CHAPTER 3 | AFFECTED ENVIRONMENT

Cherokee County natural resources potentially affected by mining-related contamination include rivers and lakes, ground water, and geologic/terrestrial resources. The area also supports a wide variety of fish, birds, and other wildlife. Fifty-one species present in Cherokee County are included on state or Federal threatened and endangered (T&E) species lists or are otherwise of special concern.

The following paragraphs briefly summarize key features of the county's natural resources, including information about what makes the area unique, and also available information about the threat posed to these resources by mining-related and other contamination. These paragraphs describe those natural resources in or near areas impacted by mining activities. Given the locations of their facilities, FWS expects that the natural resources impacted by Eagle-Picher and LTV, as well as other responsible parties include: terrestrial parts of the Treece, Baxter Springs, Galena, and Crestline subsites; the Boone aquifer; Empire Lake; and a number of rivers and streams, primarily Spring River, Short Creek, Shoal Creek, Willow Creek, Spring Branch, and Tar Creek.

3.1 SURFACE WATER RESOURCES: RIVERS, LAKES, STREAMS

SPRING RIVER

The Spring River flows southwest into the state from Missouri, entering Cherokee County about ten miles north of Galena (Exhibit 3). It exits southward into Oklahoma, where it converges with the Neosho River to form the Grand River. In Kansas, the Spring River drains 500 square miles and flows through, near, or adjacent to areas heavily impacted by mining, including the Lawton, Badger, Galena, Baxter Springs, Waco, and Crestline Superfund subsites (KDHE 1980).

The Spring River is one of the state's most valued surface water resources. It ranks fifth in annual average flow and third-highest in critical low flow (United States Geological Survey (USGS) WATSTORE database). Upstream of the confluence with Center Creek, the river supports at least 74 fish and 23 mussel species, including the federally and state-threatened Neosho madtom (*Noturus placidus*). Ten other resident fish and shellfish species are listed as threatened or endangered in the State of Kansas, and 35 species are designated as in need of conservation (*i.e.*, SINC). As shown in Exhibit 9, some reaches support high-quality riparian corridors.[24]

[24] Riparian corridors are low-lying natural lands within a certain distance of rivers or streams. Healthy riparian corridors are extremely important to the health of the surface waters they surround. They help reduce both erosion and nutrient pollution (for example, from fertilizer runoff), provide habitat for aquatic-associated animals (for example, nesting

The Spring River's importance as a natural resource has been recognized by a number of organizations. KDHE classifies the river as an exceptional state water and a special aquatic life use water (KDHE 2004a). The Kansas Department of Wildlife and Parks (KDWP) classifies the Spring River as "critical habitat for numerous threatened and endangered species" (for example, Neosho madtom) and as a highest-valued fishery resource (Moss and Brunson 1981). The National Park Service classifies the river as an outstandingly remarkable stream for scenic, recreational, fishing, and wildlife attributes (NPS 1982).

EXHIBIT 9 SPRING RIVER RIPARIAN CORRIDOR

Photo courtesy of Industrial Economics, Inc.

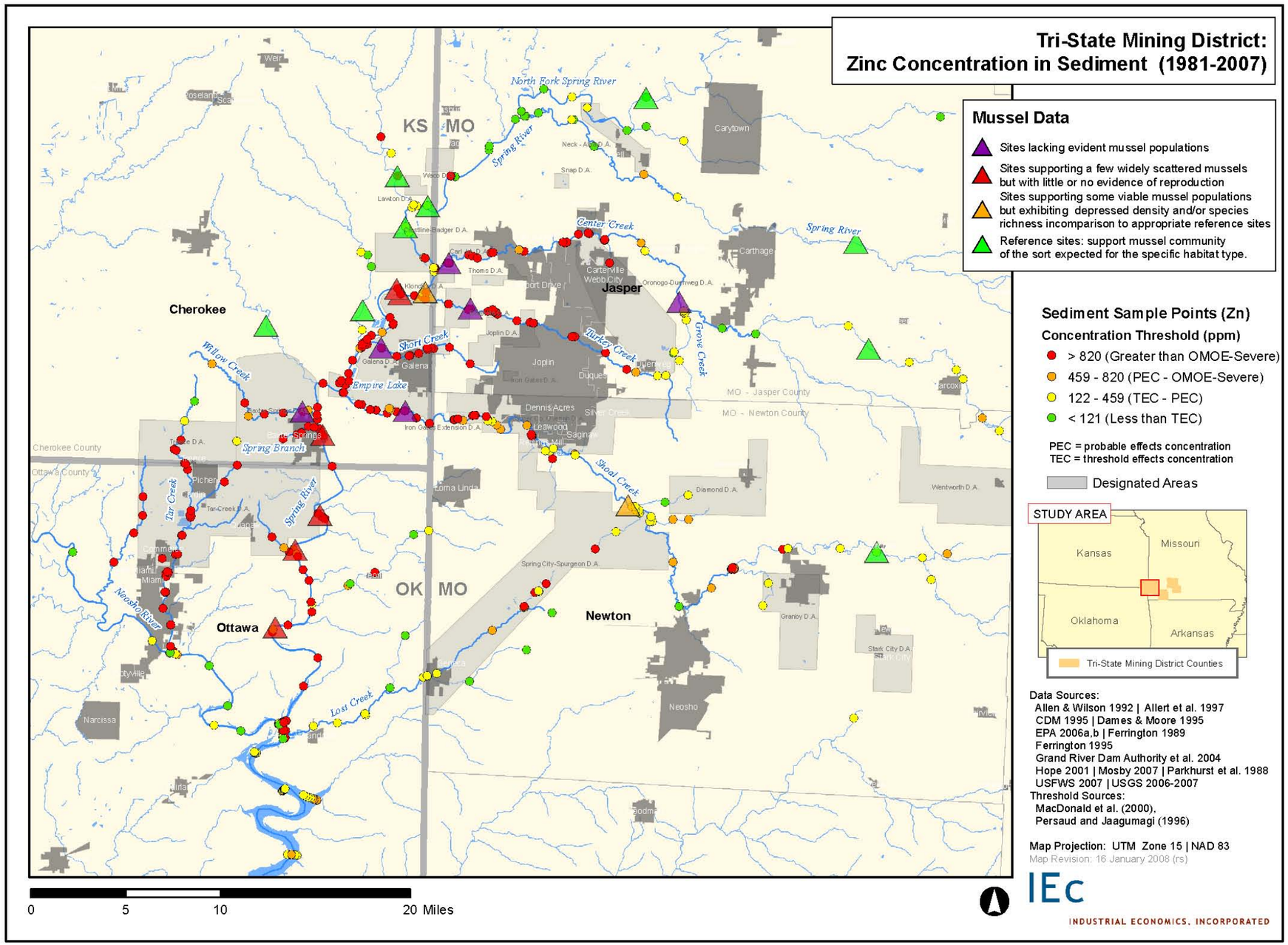
locations for birds and den locations for mink) and also provide continuous corridors of habitat that allow fauna to travel from one location to another. High-quality riparian corridors often support many different species of plants.

EXHIBIT 10 TRI-STATE MINING DISTRICT: SEDIMENT ZINC CONCENTRATIONS AND MUSSEL COMMUNITY HEALTH

Notes:
The Threshold Effects Concentration (TEC) is defined as the concentration below which adverse effects are not expected to occur. While samples below the TEC are unlikely to cause injury, samples above the TEC will exhibit toxicity in some cases, but not others (MacDonald et al. 2000).

The Probable Effects Concentration (PEC) is defined as the Concentration above which adverse effects are expected to occur "more likely than not" (ibid.).

The OMOE-Severe value is the concentration above which pronounced disturbance of the sediment-dwelling community is expected; detrimental to the majority of benthic species; 95th percentile of incidence of adverse effects, as defined by Persaud and Jaagumagi (1993).



Spring River, especially in its more downstream reaches, has elevated metals levels (CH2M Hill 1987). KDHE's 2002 303(d) list (KDHE 2002) indicates that the lower river is impaired by lead, copper, and zinc.[25] As shown in Exhibit 10, zinc levels in sediments frequently exceed values associated in the literature with adverse impacts to benthic organisms. These benchmarks include the Threshold Effect Concentration (TEC), Probable Effects Concentration (PEC), and Ontario Ministry of the Environment (OMOE) Severe values (MacDonald *et al.* 2000; Persaud and Jaagumagi 1993).[26]

Field data confirm that elevated metals concentrations appear to be impacting the river's aquatic life. Wildhaber *et al.* (2000) investigated fish populations in the Spring River and concluded that these fish, especially Neosho madtoms, are limited in part by the presence of metals in the water. Mussel populations also appear to have been impacted: Obermeyer *et al.* (1995) reported that only the portion of the river upstream of Center Creek is rich with these organisms, and Angelo *et al.* (2007) confirms this finding (Exhibit 10). Cope (1985) states that "[d]rainage from mines and mine tailings along Center, Turkey, and Short creeks… probably contribute pollutants that are toxic to naiads [mussels]."

SPRING RIVER TRIBUTARIES

As shown in Exhibit 3**,** key tributaries of the Spring River, ordered from north to south and entering on the east (E) or west (W) side, are as follows: Cow Creek (W), Center Creek (E), Turkey Creek (E), Shawnee Creek (W), Short Creek (E), Shoal Creek (E), Brush Creek (W), Willow Creek (W), and Spring Branch (W). Similar to the Spring River, some of these tributaries are habitat to valued aquatic animals including threatened and endangered species. Many of these tributaries flow through mining-affected lands and have sediment metal levels that exceed TEC, PEC, and OMOE-Severe thresholds (Exhibit 10). The following paragraphs briefly describe key characteristics of each.

Cow Creek is the major Kansas tributary to the Spring River in the northern region of the watershed (KDHE 1980). It originates in Crawford County and flows southeast before converging with the Spring River in Cherokee County (KDHE 1980). Cow Creek drains coal-mined and agricultural areas (Dames & Moore 1995), and receives treated sewage effluents and storm runoff from the City of Pittsburg, Kansas (City of Pittsburg 2003).

[25] Section 303(d) of the Federal Clean Water Act requires states to periodically prepare a list (referred to as a 303(d) list) of all surface waters in the state with pollutant concentrations that exceed water quality standards. These waters are considered to be impaired with respect to specific beneficial uses associated with the water quality standards, such as drinking, recreation, aquatic habitat, and/or industrial use. Kansas's 2004 303(d) list is available at http://www.kdhe.state.ks.us/tmdl/NE2004.html (visited 5/19/04).

[26] Injuries to sediment-dwelling organisms begin to be observed when contaminant concentrations in sediment exceed the Threshold Effects Concentration (TEC). More specifically, the TEC is defined as the concentration below which adverse effects are not expected to occur. While samples below the TEC are unlikely to cause injury (i.e., the TEC correctly predicts the absence of toxicity 81 percent of the time), samples above the TEC will exhibit toxicity in some cases, but not others (MacDonald et al. 2000). The TEC in parts per million is 0.99 for cadmium, 121 for lead, and 35.8 for zinc. The PEC is defined as the Concentration above which adverse effects are expected to occur "more likely than not". The PEC in parts per million is 4.98 for cadmium, 459 for lead, and 128 for zinc. Finally, the OMOE-Severe is the concentration above which pronounced disturbance of the sediment-dwelling community is expected; detrimental to the majority of benthic species; 95th percentile of incidence of adverse effects, as defined by Persaud and Jaagumagi (1996). The OMOE-Severe threshold in parts per million is 10 for cadmium, 820 for lead, and 250 for zinc.

KDHE's 303(d) list for 2002 states that Cow Creek is impaired by sulfate, and the 2004 list adds low dissolved oxygen as an additional impairment. Pope (2005) notes that Cow Creek has relatively low streambed sediment metals concentrations, compared with the lower reaches of the Spring River, Shoal Creek and Spring Branch Creek. Despite the listed impairments, as shown in Exhibit 10, Cow Creek supports a mussel community of the sort expected for the habitat type (Angelo *et al.* 2007).

Center Creek is an Ozarkian stream located in Missouri that joins the Spring River near the Kansas/Missouri border. Center Creek is a significant contributor of metal contaminants to the Spring River (Davis and Schumacher 1992); indeed, KDHE (1980) states that "Short and Center Creeks contribute the greatest amount of lead-zinc mine pollutants to the Spring River in Kansas," and Davis and Schumacher (1992) found that lead and zinc levels exceeded chronic aquatic life criteria (ALC)[27] from 1965 to 1989. KDHE monitoring data collected during the past two decades confirm the continuation of high metals loadings from Center Creek and other tributaries to the Spring River (KDHE 2004b).

The importance of Center Creek as a source of metals to the Spring River is also shown by Pope's (2005) comparison of sediment samples from the Spring River upstream and downstream of the confluence with Center Creek. Downstream samples (taken from an area about 100 ft downstream of the confluence with Center Creek) have cadmium (41 mg/kg), lead (510 mg/kg) and zinc (5,400 mg/kg) levels about 10 times higher than samples taken just 0.8 mile upstream (Pope 2005).

Center Creek's ability to fully support native aquatic biota appears to be impaired. Dames & Moore (1995) found the fish community to be both more diverse and more abundant upstream of Oronogo-Duenweg than downstream. The abundance and diversity of mussels are lower in downstream reaches of Center Creek compared both to a non-mining area in the North Fork of the Spring River and to upstream areas (Clarke and Obermeyer 1996, Angelo *et al.* 2007; see Exhibit 10). Certain mussel species historically found in this area (*Cyprogenia aberti* and *Quadrula (Orthonymus) cylindrica*) are no longer present (Clark and Obermeyer 1996).

Turkey Creek flows through Missouri before joining the Spring River south of Center Creek, just west of the border in Kansas. Like Center and Short Creeks, Turkey Creek is a typical Ozarkian stream, characterized by alternating pools and riffles with a mixture of sand, gravel, and boulder streambed bottoms (Dames & Moore 1995). Turkey Creek flows through Joplin, Missouri and receives discharges from several industries and several sewage treatment plants as well as runoff from historic mine-related areas (Dames & Moore 1995). Davis & Schumacher (1992) characterized this creek as Missouri's most contaminated interstate stream. KDHE's 2002 303(d) list indicates Turkey Creek is impaired by cadmium, lead, copper, and zinc. Some parts of the creek contain visible mine waste bars (Exhibit 11).

[27] Aquatic life criteria (ALC), are water quality standards issued by EPA and are designed to protect aquatic life from acute (short-term) and chronic (long-term) effects of contaminants. ALC also serve as guidance to states and tribes authorized to establish their own water quality standards under Section 304a of the Clean Water Act.

During some high flow sampling events in Missouri, neither cadmium nor lead concentrations exceeded chronic ALC; however, data suggest that runoff from the Oronogo-Duenweg designated area causes Turkey Creek to exceed chronic ALC for zinc (Dames & Moore 1995). Turkey Creek sediments contain elevated metals concentrations. Pope (2005) found very high sediment concentrations in Turkey Creek (cadmium - 52 mg/kg; lead - 640 mg/kg; zinc - 5,200 mg/kg) and concluded that these are "probably responsible for elevated Spring River results immediately downstream from Turkey Creek." As shown in Exhibit 10, sediment concentrations of zinc regularly exceed literature-based effects thresholds for impacts to benthic organisms.

Further, tissues from Turkey Creek fish had elevated levels of metals, and parts of the creek have altered benthic communities, indicating that these communities "may have been altered possibly by physical or chemical conditions" (Dames & Moore 1995). Angelo *et al.* (2007) found impaired or absent mussel communities on this waterway.

EXHIBIT 11 TURKEY CREEK WITH MINE WASTE BARS

Photo courtesy of Industrial Economics, Inc.

Shawnee Creek originates in north-central Cherokee County. It merges with Little Shawnee Creek before joining the Spring River near the Galena subsite. KDHE's 2002 303(d) list indicates that water quality impairments in Shawnee Creek include contamination by lead, zinc, copper, and fecal coliform. The Crestline subsite drains into Shawnee Creek.

Sediments in the area show elevated metals levels. Pope (2005) found the vast majority (78-100 percent) of samples from Shawnee Creek to exceed the threshold effects concentration (MacDonald *et al.* 2000) for all three metals of concern, and at least 10 percent of samples exceeded the probable effects concentration for cadmium and zinc.

Short Creek (Exhibit 12) passes through Missouri and the Galena subsite before joining the Spring River. The creek is highly contaminated with metals (Ferrington *et al.* 1989). CH2M Hill (1987) remarks that "[t]he USGS results show that Short Creek was a major contributor of zinc to the Spring River… Based on these [USGS] data, Short Creek was also the largest contributor of cadmium and lead loadings." KDHE's 2002 303(d) list states that water quality impairments in Short Creek include contamination by cadmium, copper, lead, and zinc.

Pope (2005) found 100 percent of samples from Short Creek to exceed the PEC for cadmium, lead, and zinc (also see Exhibit 10). Metals in the creek may be impacting local biota: KDHE (1980) notes that Short Creek is "extremely polluted [in Kansas] with toxic heavy metals concentrations, especially zinc… This is reflected in the benthic samples by the continuous low taxa numbers… as well as the complete absence of the pollution sensitive mayfly-stonefly groups."

EXHIBIT 12 PORTION OF SHORT CREEK NEAR GALENA, WITH ALGAE

Photo courtesy of Industrial Economics, Inc.

Shoal Creek runs through Missouri, forms the southern border of the Galena subsite, and joins the Spring River at Empire Lake. The creek has been described as "the only Ozark-type stream in Kansas" (KDHE 1980).[28] As an Ozarkian stream, Shoal Creek has exceptionally clear water and a rocky bottom (Exhibit 13). These features make Shoal Creek "unique... for its aesthetic qualities" (KDHE 1980).

Parts of Shoal Creek suffer from metals contamination. KDHE's 2002 303(d) list indicates that water quality impairments in Shoal Creek include contamination by lead and zinc. Ferrington *et al.* (1989) notes that the Shoal Creek arm of the Empire Lake reservoir "has higher concentrations of metals than expected" and "it must be concluded that movements of metals out of tailings areas via one or more of these intermittent streams [that join with Shoal Creek]… contribute significantly to the elevated metals concentrations in sediments of the Shoal Creek arm."

Exhibit 10 illustrates patterns of zinc contamination in Shoal Creek, and their relationship to literature-based benthic effects thresholds. As indicated in this exhibit, the creek is highly contaminated. Pope (2005) similarly concludes that almost all samples from Shoal Creek exceed the PEC for several metals: 100 percent of samples exceed the PEC for cadmium and zinc, while 89 percent of samples exceeded the PEC for lead.

EXHIBIT 13 SHOAL CREEK AT LOW FLOW NEAR SCHERMERHORN PARK

Photo courtesy of Industrial Economics, Inc.

[28] Although Center Creek is also an Ozarkian stream, only a very small portion of the creek lies within Kansas. Most of Center Creek is in Missouri.

Data on unionid mussel communities in Shoal Creek suggest that the creek undergoes a radical transformation in quality downstream of Joplin, Missouri. Cope (1985) found only a single living mussel plus a small number of dead mussels at a Shoal Creek station south of the Galena subsite. Obermeyer *et al.* (1997) found the Neosho mucket (*Lampsilis rafinesqueana)* to be present in the more upstream reaches of Shoal Creek in Missouri, but in the Kansas stations closest to the creek's confluence with the Spring River, found either no evidence of the species or only weathered/relic mussel shells. Angelo *et al.* (2007) similarly found evidence of severe impacts to the mussel community in more downstream reaches (Exhibit 10).

Brush Creek is an intermittent[29] stream that originates in the northwestern portion of the Spring River basin and flows southeasterly before converging with the Spring River near Riverton, Kansas (KDHE 1980). Although there was little mining activity in its watershed (KDHE 1980), Pope (2005) found exceedences of sediment quality thresholds for cadmium (40 percent of samples), lead (90 percent of samples) and zinc (90 percent of samples). Ten percent of samples also exceeded the PEC for zinc. This suggests widespread effects of mining, even in areas not directly downstream of mines.

Willow Creek is an intermittent tributary that runs through the Baxter Springs subsite and also contributes to Spring River metal loads. KDHE (1980) found that during times of high runoff or mine "dewatering" operations, high concentrations of metal contaminants were introduced into the Spring River via Willow Creek. Dames and Moore (1993a) state that mine water has discharged into the creek from the Bruger shafts, and that shaft discharge may account for a significant part of the metal load carried by the creek. The mine water discharge contained zinc concentrations that can be acutely toxic to resident aquatic organisms, although some data suggest that populations of key aquatic species have not been significantly reduced (Dames & Moore 1993a). As part of the ongoing Superfund process, EPA attempted to control minewater discharge to the creek by limiting recharge to the mine workings in the vicinity of the Bruger shafts (USEPA 1997). As of June 2004, however, and despite the remedial actions undertaken, this shaft was still flowing (personal communication, D. Drake, EPA, to J. Miesner, FWS).

Willow Creek sediments show elevated cadmium, lead and zinc (*i.e.*, Exhibit 10). Pope (2005) found the vast majority of sediment samples from Willow Creek exceeded the PEC for all three metals (79 percent for cadmium; 67 percent for lead, and 100 percent for zinc).

Spring Branch is an intermittent tributary to the Spring River with a watershed of 3.3 square miles, all of which is contained in the Baxter Springs subsite (Dames & Moore 1993a). Land use in the Spring Branch watershed is primarily agricultural but also includes the city of Baxter Springs (Dames & Moore 1993a). Water quality in the Spring Branch has been and continues to be impacted by past mining activities; for example, Dames & Moore (1993a) stated that mill waste areas are still present in 16 percent of its

[29] Intermittent, streams and creeks only contain flowing water for part of the year. The rest of the year, they contain standing pools separated by dry areas.

watershed, and outwash tailings are located in the stream channel. Similarly, "cadmium and zinc concentrations exceeded chronic ALC in all samples tested," and lead concentrations exceeded ALC during periods of higher flow. A portion of the high metal loads in Spring Branch was attributed to overflow from the Ballard tailings impoundment, a site that was addressed in EPA's ROD for the Baxter Springs/Treece OU (USEPA 1997).

As reported in the ROD (USEPA, 1997), the Ballard tailings impoundment was drained, filled, regraded, and revegetated to prevent deposition of tailings in Spring Branch and Willow Creek during storm events. Exhibits 30 through 33 show the Spring Branch itself and adjacent upland areas before and after restoration. Despite efforts to reduce human health risk and control mine waste discharge, metals levels in Spring Branch continue to be elevated above levels harmful to the biota (EPA 2006).

EMPIRE LAKE

Empire Lake, located near Riverton, was formed by a dam first erected in the early 1900s. The lake is owned by the Empire District Electric Company, which uses lake water as a coolant in its coal-fired power plant. Considerable sediment has accumulated behind the dam, resulting in shallow water depths throughout most of the lake: KDHE's 2002 303(d) list (KDHE 2002) states that the lake is impaired by siltation. In part because of this sedimentation, the lake "is thought to act as a sink for both nutrients and heavy metals" (KDHE 1980).

Ferrington *et al.* (1989) evaluated the lake's benthic invertebrate community and concluded that "the main effect of high concentrations of cadmium, lead and zinc in the sediments of Empire Lake is reduction of the standing crop density of aquatic macroinvertebrates, and presumably overall productivity of the reservoir system." More recently, Juracek (2006) evaluated the status and trends in sedimentation and metals concentrations in the lake. An extensive field investigation was done to assess metals concentrations and estimate metals volumes throughout the lake. Median concentrations of cadmium, lead, and zinc were 29 mg/kg, 270 mg/kg, and 4,900 mg/kg, respectively, and almost every sample from the lake bottom far exceeded MacDonald *et al.* (2000)'s probable effects concentrations for sediment. Estimated cadmium, lead, and zinc volumes in the lake were 78,000 pounds, 650,000 pounds, and 12,000,000 pounds, respectively. Trend analysis suggests that concentrations of these metals in bottom sediments decreased following the end of mining in the watershed. However, concentrations in the most recently deposited bottom sediments still far exceed the probable effects guidelines for all three metals (*ibid.*).

While the lake does serve as a sink for metals, it may also serve as a source for downstream areas, at least during high-flow periods. Contaminated sediment was found immediately downstream from Empire Lake in the Spring River, indicating that some contaminated sediment may pass through the lake (Juracek 2006).

TAR CREEK

Tar Creek is the principal stream in the Treece subsite and flows into Oklahoma from Cherokee County where it joins the Neosho River (Dames & Moore 1993a). Available data suggest that Tar Creek is highly impacted by metal concentrations. KDHE's 2002 303(d) list (KDHE 2002) indicates that Tar Creek is impaired by lead, cadmium, zinc, and sulfate. As shown in Exhibit 10, zinc levels in sediments frequently exceed values associated in the literature with adverse impacts to benthic organisms.

Dames & Moore (1993a) similarly indicate that the concentration of zinc in Tar Creek exceeds levels that are acutely toxic to some of the more sensitive species that could inhabit these ephemeral streams, and therefore could be affecting the species composition. Fish numbers in the lower segment of the Kansas section of Tar Creek were low relative to other streams in the subsite, and the only fish collected were of the sunfish family (*Centrarchidae*) (Dames & Moore 1993a).

3.2 GEOLOGIC RESOURCES

Cherokee County lies within the Ozark Plateau and Cherokee Lowlands geographical provinces. The Ozark Plateau is characterized by thin, rocky soil and steep slopes, while the Cherokee Lowlands have gentler slopes and deeper soils more suitable to cropland (Dames & Moore 1993a). In its natural state, the soils support diverse ecosystems, such as tallgrass prairie and deciduous woodland.

Many geologic resources within the Cherokee County Site are either currently covered by mine waste piles, fall within the footprints of former piles, or are near mine waste piles. These areas tend to have higher metals concentrations than occur in other, nearby areas: in the Baxter Springs and Treece subsites, for example, researchers found that near-pile soils had metal concentrations that "are generally higher than concentrations in agricultural and A Horizon [surficial] soils (Dames & Moore 1993a). Furthermore, mill site soils had concentrations "similar to bulk chat values."

3.3 GROUND WATER

Two major aquifers, one shallow and one deep, underlie the Cherokee County mining area. The shallow aquifer, called the Boone aquifer, is comprised of Mississippian limestones, which also contain the lead-zinc deposits mined in the area (Dames & Moore 1993b). The rock underlying the Boone aquifer is impermeable limestone, which confines the aquifer and largely prevents downward movement of the water (Dames & Moore 1993a). Water from the surface (for example, precipitation) can sink into the ground and enter the Boone through natural areas of permeability in the limestone or through mine workings (Dames & Moore 1993a), recharging the aquifer.

During times of heavy precipitation, ground water in the Boone aquifer discharges into mine shafts and drill holes, as observed in the Baxter Springs subsite in June 1990 (Dames & Moore 1993a). Some discharge also occurs directly from the Boone along the streambeds of tributaries to the Spring River (Dames & Moore 1993a).

For instance, the Boone aquifer was once routinely used as a source of drinking water by the residents of Galena, but EPA determined that metal contamination of the aquifer was significant enough to render the water unsafe to drink and in 1997 provided an alternate water supply as part of its selected remedial action for the Galena Alternate Water Supply OU (EPA 1997). The selected remedy included the provision of water from the deep aquifer, called the Roubidoux, to area residents. At the current time, there is little evidence of contamination in the Roubidoux (Dames & Moore 1993a).

The Roubidoux is the principal source of water for public, industrial, domestic, and stock supplies for the area (Dames & Moore 1993b). Its ground water tends to flow out of Cherokee County to the west, then turns south towards Oklahoma (Dames & Moore 1993a). Recharge occurs via precipitation falling on the western flank of the Ozark Dome in Missouri (Dames & Moore 1993a). There may also be downward leakage from the Boone through fractures and well shafts, but evidence suggests that this is not a significant source of recharge (Dames & Moore 1993a). Discharge occurs primarily through removal for human needs (Dames & Moore 1993a).

The Roubidoux is used not only by Cherokee County residents but also by residents of neighboring Missouri and Oklahoma. A recent study of water supplies in Missouri's Jasper and Newton Counties noted that "groundwater withdrawals from the [Roubidoux] aquifer are increasing rapidly" and that this poses a future risk of contamination of the lower aquifer by the upper (Springfield Plateau) aquifer in Missouri (Wittman *et al.* 2003). Future water demands are expected to increase further; this, "combined with the limited capacity of the aquifer, make it likely that [resource] conflicts will occur" (Wittman *et al.* 2003).

3.4 BIOTIC ENVIRONMENT

THREATENED AND ENDANGERED SPECIES

As indicated in Appendix A, a number of species present in Cherokee County are included on state or Federal threatened and endangered species lists or are otherwise of special concern. These species have been identified at different locations throughout the county. The Spring River, for instance, supports the federally and state-threatened Neosho madtom (*Noturus placidus*). Obermeyer *et al.* (1997) found the Neosho mucket, a candidate species for Federal listing, to be relatively abundant in the Spring River between Stott City, Missouri and the river's confluence with Center Creek.[30] The federal candidate and state threatened Arkansas darter is found in the Spring River basin, as are a number of other fish species designated by the State of Kansas as threatened or SINC (*i.e.*, a species in need of conservation).

Cherokee County amphibians include a number of special status species. The Shoal Creek drainage basin is believed to host the cave salamander (*Eurycea lucifuga)* and the grotto salamander (*Typhlotriton splaeus*) (CH2M Hill 1988). State-designated threatened (T) or endangered (E) amphibian species with designated critical habitat in the Cherokee

[30] The abundance of this mussel declines appreciably below Center Creek, and it appears to be absent below Turkey Creek.

County Spring River basin include: cave salamander (E), many-ribbed salamander (*Eurycea multiplicata*, E), grotto salamander (E), eastern newt (*Notophthalmus viridescens*, T), longtail salamander (*Eurycea longicauda*, T), eastern narrowmouth toad (*Gastrophryne carolinensis*, T), green frog (*Rana clamitans*, T), and spring peeper (*Pseudacris crucifer*, T) (Collins *et al.* 1995, KAR 2003, KDWP 2005).

Special status avian species include the state threatened bald eagle (*Haliaeetus leucocephalus*) and the state endangered peregrine falcon (*Falco peregrinus*), among others. Special status mammals include the Kansas-threatened eastern spotted skunk (*Spilogale putorius*), the Kansas- and federally-endangered gray bat (*Myotis grisecens*). There are no known special status terrestrial plants in Cherokee County.

AQUATIC AND AMPHIBIOUS SPECIES

Cherokee County's aquatic organisms include a wide variety of plants and animals. Among these are a number of larger or recreationally important fish species such as smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), walleye (*Stizostedion vitreum*), and many others.[31] Some fish species inhabit subsidence pits and flotation tailings ponds; these consist primarily of green sunfish, although local residents report that largemouth bass and crappie may also be found in some mine or mill ponds (Dames & Moore 1993a). Certain ponds are stocked and may support non-native fish species (Dames & Moore 1993b). Although few formal fish surveys have been conducted in ephemeral streams, some likely support yellow bullhead, black bullhead, green sunfish, various minnow species, red shiner (*Cyprinella lutrensis*), slough darter (*Etheostoma gracile*), brook silverside (*Labidesthes sicculus*) and mosquitofish (*Gambusia spp.*) (Dames & Moore 1993b). The Ozark cavefish (*Amblyopsis rosae*) is present throughout parts of the Ozark uplift in Missouri and Oklahoma and may also be present in Cherokee County.

Freshwater mussels also occur in both the Spring and Neosho River basins. The "Surface Water Resources" section above presents some available evidence of potential contaminant-related injuries to Cherokee County fish and mussels.

BIRDS

Birds make use of both aquatic and terrestrial habitat in Cherokee County. The North American Breeding Bird Survey effort regularly surveys birds through the Tri-State District, including parts of Cherokee County, and has identified at least 100 species in the district as a whole (Beyer *et al.* 2004). Water-affiliated species observed during these surveys in Cherokee County include the great blue heron (*Ardea herodias*), several egret species, and mallard (*Anas platyrhynchos*) (Sauer *et al.* 2001, as cited in Beyer *et al.*

[31] Additional larger or recreationally important fish in the area include: shortnose gar (*Lepisosteus platostomus*), river carpsucker (*Carpiodes carpio*), white sucker (*Catostomus commersoni*), black bullhead (*Ameiurus melas*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), white bass (*Marone chrysops*), rock bass (*Ambloplites rupestris*), green sunfish (*Lepomis cyanellus*), warmouth (*Lepomis gulosus*), bluegill (*Lepomis macrochirus*, spotted bass (*Micropterus punctulatus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), and many others (Cross and Collins 1995).

2004). Dames & Moore (1993a) report that larger species, such as duck, geese, herons, egrets, pelicans, swans and shorebirds specifically use Spring River and Empire Lake, among other wetlands. Waterbirds observed in the Baxter Springs/Treece subsite include the Canada goose (*Branta canadensis*), mallard, wood duck (*Aix sponsa*), blue-winged teal (*Anas discors*), great blue heron, and an egret (Dames & Moore 1995).

Bird species attracted to native prairie and other open areas include, but are not limited to, the common bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), western meadowlark (*Sturnella neglecta*), and field sparrow (*Spizella pusilla*) (Dames & Moore 1993a). The North American Breeding Bird Survey effort observed all these in Cherokee County as well as numerous other bird species (Sauer *et al.* 2001, as cited in Beyer *et al.* 2004). Dames & Moore (1993a) report the presence of wild turkey (*Meleagris gallopavo*), owls, hawks, thrushes, and woodpeckers in the Baxter Spring/Treece subsite.

MAMMALS

Cherokee County mammals rely on both aquatic and terrestrial habitats. Muskrat, mink, and beaver can be found near wetlands and along streams (Dames & Moore 1993a). Mammals observed in both the Baxter Spring/Treece subsite and on the Missouri side of the Spring River include raccoon (*Procyon lotor*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), grey fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), bobcat (*Lynx rufus*), mink (*Mustela vison*), opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), whitetail deer (*Odocoileus virginianus*), badger (*Taxidea taxus taxus*), squirrels, shrews, and various other small rodents (Dames & Moore 1993a, Dames & Moore 1995).

VEGETATION

Prior to significant European settlement of the area, Cherokee County was dominated by prairie (*i.e.,* Exhibit 14): “when there was scarcely any land in the county that had been touched with the plow, and when there were no roads established by any public act, the meager woodland was found only along Spring River and its larger tributaries, and probably a mere fringe along the Neosho River and the larger streams which flow into it. The county was almost a solid sward of prairie grass” (Allison 1904). In Cherokee County today, croplands, grasslands, woodlands, and wetlands are interspersed with spaces dominated by mining impacts (Dames & Moore 1993a).

Open areas such as cropland, pasture, meadows, and overgrown areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The remaining areas of native prairie, including native prairie hay meadows, are highly valued because they are among the most endangered ecosystems in the world. Although native prairies formerly covered vast areas, they are rare today and continue to be lost to human development. The continent's tallgrass prairie once covered 400,000 square miles of North America, from Indiana to Kansas and from Canada to Texas. Today, after years of farming, grazing and development, less than one percent of the original tallgrass prairie remains (Packard and Mutel 1997).

EXHIBIT 14 NATIVE PRAIRIE, DIAMOND GROVE, MISSOURI

Photos courtesy of John Miesner, U.S. Fish and Wildlife Service.

Native tallgrass prairies support native plants and support exceptionally high numbers of plant species, including rare Midwest species. Thirty acres of hay meadow in eastern Kansas probably contain a few hundred native plant species, including grasses and forbs[32] (Exhibit 15) (Robertson 1996). The seed banks[33] are exceptionally rich, even in areas used as hay meadows. Native prairies may also support important rangeland grass species, such as the big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparius*), and Indiangrass (*Sorghastrum nutans*) (Dames & Moore 1993a).

Native prairies are also of value because they support many species of insects and fungi, which live in the ground in close association with prairie plants. In fact, a large percentage of the biological activities that take place as a part of the prairie tallgrass environment actually occur underground (Packard and Mutel 1997). Native prairies are one of Kansas's climax communities. They take decades or longer to form, and even restoration projects that replant native grasses cannot fully replicate the complex insect, small mammal, bacteria, fungi and soil invertebrate communities that occur in the original, natural prairie areas (Whitney 1998).

Cherokee County's vegetative habitat also includes cool season grasslands, which support cool season grasses such as brome (*Bromus* spp.), fescue (*Festucu arundinacea* Schreb.), Canada wildrye (*Elymus canadensis*), Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Agropyron smithii*), and little barley (*Hordeum pusillum*) (Packard and Mutel 1997). Cool season grasses dominated the area thousands of years ago when temperatures were colder. As the climate warmed, warm season grasses began to predominate, although the cool season species have not been fully out-competed and are still a part of the native complement of grassland plants (Owensby *et al.* 1999).

Both cool and warm season grasslands have agricultural value. Cool season grasses green-up earlier in the season. They also grow in the fall after warm season grasses have finished their major growth of the year. Farmers tend to graze their herds on cool season grasses between the green-up and the end of May, and from September through October. During the height of summer, cattle are put to pasture on warm season fields (Missouri Department of Conservation undated).

[32] Forbs are herbaceous, non-grass species.

[33] Seed banks are reserves of viable seeds present naturally on the surface and in the soil.

EXHIBIT 15 NATIVE PRAIRIE FORBS, DIAMOND GROVE, MISSOURI

Photos courtesy of John Miesner, U.S. Fish and Wildlife Service.

In addition to supporting grasslands, Cherokee County also supports some forests, which altogether cover about nine percent of the county's area. These woodlands tend to occur as irregular areas or strips and as riparian corridors (Dames & Moore 1993a). Woodlands also occur as strips on upland drainageways and on steep upland slopes. Native forests are characterized by a variety of oak species (*Quercus* spp.), black walnut (*Juglans nigra*), pecan and other hickory species (*Carya* spp.), and associated shrubs, grasses, legumes, and wild herbaceous plants. The southeast corner of the county is the most biologically diverse region of the state in terms of the number of native woody species.

Some of the most valued wooded areas in the county occur as riparian corridors. Prior to European settlement of the area, woodlands were found "only along Spring River and its larger tributaries, and probably a mere fringe along the Neosho River and the larger streams which flow into it" (Allison 1904). Today, some of these areas remain. Wooded riparian corridors occur along larger surface waters, such as the Spring River, while grassland corridors are more common along smaller creeks and streams.

When continuous, these corridors allow species to migrate from location to location. Riparian corridors also provide important habitat for a variety of species, including aquatically-linked birds and mammals such as, raccoons, mink, wood ducks, and others. Squirrels, deer, turkeys, and songbirds also make use of wooded riparian areas (KDWP and KFS undated). Woodlands offer wildlife protection from wind, snow, and predators (KDWP and KFS undated), as well as providing food sources not included in prairies (*i.e.*, nuts and certain berries). Mulberry, oaks, hickory, pecan, walnut, and hackberry are common woodland species with high wildlife food values. Riparian corridors also help aquatic resources, protecting or buffering them from various landward disturbances, including pesticide runoff, fertilizer runoff, and erosion: Zaimes *et al.* (2004) found that streams edged by forest buffers had significantly lower erosion rates than either row-crop fields or continuously grazed pastures.

The Trustees have estimated that approximately 4,000 terrestrial acres in Cherokee County have been affected by mining activities (State of Kansas and DOI 2003). Chat piles in Cherokee County do not support normal stands of terrestrial vegetation. In addition, terrestrial vegetation has been significantly altered, and habitat has been lost because of hazardous substances at sites where chat piles formerly existed but have since been removed. Plant communities in many of these areas now provide little habitat for birds and wildlife. Vegetation communities adjacent to mine wastes also appear to have been affected, though to a lesser extent, and the ability of these areas to provide habitat may have been impaired as well (State of Kansas and DOI 2003).

3.5 CULTURAL ENVIRONMENT AND HUMAN USE

DEMOGRAPHICS

The total population of Cherokee County is 21,451 (USCB undated). Within the Cherokee County Superfund Site, population centers include the towns of Baxter Springs (pop. 4,246), Galena (pop. 3,163), and Treece (pop. 144) (USCB 2005). The population of the three towns decreased six percent, one percent, and 13 percent, respectively,

between the 1990 and 2000 censuses. Exhibit 16 summarizes age and race information for the county and for the State of Kansas.

EXHIBIT 16 CHEROKEE COUNTY DEMOGRAPHICS - 2006

	CHEROKEE COUNTY	STATE OF KANSAS
Age		
Persons under 18 years old	24.3%	25.2%
Persons over 65 years old	15.1%	12.9%
Race[a]		
White persons	90.7%	81.1%
American Indian and Alaska Native persons	3.8%	1.0%
Hispanic or Latino persons	1.2%	8.6%
Black or African American persons	0.7%	6.0%
Asian persons	0.5%	2.2%

Source: USCB undated.
Notes: Percentages do not sum to 100 because not all censused categories are included.

EMPLOYMENT AND INCOME

Approximately 10,800 individuals comprise Cherokee County's labor force (USCB 2000). In 2006, unemployment was approximately 5.1 percent, a value that exceeded the statewide figure of 4.5 percent. Cherokee County's unemployment rate has exceeded that of the state in every year since 1990.[34]

Employed civilians work in a variety of industries, including: (a) manufacturing (25.5 percent); (b) educational, health and social services (22.0 percent); and (c) retail trade (10.4 percent). About 3.8 percent of the employed civilian population works in the agriculture, forestry, fishing, hunting, and mining group of industries (USCB 2000).

Cherokee County's residents have lower income and are poorer than Kansas residents as a whole. Median household income for the county, reported as $33,151 in 2004, was significantly lower than the state median of $41,664 (USCB undated). That same year, 15.6 percent of Cherokee County's population was below poverty level, compared to 11.1 percent of the state's population (USCB undated). Although the Cherokee County's homeownership rate in 2000 was slightly higher than that of Kansas (76.1 versus 69.2 percent), the median value of owner-occupied housing units in the county was roughly half that of the state ($46,900 versus $83,500) (USCB undated).

LAND USE

Cherokee County is largely agricultural. The 2002 Census of Agriculture reported 746 farms in the county, totaling approximately 290,000 acres (NASS 2002). By acreage, the main crops are soybeans and wheat, with smaller areas devoted to forage production,

[34] Analysis based on data from the Real Estate Center at Texas A&M University, viewed 4/21/08 at <http://recenter.tamu.edu/data/empc/> and < http://recenter.tamu.edu/data/emps/emps20.htm>.

sorghum, and corn (NASS 2002). The main pasture grass is tall fescue, a cool season grass (Dames & Moore 1993a). Exhibit 17 presents additional information about land uses in the county.

EXHIBIT 17 CHEROKEE COUNTY LAND USE

LAND USE	ACRES
Cropland	228,595
Grassland	97,004
Woodland	37,828
Water	6,587
Residential	3,787
Commercial/Industrial	489
Other	3,946
Data source: Land Cover [ArcInfo Interchange]. Published 1993. Lawrence, KS: Kansas Applied Remote Sensing.	

ECONOMIC ACTIVITY

Industrial facilities within the Cherokee County Superfund Site include a coal-fired power plant on the Spring River, near Empire Lake, operated by the Empire District Electric Power Company, in addition to various small manufacturing facilities concentrated around Galena and Baxter Springs (Dames & Moore 1993a, EPA 2003). Processing of chat for commercial use in road base and asphalt is conducted throughout the site by such companies as Southwest Rock and Chat Company, Inc. and O'Brian Rock Co., Inc. (Dames & Moore 1993a, EPA 2003). The surface and mineral rights within the site are mostly privately owned, except for land within city limits, roads or highways (Dames & Moore 1993a).

Agricultural production in the county includes both crops and livestock. In 2002, crop sales accounted for about 58 percent of total sales of US$49,586,000; livestock sales accounted for the remaining 42 percent. Grains, oilseeds, dry beans, and dry peas comprised over 90 percent of crop sales (NASS 2002). Turkeys were the largest livestock product both numerically and in value terms. Other livestock include both beef and dairy cattle, (Dames & Moore 1993a), as well as much smaller numbers of hogs and pigs (NASS 2002).

RECREATIONAL AND CULTURAL RESOURCES

Empire Lake is the only lake in Cherokee County and is used by residents for recreational purposes. In addition, Cherokee County contains two nature reserves. The Spring River Wildlife Area is north of the city of Galena, and is 424 acres in size. Activities in the Spring River Wildlife Area include hunting, fishing, hiking, and other outdoor recreation. Schermerhorn Park is located on 24 acres that span Shoal Creek two miles south of Galena, and contains a cave that is habitat to the Kansas endangered dark-sided

salamander (*Eurycea longicauda melanopleura)*, cave salamander (*Eurycea lucifiga)*, and graybelly salamander (*Eurycea multiplicata*).[35] Recreational opportunities include hiking and wildlife observation. The Southeast Kansas Nature Center of Galena, is located in the park.[36]

Although not within the Cherokee County Superfund Site, the Mined Land Wildlife Area is a large wildlife reserve located in the northwestern part of Cherokee County. The site of former coal strip-mining, today the strip pits have become lakes that support a variety of wildlife. The Mined Land Wildlife Area includes 14,500 acres (KDWP undated). Hunting opportunities in these areas include white-tailed deer, eastern turkey, quail, mourning dove, and various waterfowl (KDWP undated). Fishing takes place in both natural streams and mining-created lakes and ponds (KDWP undated). Sportfish include largemouth bass, rainbow trout, walleye, channel catfish, crappie, bluegill and warmouth (KDWP undated). Other recreational opportunities include hiking, canoeing, and wildlife observation.

Cultural resources include the Brush Creek Bridge and Johnston Library in Baxter Springs, which are listed in the National Register of Historic Places, as is the Edgar Backus Schermerhorn House in Galena (NRHP). Baxter Springs is located on historic Rt. 66 and the Military Frontier Scenic Byway, and contains 16 Civil War sites as well as the Baxter Springs Heritage Center and Museum (Baxter Springs Chamber of Commerce, Kansas State Library). Galena is also located on Rt. 66 and contains the Galena Mining and Historical Museum (Kansas State Library).

The Kansas State Historical Society also maintains records of historic and archaeologically important sites in the county.

[35] See http://www.naturalkansas.org/schermerhorn.htm, accessed 4/21/08.

[36] See http://www.apexcorp.com/~rmangile/Sgas/GalenaNC.html, accessed 4/21/08.