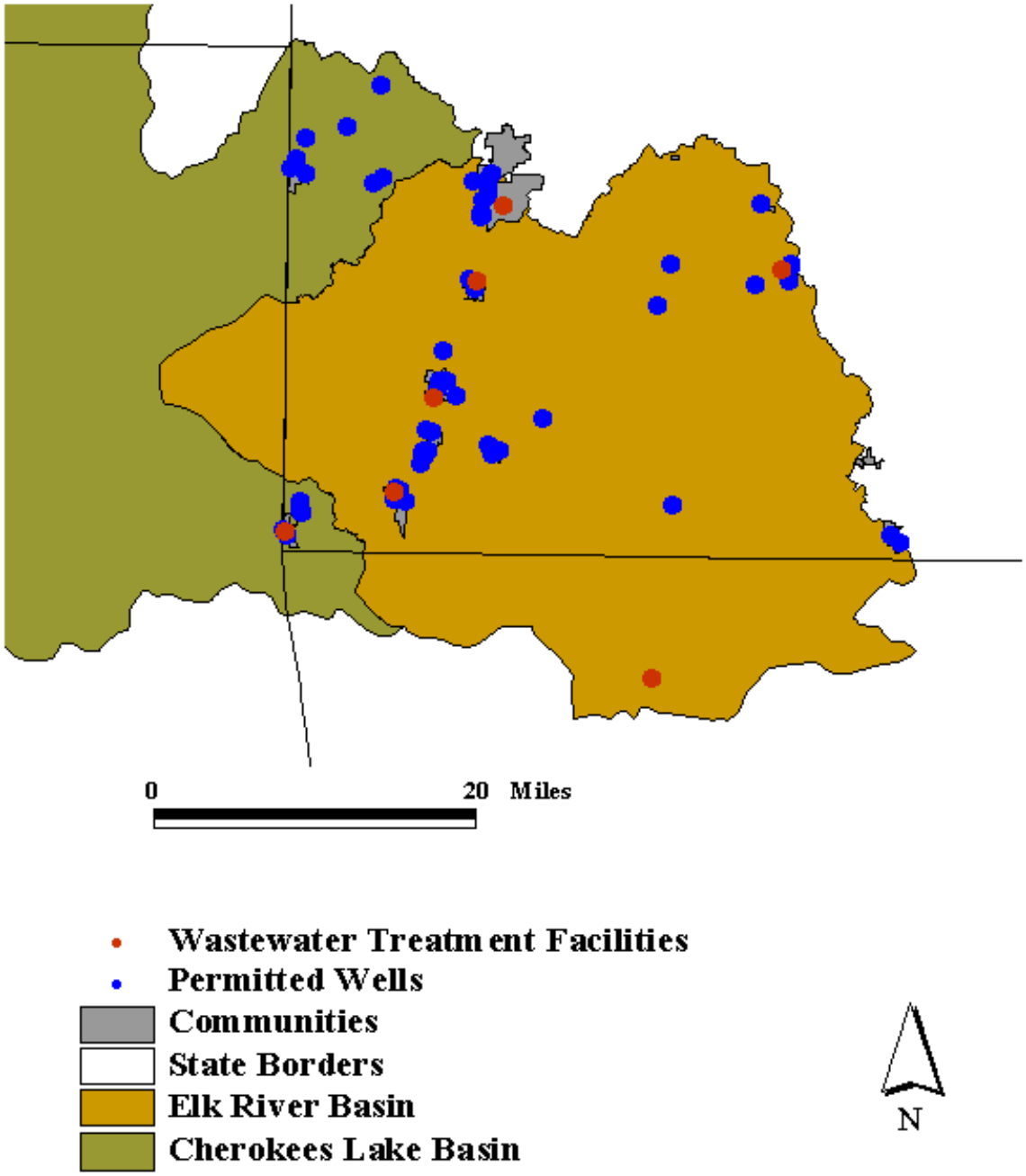
Oct. 07, 1994	Little Sugar Creek	McDonald			diesel fuel
Oct. 22, 1994	Stogdon Creek	McDonald			poultry waste
Dec. 20, 1991	Honey Creek	McDonald			petroleum
Aug. 09, 1989	Little Sugar Creek	McDonald	0		mining
Mar. 13, 1987	Cave Springs Branch	McDonald	317	$50.62	poultry waste
Dec. 08, 1986	Indian Creek	McDonald	0	0	railroad
May 12, 1985	Buffalo Creek	McDonald	0	0	unknown
Apr. 27, 1984	Indian Creek	McDonald			municipal sewage
Dec. 09, 1983	Indian Creek	McDonald	unknown	0	dodecyl benzen/railroad
Aug. 08, 1982	Patterson Creek	McDonald			unknown pesticide
Post-1982 Total			325	$54.64	

Table 7. Municipal water supplies in the Elk River basin in Missouri.

Community	Source	Capacity (million gallons/day)
Seneca	Well	1-10
Goodman	Well	less than .25
Stella	Well	less than .25
Lanagan	Well	less than .25
Pineville	Well	less than .25
Anderson	Well	.25-1.0
Southwest City	Well	.25-1.0
Noel	Well	1-10
Seligman	Well	less than .25
Washburn	Well	less than .25

Source: MDNR (1986).

Figure 16. Permitted wells and wastewater treatment facilities in the Elk River basin.



specifying monitoring and reporting requirements. National Pollutant Discharge Elimination System (NPDES) permits regulate household and industrial wastes that are collected in sewers and treated at municipal wastewater treatment plants. These permits also regulate industrial point sources and concentrated animal feeding operations that discharge into other wastewater collection systems or that discharge directly into receiving waters. Table 8 lists NPDES permitted point source discharges in the Elk River basin.

The Toxic Release Inventory (TRI) is an EPA generated source of information about toxic chemicals that are being used, manufactured, treated, transported, or released into the environment from various sources. Table 9 lists facilities in the Elk River basin that are monitored as part of the TRI system.

Hazardous waste information is tracked by state and federal agencies as part of the Resource Conservation and Recovery Act (RCRA). EPA maintains this information in a database called the Resource Conservation and Recovery Information System (RCRIS). Table 10 lists various facilities in the Elk River basin that generate, transport, treat, or dispose of hazardous waste that are monitored under RCRA.

Air emissions of pollutants is reported on as part of the Aerometric Information Retrieval System (AIRS). The AIRS facility subsystem (AFS) contains information on compliance and emissions of facilities with air pollution point sources that are monitored by EPA and/or state regulatory agencies. Table 11 lists facilities that are monitored under the AIRS/AFS system in the Elk River basin.

Non-Point Source Pollution

Animal Feeding Operations

The Elk River basin is an area of low human population but intense confined animal agriculture. Corporate farming, concentrated poultry and hog operations, are the largest water quality concern in the watershed. The main concern associated with these operations are the large amounts of land-applied waste and the potential for direct contamination from animal waste lagoons. The majority of the animal feeding operations in the watershed produce poultry. Processing plants associated with the confined animal industry have negatively impacted water quality in streams of the Elk River watershed.

The Missouri Department of Natural Resources (MDNR) tracking records indicate that there were six permitted animal feeding operations in the watershed in 1982, with a human population equivalent (PE) of 94,724. Population equivalent (PE) is a measurement that converts waste of biological origin to the equivalent amount of human population needed to cause the same effect. In 1985 free-ranging livestock (cattle) were listed as the main concern and confined livestock second (MDNR 1985). In 1985 the number of hogs and cattle in the watershed was estimated to produce 1,559,000 PE, and the poultry operations in the watershed were estimated to produce 177,800 PE of waste. The total estimated population equivalent waste produced by livestock and poultry in the watershed was 1,736,800 in 1985 (MDNR 1985).

In 1995 animal confinement waste was listed as a "basin-wide concern" with no mention of free-ranging livestock (MDNR 1996). By 1998 there were 265 animal feeding operations (4,417 % increase over 1982) in the watershed (MDNR 1998a). Of these confinement operations, 252 were poultry. They produced estimated wastes of 1,374,984 PE (MDNR 1998a). There are an estimated 90,064 head of cattle in the watershed with an estimated PE of 1,116,793 (MASS 1998). The two combined are estimated to produce waste equal to that of 2,491,777 people. This estimate may be low considering

Table 8. Permitted point source discharges in the Elk River basin.

Facility	Type Facility	Design PE[1]	Receiving Stream	NPDES Permit
Anderson	1 - Cell Lagoon		Indian Creek	IMO0025801
Goodman #1	1 - Cell Lagoon		Tributary of Buffalo Creek	IMO0040771
Goodman #2	1 - Cell Lagoon		Tributary of Indian Creek	IMO0040789
Goodman #3	1 - Cell Lagoon		Tributary of Indian Creek	IMO0040797
Neosho South	Trickling filter-Tertiary	17,647	Buffalo Creek	IMO0039934
Noel	2 - Cell Lagoon		Elk River	IMO0054721
Seneca	2 - Cell Lagoon		Lost Creek	IMO0023035
South West City (Domestic)	2 - Cell Lagoon		Honey Creek	IMO0036765
South West City (Industrial Park)	Aerated Lagoon	10,000	Cave Spring Branch	IMO0036773
Stella	2 - Cell Lagoon		No Discharge	LA2240
Wheaton	1 - Cell Lagoon		Tributary of S. Indian Creek	IMO0041041
Teledyne			Buffalo Creek	IMO0002518
Linde Company			Buffalo Creek	IMO0083411
Noel Water Company	2 - Cell Lagoon and Polishing Lagoon	32,250	Elk River	IMO0002500
Lanagan Housing Authority	Extended Aeration Plant	24	Tributary of Indian Creek	IMO0049948
Noel Suds Parlor	1 - Cell Lagoon	42	Elk River	IMO0082741

Pineville Laundry	Rock Filter		Elk River	
Pineville Housing Authority	Extended Aeration Plant	42	Dog Hollow Creek	IMO0037028
Browning Laundry	1 - Cell Lagoon	46	Tributary of Big Sugar Creek	IMO0049468
Edgewaters Enterprises Inc.	Septic Tank and Sand Filter	5	Tributary of Buffalo Creek	IMO0082376
Ozark Hillbilly Mobile Home Park	2 - Cell Lagoon	15	Tributary of Buffalo Creek	IMO0084531
Benton County Stone Company			Tributary of Butler Creek	AR0046639
City of Bentonville			Town Branch	AR0022403
City of Pea Ridge			Otter Creek	AR0020672
City of Sulphur Springs			Butler Creek	AR0036480
Village Wastewater Company - North			Little Sugar Creek	AR0034258
Village Wastewater Company - Inc.			Little Sugar Creek	AR0034266

[1] - Human Population Equivalent

Source: ADPCE (1996) and MDNR (1998a).

Table 9. Toxic release inventory facilities in the Elk River basin.

Facility	Facility ID	Address	City	State
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Cooper Furniture Industries Inc.	MOD985774629	150 W. Boyer Street	Goodman	MO
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Kraft General Foods	ARD040628919	507 SE E Street	Bentonville	AR
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Simmons Industries	MOD037130184	Rt. 1	South West City	MO
Sunbeam Leisure Products Company	MOD041707563	4101 Howard Bush Drive	Neosho	MO
Tyson Foods Krispy Kitchens	ARD983269127	801 SE 8th Street	Bentonville	AR

Source: U.S. Environmental Protection Agency website (1999).

Table 10. Facilities that are involved with hazardous wastes in the Elk River basin.

Facility	Facility ID	Address	City	State
American Store Interiors	ARD981593882	205 SE S Street	Bentonville	AR
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Bentonville City Wastewater Plant	ARD980507586	SE 3rd & D	Bentonville	AR
Concordia Care Center	ARD053142907	7 Professional Drive	Bella Vista	AR
Crowder College - Env. Res. Ctr.	MO0000679738	601 Laclede Avenue	Neosho	MO
CTS Corporation	ARD078907821	1300 SE 8th Street	Bentonville	AR
Ex-Cell of Bentonville	AR0000334862	301 SE J Street	Bentonville	AR
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Kraft General Foods	ARD040628919	507 SE E Street	Bentonville	AR
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO
Marble Enterprises Inc.	MOD985768597	Rt. 6 Box 41 M	Neosho	MO
Old Town One Hour Dry Cleaners	ARD983272642	1009 NW 11th	Bentonville	AR
Precision Manufacturers Inc.	ARD983267253	203 SE S Street	Bentonville	AR
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Rain Forest Moose Ltd.	AR0000548321	11739 Lindy	Rogers	AR

Rogers Tool Works Inc.	**ARD980620256**	**1602 E Central Street**	**Bentonville**	**AR**
Sibley Agri Corp.	**MOD985792266**	**Sibley Industrial Park Rd.**	**Anderson**	**MO**
Sibley Engineering and Manufacturing Co.	**MOD053157277**	**Hwy 59 S**	**Noel**	**MO**
Stella Precision Fabricators	**MOD098267826**	**NE edge of town**	**Stella**	**MO**
Village Dry Cleaners	**ARD184741775**	**27 Riordan Road**	**Bella Vista**	**AR**
Wal-Mart PMDC	**ARD983267691**	**1108 SE 10th Street**	**Bentonville**	**AR**
Wal-Mart Stores Inc.	**ARD138091079**	**601 Walton Boulevard**	**Bentonville**	**AR**
Wal-Mart Stores Inc.	**ARD983274143**	**1102 SE 5th Street**	**Bentonville**	**AR**
Wholesale Transmission	**ARD056582273**	**510 SW A Street**	**Bentonville**	**AR**

Source: U.S. Environmental Protection Agency website (1999).

Table 11. Facilities with airborne pollutant emissions in the Elk River basin.

Facility	Facility ID	Address	City	State
Bailey Quarries Inc. - Jane Quarry	MO0001553684	South of Hwy 90	Jane	MO
Bates Medical Center	AR0001253210	602 N. Walton	Bentonville	AR
Bella Vista Funeral Home	AR0001253228	2258 Forest Hills Boulevard	Bella Vista	AR
Benton County OES	ARD983278706	201 NE 2nd	Bentonville	AR
Bentonville Casting Co.	ARD983266792	1019 SE 8th Street	Bentonville	AR
Bentonville School District 6	ARD981157068	400 NW 2nd Street	Bentonville	AR
Central States Press	MO0001565027	Hwy 71	Nevada	MO
Community Publishers, Inc.	AR0000818922	209 NW A Street	Bentonville	AR
Concordia Care Center	ARD053142907	7 Professional Drive	Bella Vista	AR
Cooper Furniture Industries Inc.	MOD985774629	150 W. Boyer Street	Goodman	MO
CTS Corporation	ARD078907821	1300 SE 8th Street	Bentonville	AR
Dixieland Inc.	AR0001425552	702 SE 5th	Bentonville	AR
Dynamic Enterprises Inc. - Bill Fleeman	AR0001573237	813 W Central	Bentonville	AR
Evan Electric Motor Center	ARD983268434	2001 N 13th Street	Rogers	AR
First Baptist Church	ARD983278722	200 SW A	Bentonville	AR
FM Corporation	ARD086635018	2503 Walter Tower Road	Rogers	AR
Foam Corporation	ARD983286709	3535 Hudson Road	Rogers	AR
Hudson Foods Inc.	MOD985774728	Hwy 59 N. & DD Hwy	Noel	MO
Jobe Enterprises Inc.	MOD985814516	Rt. 6	Neosho	MO
La Z Boy Midwest Chair Company	MOD049563273	4301 Howard Bush Drive	Neosho	MO
Ozark Wood Products Inc.	MOD985813380	Hwy 71 & C	Goodman	MO
Premier Turbines	MOD050715655	3551 Doniphan Drive	Neosho	MO
Simmons Industries	MO0001553403	Hwy 59 S	Anderson	MO

Southwest Lime Co.	**MO0001558063**	**Hwy EE**	**Lanagan**	**MO**
Southwestern Bell	**ARD983278656**	**Hwy 71**	**Bella Vista**	**AR**
Southwestern Bell	**ARD983285537**	**207 SW A Street**	**Bentonville**	**AR**
Wal-Mart Stores Inc.	**ARD138091079**	**601 Walton Boulevard**	**Bentonville**	**AR**
Walton Enterprises	**AR0000815530**	**125 W Central, Suite 21**	**Bentonville**	**AR**

Source: U.S. Environmental Protection Agency website (1999).

animal feeding operations that house less than 7,000 animal units are not required to hold permits or letters of approval (LOA) and the number of poultry and hogs raised without permit or LOA are not part of this figure. Parts of the Elk River basin that lie in Arkansas and Oklahoma are also not included in these estimates, so they are undoubtedly higher than the figures presented. Known information on animal feeding operations in the Elk River basin can be found in Appendix B.

Animal feeding operations that have more than 7,000 animal units in Missouri are regulated by MDNR. MDNR animal feeding operation regulations require (based on the number of animal units) a specified area of vegetated land be available and used for the spreading of waste. If enough land is not available, the waste must be hauled and spread elsewhere, sold, or contained in closed lagoons. The increased number of animal feeding operations in the watershed are related to increased land conversion to pasture or crop land. Land application of animal waste (primarily poultry litter) has added to soil productivity and improved pasture and hay production. These elements have lead to an unquantified increase in land clearing and cattle production (G. Parsons and V. Kugler, MDNR, pers. com.). Arkansas regulates liquid waste storage and disposal, while dry litter handling and disposal is unregulated.

George Parsons (MDNR, pers. comm.) indicated that many animal feeding operation operators, who land apply dry waste, may over-apply the manure. In Arkansas the disposal of dry litter is not regulated so the amount applied is unknown. Phosphorus contamination of streams in the watershed is inevitable if wastes are over-applied. This will probably increase the miles of streams in the Elk River basin that do not meet water quality standards in the future.

Free-ranging cattle and problems associated with them, including waste introduced to surface and groundwater, stream corridor destruction, and increased soil erosion, are concerns in the Elk River basin. Observations made during an April 1998 flyover of the basin confirmed that large numbers of cattle were present. Subsequent conversations with MDNR personnel, responsible for regulating and inspecting animal feeding operations, indicate that a symbiotic relationship exists between corporate agriculture and other agricultural land use practices. With an increase in the number of animal feeding operations, an increase in clearing for pasture and commensurate increase in cattle numbers occurs (G. Parsons and V. Kugler, MDNR, pers. comm.).

Results from the United States Census of Agriculture (NASS 1992) found that Barry ($95,299,000), Newton ($84,209,000), and McDonald ($80,162,000), were the top three Missouri counties for market value of livestock and poultry products. In 1997 McDonald ($153,519,000), Barry ($147,844,000), and Newton ($117,404,000) counties ranked second, third, and fourth respectively, in market value of livestock and poultry products (NASS 1998). These are further examples of the expanding poultry and livestock industry in the basin.

Erosion

Sheet and rill erosion on tilled lands is 13-18 tons/acre/year, pasture 5-9 tons/acre/year, and ungrazed forest less than 0.5 tons/acre/year. Gully erosion is slight, with less than 100 tons/mi^2/year. Sheet erosion for all lands within the Elk River basin averages 4.4 tons/acre/year. Sediment yield by streams in the Elk river basin is 1.4 tons/acre/year, primarily from sheet and rill erosion (Anderson 1980). Erosion is not considered to be a severe problem in the Elk River basin (MDNR 1985 and MDNR 1996). Helicopter video taken in the spring of 1998 revealed localized streambank erosion problems throughout the watershed.

Figures from 1973 indicate that 5% to 10% of the land in the watershed was in cultivation, with about the same amount in pasture production. Watershed land use was listed as 35% row crops and pasture and 65% forested from 1985 through 1995 (MDNR 1985; MDNR 1996). Land in cultivation and pasture production has probably increased throughout the watershed as the number of animal feeding operations has increased. Considerably more land has been cleared for pasture production, and the balance between pasture/row crop and forest land use in now closer to 50:50 (George Parsons, MDNR, pers. comm.).

Most riparian clearing is localized and problems associated with streambank erosion occur at various sites throughout the watershed. Lost Creek and the upper one-third of Indian Creek were areas with noticeably poor or missing riparian corridors. A larger than normal gravel bedload was observed in Big Sugar Creek.

Urbanization

Water quality problems associated with increased urban development are an ongoing concern in the Little Sugar Creek sub-basin (MDNR 1985; MDNR 1996). Little Sugar Creek headwaters originate in the Bentonville area and then flow through the Bella Vista retirement community before entering Missouri. The cities of Bella Vista and Bentonville, Arkansas had a 1990 combined population of 21,340 people. The entire population of McDonald County, Missouri in the same year was 16,938. The 1980 population of Benton County, Arkansas, of which about half lies in the watershed, was 78,115. The 1990 Benton County, Arkansas, population was 97,499 (25% increase). It increased to 120,932 (55% increase) in 1995, and 134,162 (72% increase) in 1998. Much of this increase has been in the Bentonville and Bella Vista areas. McDonald County’s population was 14,917 in 1980, 16,938 (13% increase) in 1990, 18,553 (24% increase) in 1995, and 19,887 (33 % increase) in 1998 (U.S. Census 1998). It appears that urbanization may be expanding from northwest Arkansas into southwest Missouri. Population increases in the Arkansas portion of the Elk River basin will affect Missouri waters. Increasing nuisance algae has been noted in Little Sugar Creek in Missouri (MDNR 1996). Possible problems with reduced flows from Arkansas into the Missouri portion of the watershed have also become a concern. Decreased flows have the potential to negatively affect water quality and aquatic life in the watershed.

Mining

Gravel mining (including removal of gravel from streambeds) occurs throughout the Elk River basin. Little Sugar Creek and its tributaries appear to have the most intensive gravel mining of all the sub-watersheds in the basin. There are many small localized areas where it appears the landowner has removed gravel from or re-arranged gravel bars to use on farm roads and/or try to prevent bank erosion. Another type of rock mining that is significant in the Elk River basin is limestone quarrying. Several large limestone quarries are found in the basin.

Mining of lead, zinc, and tripoli was conducted in the northernmost areas of the basin (part of the tri-state mining district). Most of this mining activity has ceased, but old mine shafts and mine tailings can be found in the upper reaches of the Indian Creek sub-basin and Buffalo Creek sub-basin. These areas may create water quality problems with leaching of materials and by providing avenues for mixing of surface waters with groundwater.

Known information on gravel, limestone, and mineral mining in the Elk River basin is presented in Table 12. Figure 17 presents the location of mines scattered throughout the basin.

Table 12. Known information about mines found in the Elk River basin.

Owner/Operator	Commodity	Type of Mine	Status	Acres	Depth (feet)	Location T - R - Sec.
Carborundum Company	Tripoli	Processing Plant	Inactive			24N - 34W - 08
Baxter Diggings	Zinc & Lead	Underground	Inactive	3.5	50	25N - 33W -01
Baxter Mines	Lead	Underground	Inactive	0.13		25N - 33W -04
Carpenter's Shafts	Zinc & Lead	Underground	Inactive	0.75		25N - 33W -02
Freeto Quarry	Limestone	Surface	Inactive	7.00		24N - 32W - 07
Cornwall Diggings	Lead	Underground	Inactive	0.38		26N - 33W - 36
Sheets Shaft	Zinc & Lead	Underground	Inactive	0.13		26N - 33W - 36
Sibley Diggings	Lead	Underground	Inactive	0.0	65	24N - 34W - 08
C. Huber	Lead & Barium	Underground	Inactive	0.0	100	24N - 34W - 36
Unknown	Limestone	Surface	Inactive		0	24N - 33W - 24
We -May Corp.	Limestone	Surface	Inactive		0	24N - 33W - 36
Southwest Lime Co.	Limestone	Surface	Inactive		0	25N - 32W - 07
Unknown	Lead	Underground	Inactive			25N - 33W - 22
F & J Knox	Zinc & Lead	Underground	Inactive			24N - 33W - 29
E. Hatzfield	Zinc & Lead	Underground	Inactive			25N - 33W - 02

Table 12

Seneca Lead & Zinc Co.	Zinc & Lead	Underground	Inactive	0.25	130	25N - 34W - 36
Unknown	Zinc & Lead	Underground	Inactive	0.13		25N - 34W - 04
Unknown	Zinc & Lead	Underground	Inactive			26N - 33W - 26
E. Olson	Zinc & Lead	Underground	Inactive	0.75		26N - 33W - 34
Unknown	Silicon & Tripoli	Surface	Inactive	2.5	0	25N - 33W - 26
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	0.5	0	25N - 33W - 25
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	0.25	0	25N - 33W - 25
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	0.75	0	25N - 33W - 24
Barnsdall-American	Silicon & Tripoli	Surface	Inactive	0.06	0	25N - 33W - 15
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	2.5	0	25N - 33W - 24
Unknown	Silicon & Tripoli	Surface	Inactive	2.25	0	25N - 33W - 24
Carborundum Co.	Silicon & Tripoli	Surface	Inactive	1.5	0	25N - 33W - 23
Unknown	Zinc	Underground	Inactive	0.13		25N - 33W - 04
Unknown	Silicon & Tripoli	Surface	Inactive	0.38		25N - 33W - 23
Unknown			Inactive	0.75		26N - 33W - 36
Unknown		Underground	Inactive	0.63		26N - 33W - 36
Unknown		Underground	Inactive	1.25		25N - 32W - 27

Table 12

Unknown			Inactive	0.75		25N - 33W - 01
Armstrong & Cravens Quarry	Limestone	Surface	Inactive			21N - 33W - 22
Jane Quarry	Limestone	Surface	Inactive	6.0		21N - 31W - 17
Jeffers Quarry	Limestone	Surface	Inactive			22N - 32W - 19
John P. Hughes Quarry	Limestone	Surface	Inactive			21N - 33W - 22
Joplin-Elk River Stone Co. Quarry	Limestone	Surface	Inactive			21N - 33W - 14
Lanagan Quarry	Limestone	Surface	Inactive	6.0		22N - 33W - 36
Lewis Quarry	Limestone	Surface	Inactive			21N - 33W - 26
Madge Stone Company Quarry	Limestone	Surface	Inactive	0.5		21N - 33W - 15
Mill Creek Quarry	Limestone	Surface	Inactive			21N - 33W - 23
Railroad Quarry	Limestone	Surface	Inactive			21N - 33W - 22
Truitt Quarry	Limestone	Surface	Inactive			21N - 33W - 01
Unknown	Coal	Surface	Inactive			23N - 31W - 09
Unknown	Coal	Surface	Inactive			32N - 31W - 09
Unknown	Iron	Underground	Inactive		30	23N - 34W - 14
Unknown	Iron & Coal	Underground	Inactive		116	23N - 34W - 13
Nymo Land & Mining Co.	Lead, Zinc, & Iron	Underground	Inactive		150	23N - 32W - 18

Table 12

Unknown	Limestone	Surface	Inactive	2.0		21N - 32W - 02
Unknown	Limestone	Surface	Inactive			21N - 33W - 11
Unknown	Limestone	Surface	Inactive			21N - 33W - 15
Unknown	Limestone	Surface	Inactive			21N - 33W - 26
Unknown	Limestone	Surface	Inactive			21N - 33W - 35
Unknown	Limestone	Surface	Inactive			22N - 32W - 30
Unknown	Zinc	Underground	Inactive		20	23N - 34W - 26
Unknown	Zinc	Underground	Inactive		60	23N - 34W - 26
Unknown	Zinc & Lead	Underground	Inactive		220	23N - 34W - 27
Unknown	Zinc & Lead	Underground	Inactive		25	23N - 34W - 27
Noel Concrete	Limestone	Surface	Inactive			21N - 33W - 26
McDonald County Sand & Gravel	Sand & Gravel	Surface	Active	2.0	0	21N - 31W - 17
M. F. Goswick Lime Co.	Limestone	Surface	Active	5.0	0	21N - 31W - 17
Ozark Heights Crushing	Limestone	Surface	Active	5.0	0	21N - 31W - 17
Hall & Riley Quarries & Const. Co.	Limestone	Surface	Active	40.0	0	21N - 31W - 35
Hall & Riley Quarries & Const. Co.	Limestone	Surface	Active	0	0	21N - 31W - 35

Table 12

Macco Gravel Co. Inc.	Sand & Gravel	Surface	Active	25.0	0	21N - 32W - 08
	Limestone					22N - 29W - 33
Everette Brody	Sand & Gravel	Surface				24N - 30W - 11
Jimmy and Chris Morgan	Sand & Gravel	Surface				23N - 34W - 13
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N - 33W - 12
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N - 33W - 15
Jimmy Connor	Sand & Gravel	Surface	Active		0	24N - 33W - 14
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 21
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 09
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 09
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 07
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 32W - 12
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 08
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 32W - 12
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 31W - 08
B & B Sand and Gravel	Sand & Gravel	Surface	Active		0	21N - 32W - 12
Zannie Poe	Sand & Gravel	Surface	Active		0	21N - 28W - 29

Table 12

Marvin Undernehr	**Sand & Gravel**	**Surface**	**Active**		**0**	**20N - 29W - 10**
Bella Vista Property	**Sand & Gravel**	**Surface**	**Active**		**0**	
Floyd Wolf jr.	**Sand & Gravel**	**Surface**	**Active**		**0**	**23N - 29W - 34**
McCullah & Sons Construction	**Sand & Gravel**	**Surface**	**Active**		**0**	**22N - 29W - 10**
McCullah & Sons Construction	**Sand & Gravel**	**Surface**	**Active**		**0**	**22N - 29W - 09**
Tillman Sand and Gravel	**Sand & Gravel**	**Surface**	**Active**		**0**	**22N - 30W - 35**
Ellick Garren	**Sand & Gravel**	**Surface**	**Active**		**0**	**23N - 31W - 07**
Sherry Woodard	**Sand & Gravel**	**Surface**	**Active**		**0**	**21N - 30W - 13**
Pea Ridge Gravel	**Sand & Gravel**	**Surface**	**Active**		**0**	**22N - 29W - 05**
McCullah & Sons Construction	**Sand & Gravel**	**Surface**	**Active**		**0**	**22N - 29W - 06**
Martin Henson	**Sand & Gravel**	**Surface**	**Active**		**0**	**21N - 32W - 12**
Kenneth Werries	**Sand & Gravel**	**Surface**	**Active**		**0**	**24N - 30W - 07**
Troy Henson	**Sand & Gravel**	**Surface**	**Active**		**0**	**21N - 32W - 12**

Source: MDNR (1996) and USACOE, pers. comm.

Figure 17. Mines in the Elk River basin