Appendix A: Lake Helena Watershed Characterization

WATERSHED CHARACTERIZATION

The intent of this Appendix is to put Lake Helena and its tributaries into context with the watershed in which they occur. This section provides the reader with a general understanding of the environmental characteristics of the watershed that may have relevance to the 303(d) listed water quality impairments. This section also provides some detail regarding those characteristics of the watershed that may play a significant role in pollutant loading (e.g., geographical distribution of soil types, vegetative cover, land use).

A.1 Physical Characteristics

The following sections of the document describe the physical characteristics of the watershed, such as its location, climate, hydrologic features, and land use/land cover.

A.1.1 Location

The Lake Helena watershed is located in west-central Montana, encompassing an area of nearly 620 square miles (Figure A-1, Figure A-2). The watershed is bounded by the Continental Divide on the west, and by the Elkhorn Mountains located to the southeast. In general, the streams exhibit a dendritic pattern, flowing towards Lake Helena and the Missouri River in the northeastern part of the watershed. The three major drainages of the watershed include Silver, Tenmile and Prickly Pear creeks. Major tributaries include Sevenmile Creek (Tenmile drainage), and Warm Springs Creek, Lump Gulch, Clancy Creek, and McClellan Creek. (Prickly Pear drainage). The mountainous areas of the watershed are part of the Northern Rockies ecoregion while the Helena Valley area surrounding Lake Helena is part of the Montana Valley and Foothill Prairies ecoregion (Omernik, 1987). Approximately 68 percent of the watershed is located within Lewis and Clark County, and the remaining 32 percent lies within Jefferson County (Figure A-3). Montana's capitol city, Helena, is located near the center of the watershed.

The average elevation in the watershed is 5,085 feet. Elkhorn Peak is the highest point, with an elevation of 9,379 feet above mean sea level. The minimum elevation is 3,654 feet at the surface of Lake Helena. The watershed is part of the Upper Missouri Watershed (USGS 8-digit hydrologic cataloging unit number 10030101) and includes the following 4th-field code identifiers: 120, 130, 140, and 150.

Figure A-1. City of Helena and the Lake Helena watershed.

Figure A-2. Lake Helena and the Lake Helena Valley.

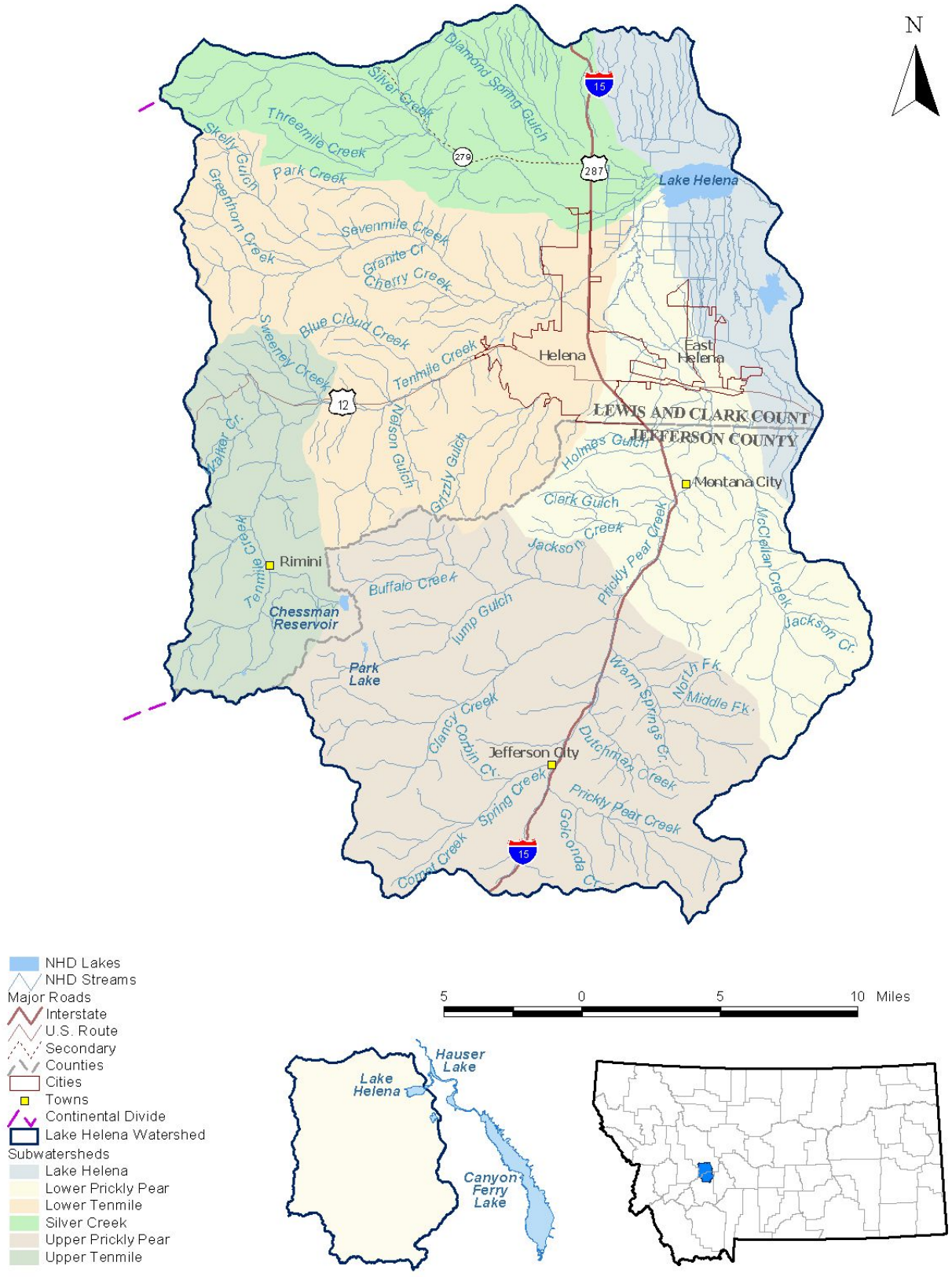

Figure A-3. Location of the Lake Helena watershed.

A.1.2 Climate

Climate in the Lake Helena watershed is classified as modified continental. It is characterized by cold weather from November through February, with temperatures dropping to zero and below (Fahrenheit), and moderate temperatures in the summer, with measurements typically under 90 degrees and rarely reaching 100 degrees. Temperatures fluctuate significantly from day to night. Most of the precipitation occurs from April through July, and June is generally the wettest month of the year. Precipitation occurs primarily as winter snow and spring rains. Summer, fall, and winter months are relatively dry, but from April to September precipitation varies greatly. Snowfall occurs from September through May.

The National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) stores and distributes weather data gathered by the Cooperative Observer Network (COOP) throughout the United States. There are three active weather stations located in the Lake Helena watershed as shown in Figure A-4 and listed in Table A-1.
Figure A-5 illustrates average maximum and minimum temperatures, and Figure A-6 shows average precipitation throughout the year for the Helena WSO station (NOAA Cooperative station number 244055-4). Likewise, Figure A-7 and Figure A-8 show average maximum and minimum temperatures and average precipitation, respectively, throughout the year for the Austin 1 W station (NOAA Cooperative station number 240375). The Helena station is located in the valley region of the watershed at an elevation of 3,830 feet and the Austin station is located at a higher elevation of 4,790 feet in a more mountainous region.

Table A-1. Active NOAA climate stations in the Lake Helena watershed.

Station Name	Coop-ID	Elevation (ft)
Austin 1 W	240375-4	4,790
Helena WSO	244055-4	3,830
Rimini 4 NE	247055-4	4,700

Total annual average precipitation and annual average snowfall at the Helena station are 11.8 inches and 50.3 inches, respectively. Average temperatures at this station range from a maximum of 83.8 °F in July to a minimum of 11.1 °F in January. At the Austin station, total annual average precipitation is 15.9 inches and annual average snowfall is 62.8 inches. Average temperatures at this station range from a maximum of 81.1 °F in July to a minimum of 11.3 °F in January.

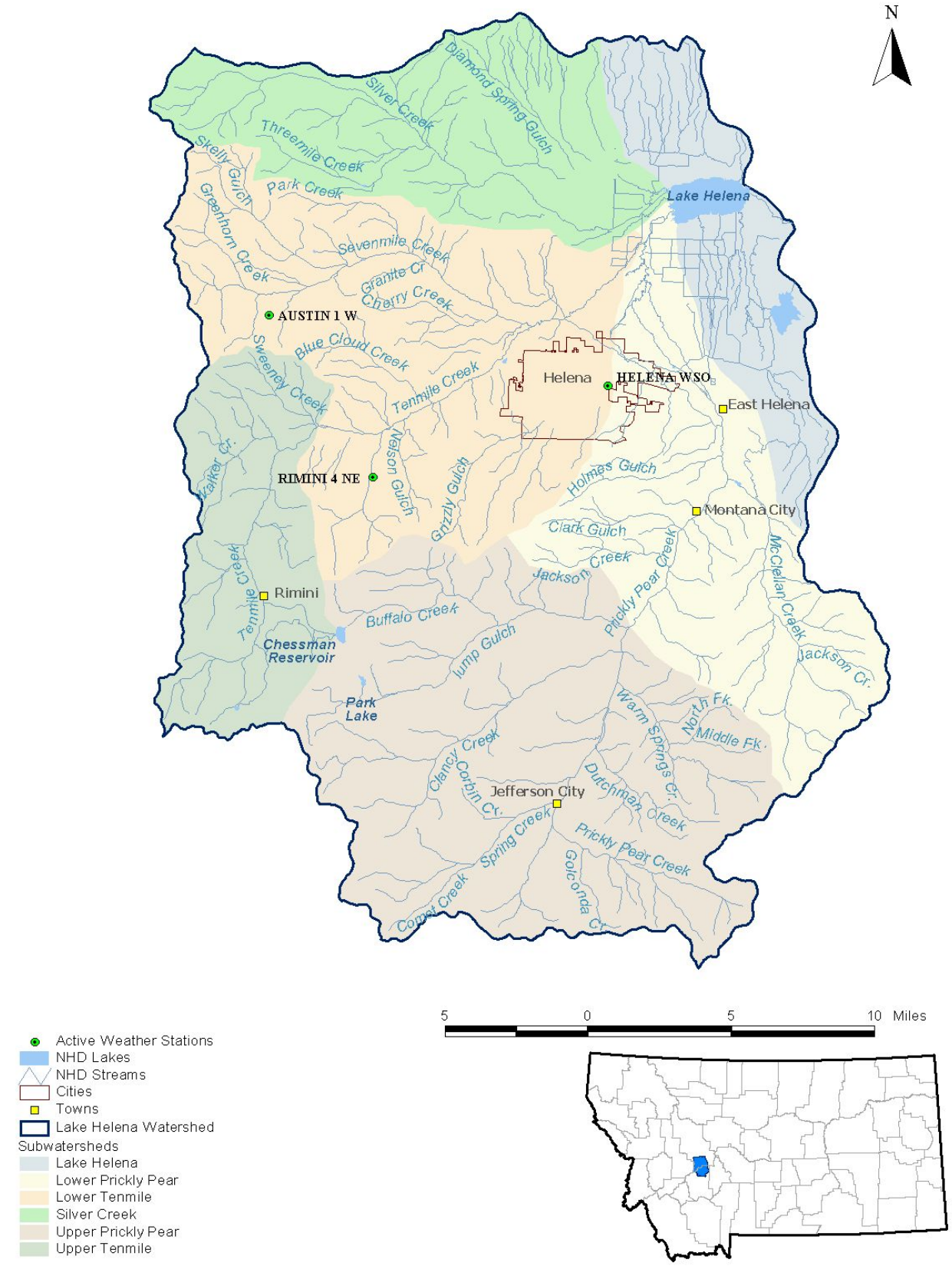

Figure A-4. Location of climate stations in the Lake Helena watershed.

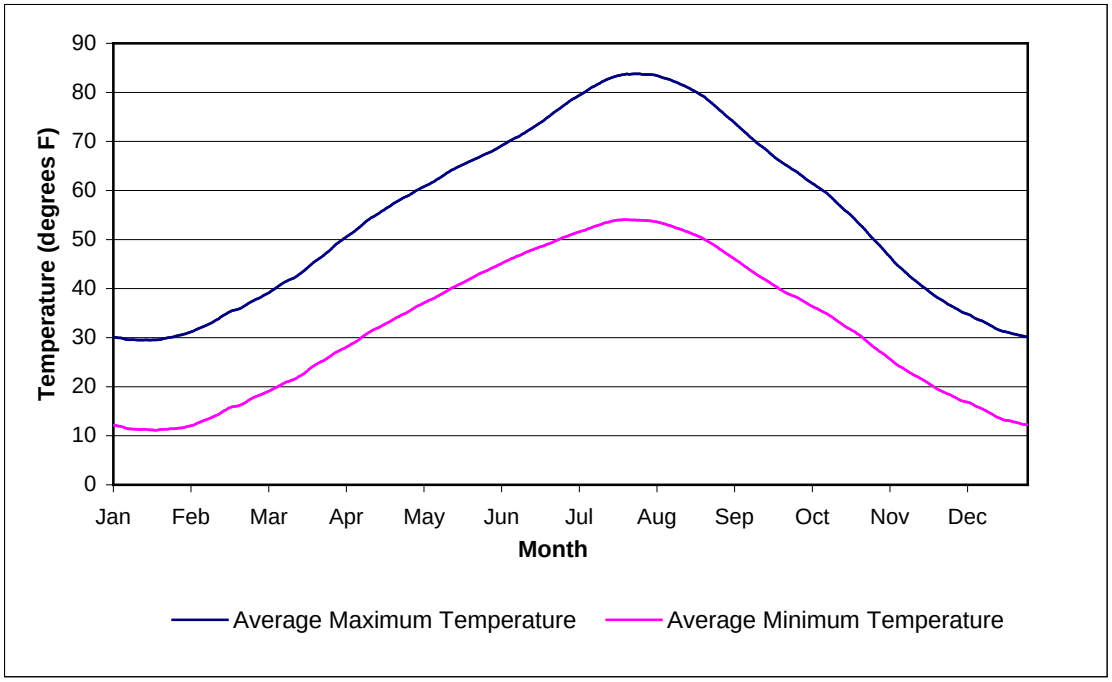

Figure A-5. Average maximum and minimum temperatures for Helena WSO, MT, Station 244055.

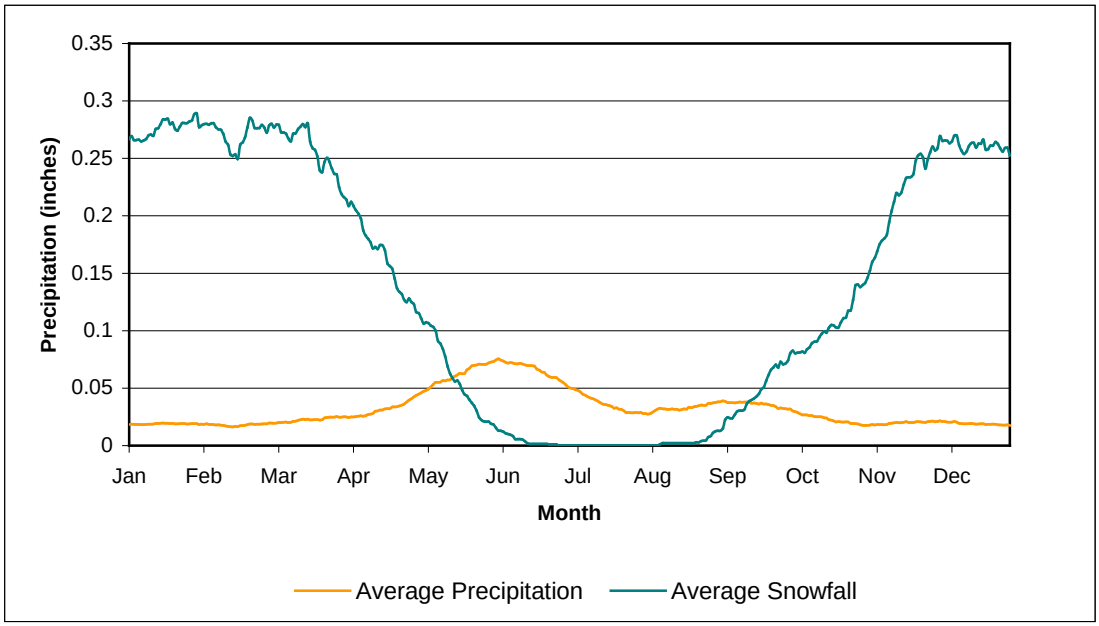

Figure A-6. Average precipitation for Helena WSO, MT, Station 244055.

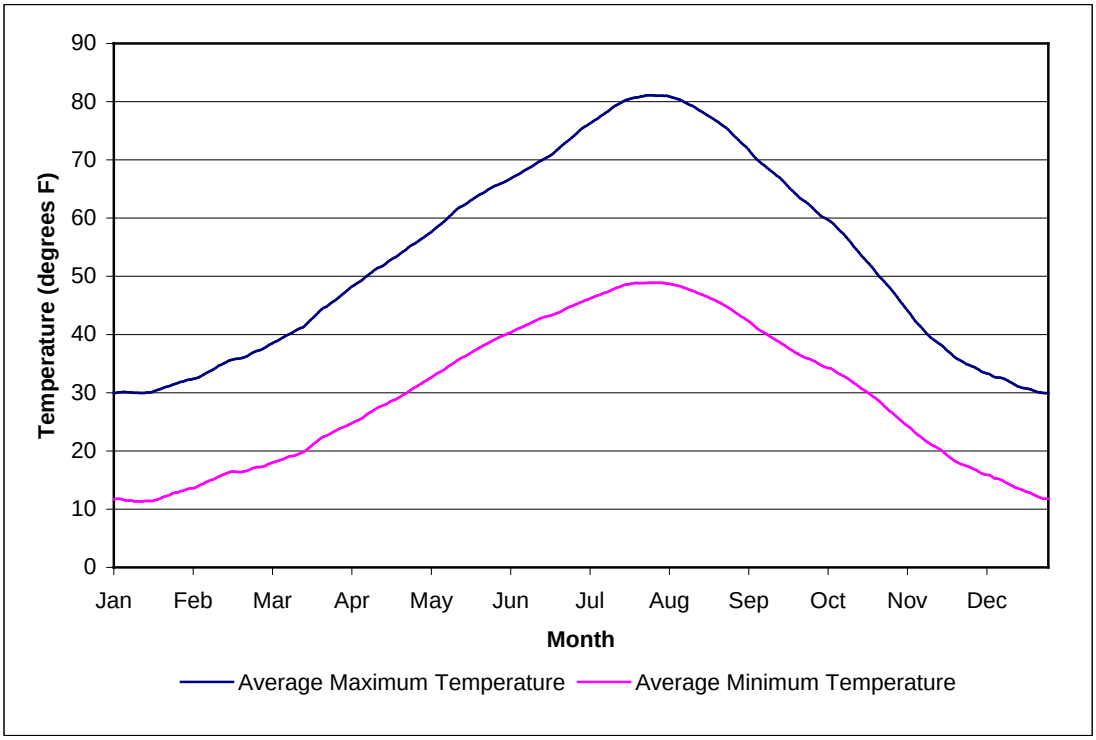

Figure A-7. Average maximum and minimum temperatures for Austin 1 W, MT, Station 240375.

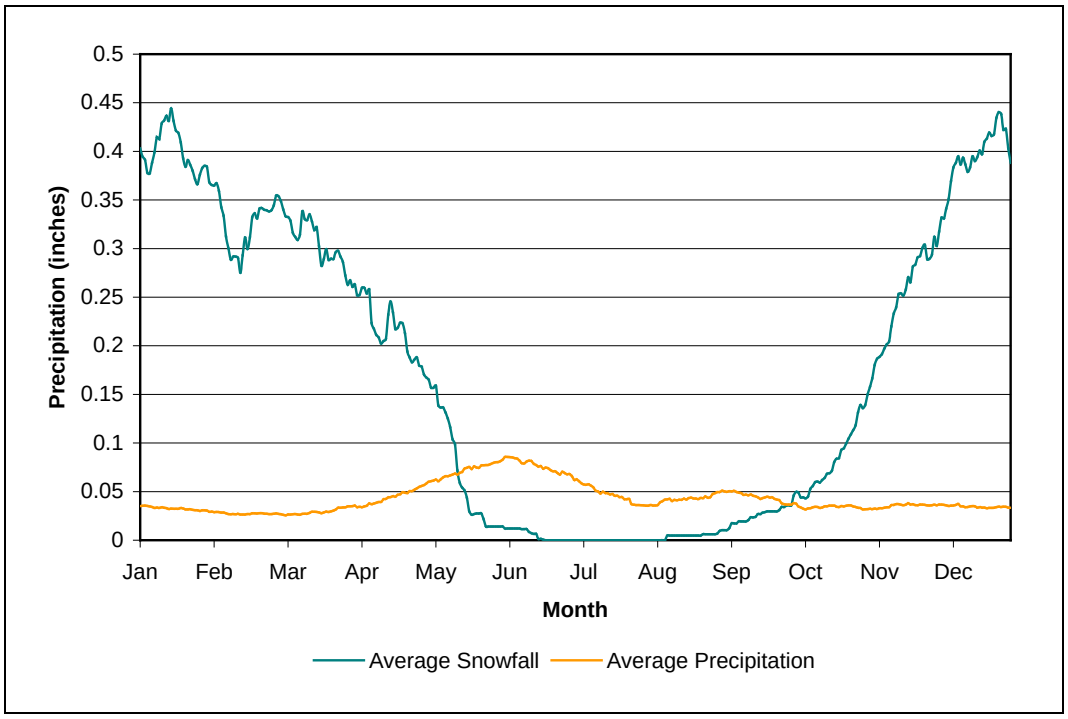

Figure A-8. Average precipitation for Austin 1 W, MT, Station 240375.

A.1.3 Topography

Figure A-9 displays the general topography within the Lake Helena watershed, and a shaded relief map of the watershed is presented in Figure A-10. As seen in Figure A-9, elevations are highest in the southern and western portions of the watershed and range from 6,000 to 9,338 feet above mean sea level. The watershed's highest point, Elkhorn Peak, is located in the southeastern corner. The lowest elevations are found in the northeastern part of the watershed in the Helena Valley surrounding Lake Helena, where elevation reaches a minimum of 3,654 feet above mean sea level. The average elevation in the watershed is 5,085 feet.

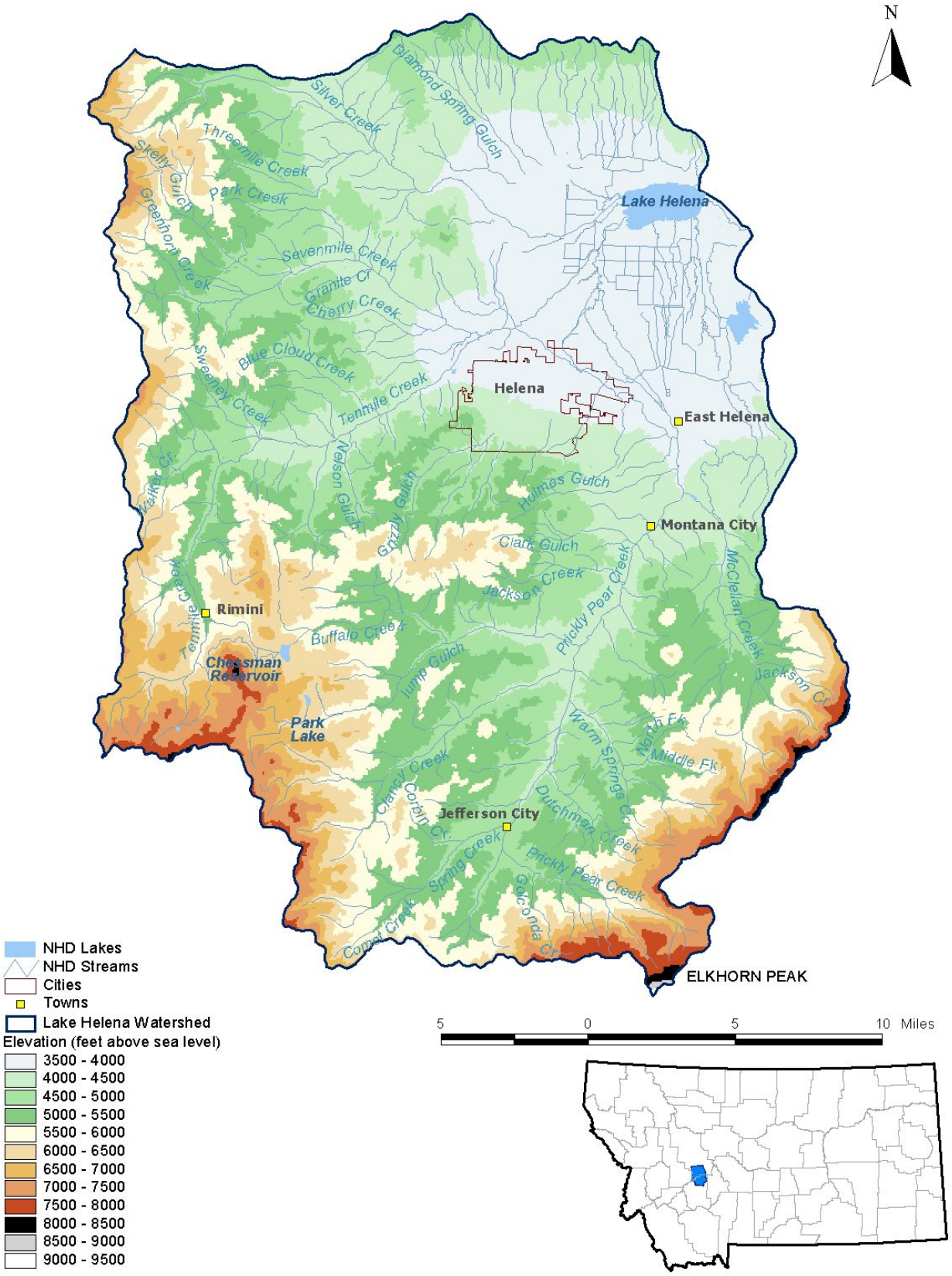

Figure A-9. Elevation in the Lake Helena watershed.

Figure A-10. Shaded relief map of the Lake Helena watershed.

A.1.4 Soils

Soils data and GIS coverages from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the Lake Helena watershed. General soils data and map unit delineations for the United States are provided as part of the State Soil Geographic (STATSGO) database. GIS coverages provide accurate locations for the soil map units (MUIDs) at a scale of 1:250,000 (USDA, 1995). A map unit is composed of several soil series having similar properties. Identification fields in the GIS coverages can be linked to the database that provides information on chemical and physical soil characteristics. Figure A-11 shows the general map unit boundaries in the Lake Helena watershed, and the following sections summarize relevant soils data.

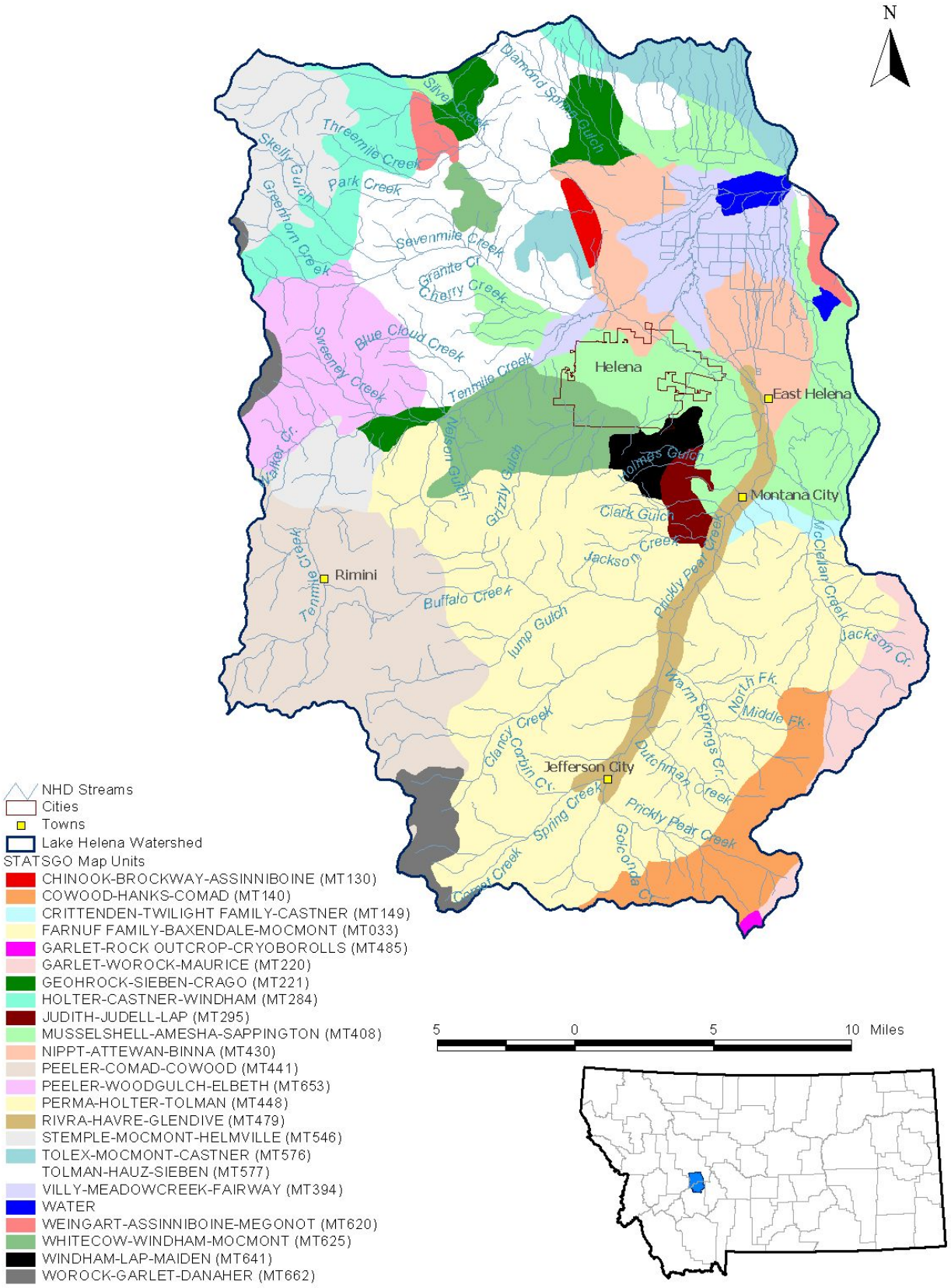

Figure A-11. General soil units in the Lake Helena watershed.

A.1.5 Universal Soil Loss Equation (USLE) K-factor

A commonly used soil attribute is the K-factor, which is a component of the Universal Soil Loss Equation (Wischmeier and Smith, 1978). The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion, and factor values may range from 0 for water surfaces to 1.00. In practice, maximum factor values generally do not exceed 0.67. Large K-factor values reflect greater inherent soil erodibility. The distribution of K-factor values in the Lake Helena watershed is shown in Figure A-12. The figure indicates that, on average, all of the soils in the watershed have K-factors ranging from 0.1 to 0.36, suggesting moderate soil erosion potential. The figure also shows that the potential for erosion is greater in the soils of the Helena Valley than in the soils of the headwaters. Actual erosion is influenced by other factors, including rainfall and runoff, land slope, vegetation cover, and land management practices.

A.1.6 Hydrologic Soil Group

NRCS has defined four hydrologic soil groups (Table A-2). The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have the worst infiltration rates, while sandy soils that are well drained have the best infiltration rates. Data for the Lake Helena watershed were obtained from STATSGO (NRCS, 2001). The data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed in Figure A-13. Soils in the Lake Helena watershed are classified as B and C, described as having moderate to slow infiltration rates when saturated.

Table A-2. Hydrologic soils group descriptions.

Hydrologic Soils Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

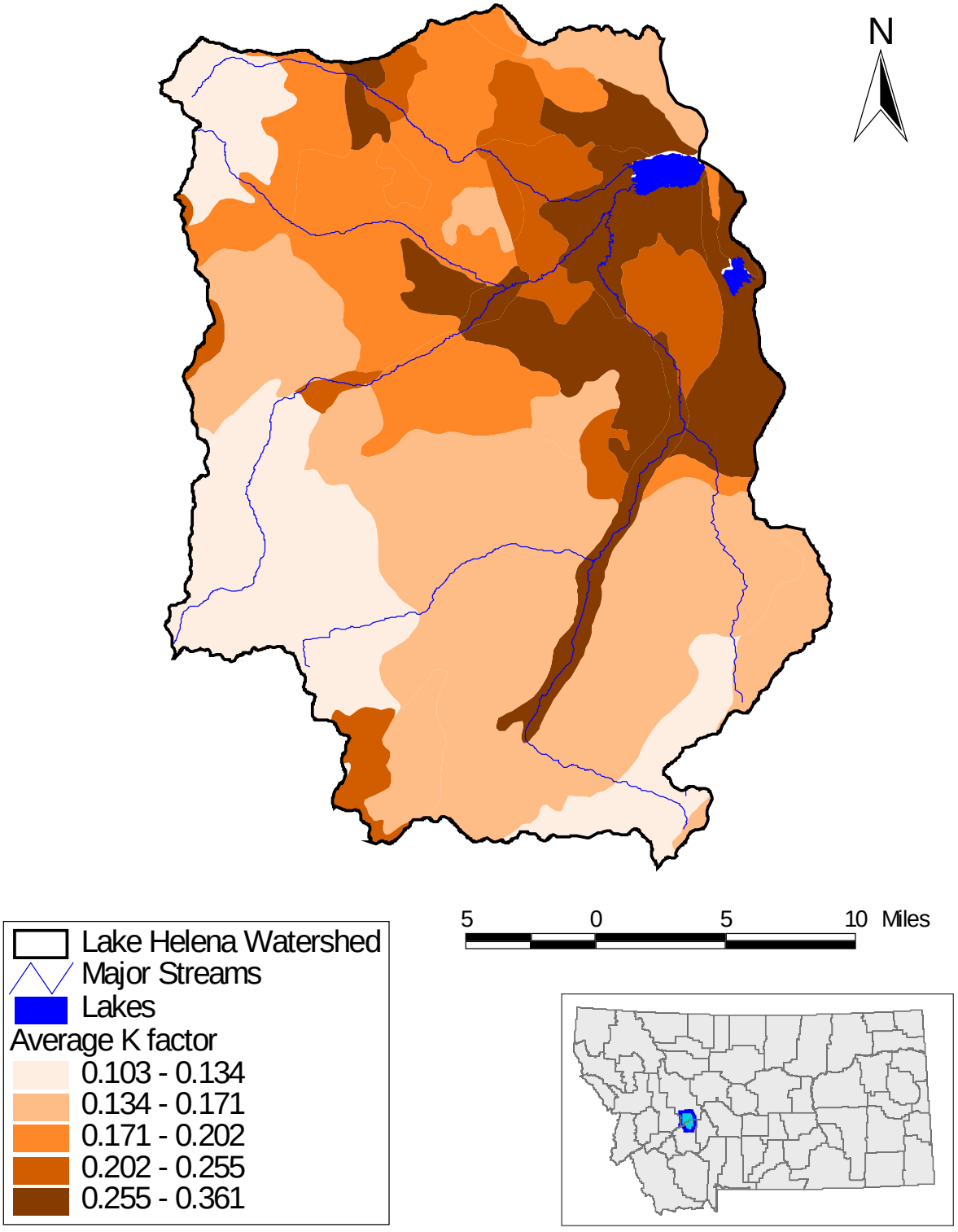

Figure A-12. Distribution of the USLE K-factor in the Lake Helena watershed.

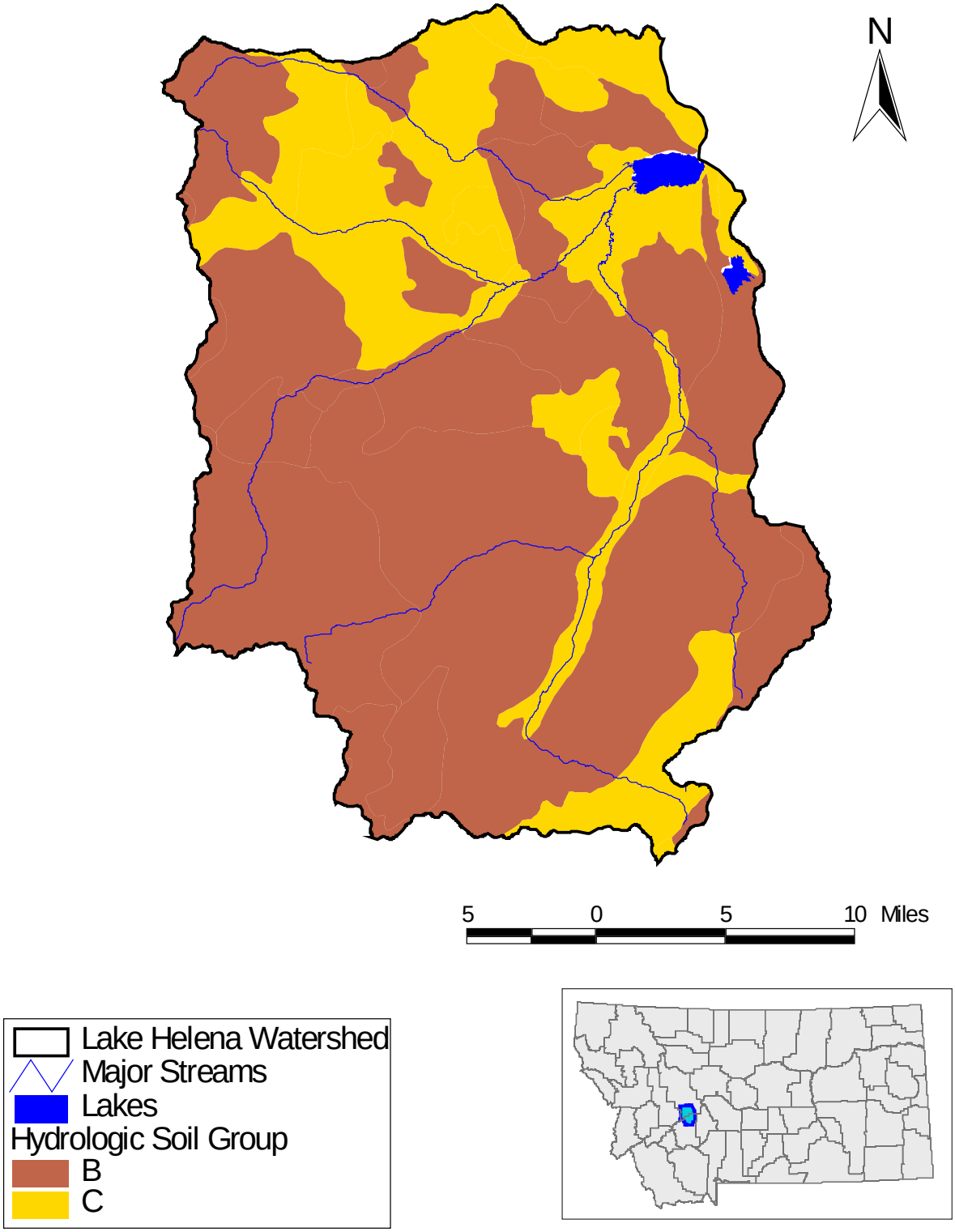

Figure A-13. Distribution of hydrologic soil groups in the Lake Helena watershed.

A.1.7 Hydrology

Surface water enters the Helena Valley principally from Prickly Pear Creek, Tenmile Creek, Silver Creek, and from irrigation water that is diverted from the Missouri River. Diversions from the Missouri River to the Helena Valley via the Helena Valley Regulating Reservoir account for an average of about 87,000 acre-feet per year of additional inflow into the watershed. The Helena Valley Irrigation District uses most of this volume of water for irrigation, while the City of Helena uses up to 5,680 acre-feet of water per year water from the regulating reservoir for municipal and industrial purposes. The City of Helena is proposing to increase its use of Missouri River water to 11,300 acre-feet/year and the Helena Valley Irrigation District is proposing to expand its irrigated acreage from 15,608 acres to about 18,200 acres (USBR, 2004).

A.1.8 Water Bodies

The reservoirs and streams within the Lake Helena watershed are shown in Figure A-14. Most surface water in the Helena Valley flows towards Lake Helena. The principal surface and groundwater discharge point is Lake Helena (Kendy et al., 1998). Lake Helena is a shallow water body at the base of the Helena Valley. The surface area is approximately 3.2 square miles, or 2,072 acres. The water elevation of Lake Helena is partly controlled by Hauser Lake, a reservoir located to the north and east of Lake Helena on the Missouri River. When Hauser Dam was constructed on the Missouri River, the wetlands in the lower reaches of Silver and Prickly Pear creeks were flooded which created Lake Helena. Hauser Lake was impounded in 1907, and an earthen causeway and control mechanisms were constructed in 1945 to separate Hauser Lake and Lake Helena, allowing the two to be regulated independently. The level of Hauser Lake is controlled for power generation, and the flow between the two reservoirs depends on the level of Lake Helena relative to that of Hauser Lake. Net flow between the two reservoirs is from Lake Helena to Hauser Lake, but flow frequently reverses (Shields, et. al., 1995). In 1912, the Montana Reservoir and Irrigation Company erected pumping plants on the north and south shores of Lake Helena for an irrigation system to serve the valley. The company operated the pumps and delivered water until the late 1940s (Kendy et al., 1998).

Major tributaries discharging to Lake Helena include Prickly Pear Creek, Tenmile Creek, Silver Creek and their tributaries. Lake Helena also receives inflow from irrigation tile drains on the south, west and north and, seasonally, from the Helena Valley Irrigation Canal on the west and from the Missouri River (Hauser Lake) backwater on the east (Kendy et al., 1998). The Silver Creek drainage is intermittent where it enters the Helena Valley and its channel has been relocated as a result of development activities. Silver Creek flows from west to east across the Helena Valley as a constructed ditch and most of its flow where it enters Lake Helena consists of groundwater tile drainage from the west and north portions of the Helena Valley.

Individual domestic and community water supply wells are present in shallow aquifers of the valley and are partially recharged by infiltrated irrigation water and septic systems, both of which can affect the quality of the water in the shallow aquifer. Some of the irrigation water returns as surface drainage to Lake Helena (Kendy et al., 1998).

The Helena Valley Irrigation District contracts with the Bureau of Reclamation for water for agricultural irrigation, and the City of Helena contracts water for municipal and industrial uses. The water is delivered from Canyon Ferry Reservoir through the Helena Valley pumping plant, tunnel and feeder canal. The water is stored in the Helena Valley Regulating Reservoir and made available to meet the demands of the irrigation district and the city (USBR, 2004). The City withdraws its water from the regulating reservoir by a pipeline to the Missouri River treatment plant. The Helena Valley Canal distributes water from the regulating reservoir. This canal, show in Figure A-14 and Figure A-15, nearly

encircles the Helena Valley alluvial plain, and water is distributed to the central part of the Helena Valley through an extensive network of lateral canals (USGS, 2001). The Helena Valley Regulating Reservoir, located 3.5 miles west of Canyon Ferry Dam on the Missouri River, can store up to 10,451 acre-ft of water.

Other impoundments in the Lake Helena watershed include Chessman and Scott reservoirs, which are part of the City of Helena's water supply storage and delivery system. These water bodies are located west of Helena in the Tenmile drainage near the Town of Rimini. Chessman and Scott reservoirs are filled every spring with runoff diverted from several small streams via a flume system. Stored water is then released on a seasonal basis to augment flows in Tenmile Creek upstream from diversions to the City's Tenmile Water Treatment Plant (Cleasby and Nimmick, 2002; City of Helena Public Works Department, 2002).

Figure A-14. Water bodies within the Lake Helena watershed.

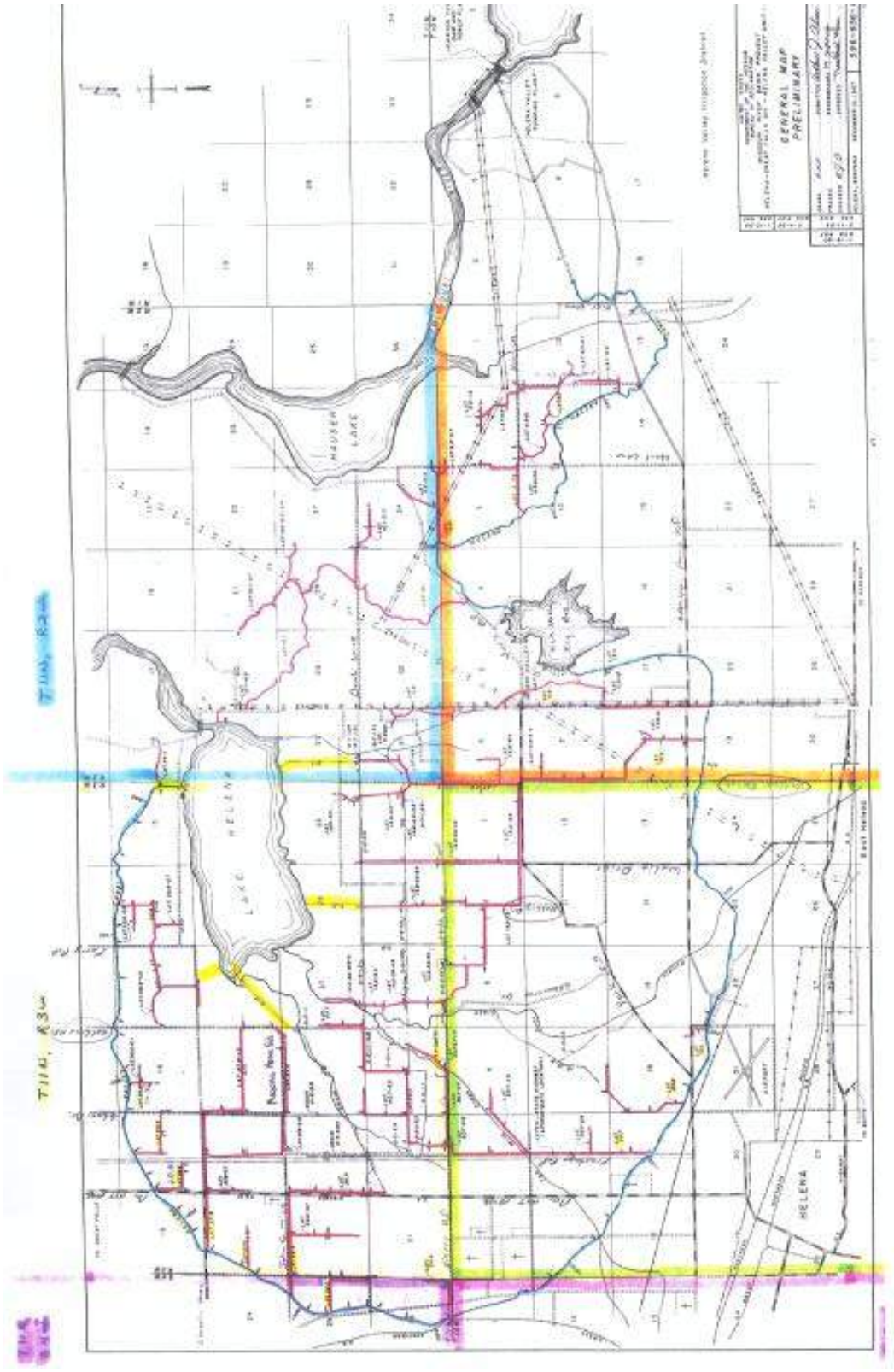

Figure A-15. Lake Helena, Helena Valley irrigation canals, and regulating reservoir (source: Helena Valley Irrigation District).

A.1.9 Flow Data

Streamflow varies from site to site and seasonally in the Helena Valley as a result of complex patterns of precipitation and runoff, groundwater and surface water interactions, and water diversions and storage. Flow increases in streams are attributed to tributary inflows or groundwater discharge, and flow depletions occur as a result of irrigation diversions and water losses to groundwater (USGS, 2001). A series of tile drains were installed throughout much of the Helena Valley during the late 1950s. The drainage system has lowered the elevation of the shallow aquifer, drained numerous acres of historic wetlands, caused the loss of natural infiltration and groundwater recharge areas, and reduced surface flows in lower Tenmile, Prickly Pear, and possibly Silver creeks. The tile drains discharge directly into Lake Helena as a series of canals. Property owners and residents along Tenmile, Sevenmile, and Prickly Pear Creeks and in other low lying areas of the watershed have routinely experienced damage to personal property due to floods associated with spring runoff and unpredictable winter thaws (Wetlands Community Partnership, 2001).

The USGS National Water Information System (NWIS) online database lists 17 streamflow gages in the Lake Helena watershed with current and historical flow data. Ten stations with recent flow data were analyzed to obtain a general understanding of flow patterns from the tributary headwaters to Lake Helena. These stations included McClellan Creek near East Helena, Prickly Pear Creek near Clancy, Prickly Pear Creek below Anderson Gulch near Jefferson City, Tenmile Creek above Prickly Pear Creek near Helena, Tenmile Creek at Green Meadow Drive at Helena, Tenmile Creek near Helena, Tenmile Creek at State Nursery Bridge near Helena, Tenmile Creek at Tenmile Water Treatment Plant near Rimini, Tenmile Creek near Rimini, and Sevenmile Creek below Granite Creek near Helena. The selected stations are described in Table A-3 and are shown in Figure A-16.

Table A-3. Selected USGS stream gages in the Lake Helena watershed.

		Drainage Area			
Station ID	**Gage Name**	**Acres**	**Square Miles**	**Start Date**	**End Date**
06061900	McClellan Creek near East Helena	21,248	33	Sep 1988	Sep 1990
06061500	Prickly Pear Creek near Clancy	122,880	192	Jul 1908	Sep 2001
06058900	Prickly Pear Creek below Anderson Gulch near Jefferson City	8,960	14	Oct 1988	Sep 1990
06064150	Tenmile Creek above Prickly Pear Creek near Helena	120,320	188	May 1997	Sep 1998
06064100	Tenmile Creek at Green Meadow Drive at Helena	103,040	161	May 1997	Sep 1998
06063000	Tenmile Creek near Helena	61,760	97	Aug 1908	Sep 1998
06062990	Tenmile Creek at State Nursery Bridge near Helena	N/A	N/A	Mar 1990	Aug 1992
06062750	Tenmile Creek at Tenmile Water Treatment Plant near Rimini	32,704	51	May 1997	Sep 2001
06062500	Tenmile Creek near Rimini	19,776	31	Oct 1914	Sep 2001
06063600	Sevenmile Creek below Granite Creek near Helena	N/A	N/A	Mar 1990	Sep 1991

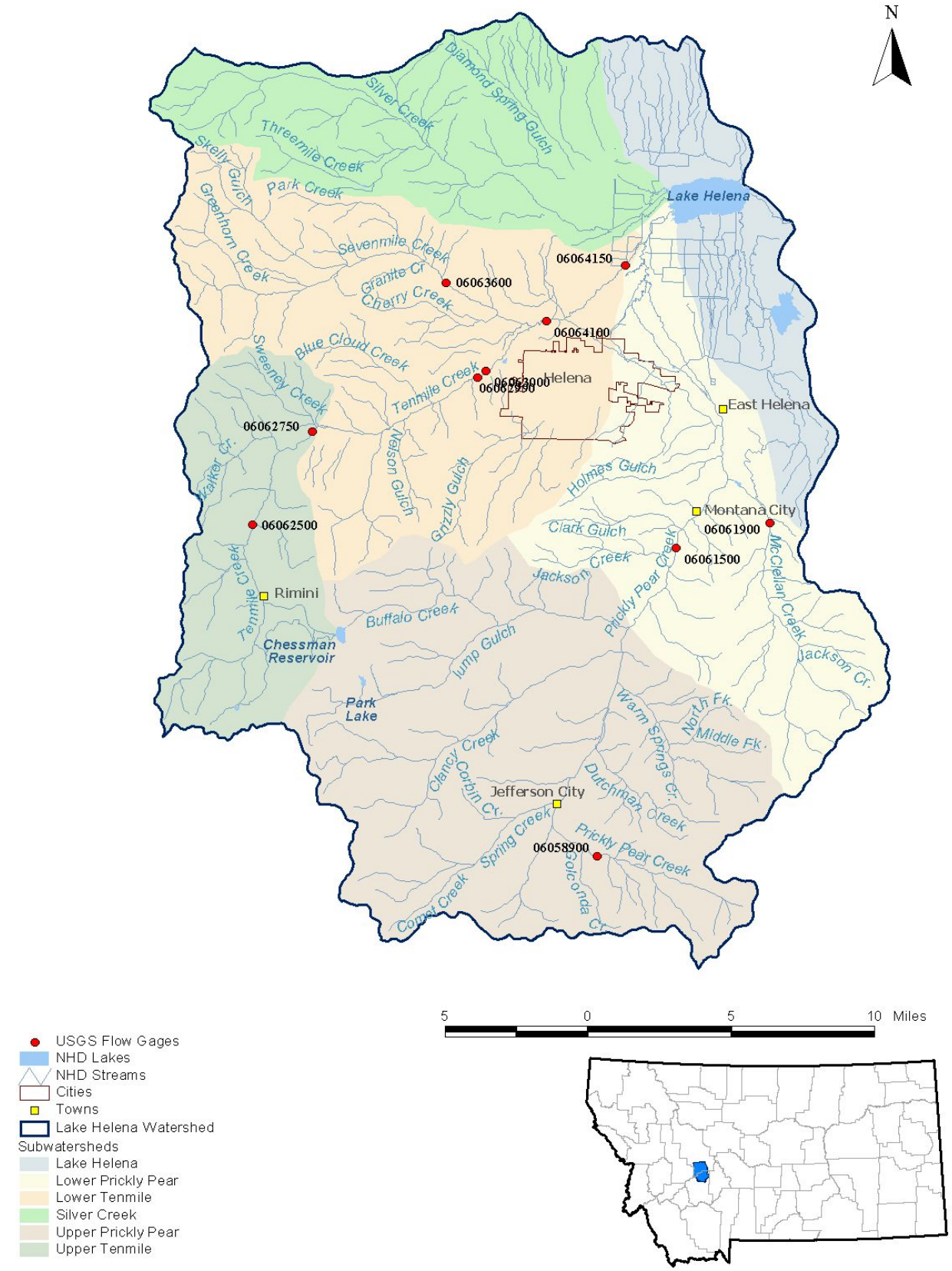

Figure A-16. Location of selected USGS streamflow gages in the Lake Helena watershed.

The average daily streamflow measured at each of six of the ten selected stations during 1990 is displayed in Figure A-17 through Figure A-20. Flow patterns at most of the stations show peaks in late April and again in early June due to snowmelt runoff and precipitation. Figure A-17 shows average daily streamflow measured at two stations along Prickly Pear Creek. Flows are noticeably higher at the downstream station number 06061500, located in the middle portion of the drainage near Clancy, than at station number 06058900, which is located in the upper drainage near Jefferson City. This is due to the larger watershed drainage area at the former station and the influence of several incoming tributaries, including Warm Springs, Clancy and Lump Gulch creeks. This station also has the highest base flow of all the stations examined. Flow patterns at station 06061900 on McClellan Creek, a tributary to the middle reaches of Prickly Pear Creek, are similar to those seen at the other stations with peaks occurring in late April and early June (Figure A-19).

Daily mean streamflows at Tenmile Creek stations 06062500 (near Rimini) and 06062990 (State Nursery Bridge) are shown in Figure A-18. These stations have very similar seasonal flow patterns, although station 06062990 is located further downstream in the watershed and has a slightly higher flow on most occasions. The highest peak flows recorded in Tenmile Creek during 1990 were measured at station 06062990. Station 06063600 on Sevenmile Creek, a Tenmile Creek tributary, showed a moderate and less variable flow when compared to patterns seen at the other gaging stations (Figure A-20).

In general, flows in Lake Helena watershed streams are low and fairly constant from September through March. The highest flows can be expected during the months of April and June, and these are typically one to two orders magnitude greater than the baseflow levels.

At present, water diverted from upper Tenmile Creek provides 70 percent of the City of Helena's municipal water supply during the months of June through September, and 100 percent of the city's water supply from October through May. Diversions are located on Tenmile Creek south of Rimini and near the confluences of Beaver, Minnehaha, Moose, and Walker creeks. Additional water is obtained from Scott and Chessman reservoirs, which collect water from several tributaries during periods of high flow. This stored water is held in reserve and accessed on an as-needed basis (E^2 Inc. et al., 2004). Municipal water diversions often dewater portions of Tenmile Creek, particularly the reach from Rimini to the mouth of Spring Creek, a distance of 0.5 mile (USGS, 2000). Further downstream near the City of Helena, seasonal irrigation withdrawals contribute to the streamflow depletion problems leaving a dry streambed in some locations. In the lower three miles of Tenmile Creek upstream of its confluence with Prickly Pear Creek, flows may be supplemented at times with water from the Helena Valley Irrigation District. This additional water may enter lower Tenmile Creek in the form of direct spills, or as irrigation return flows from either surface or groundwater sources. In general, streamflows in lower Tenmile Creek tend to be unpredictable and highly variable from month to month, reflecting a complex pattern of runoff, groundwater and surface water interactions, and diversion management (USGS, 2001).

Silver Creek's hydrology has been altered as a result of placer mining and deposition of mill wastes in its upper watershed (Maxim, 1996). Further downstream, Silver Creek becomes intermittent due to irrigation diversions, channel alterations, and other hydrologic modifications. Silver Creek flows into Lake Helena as a constructed ditch and most of its flow at that location originates from groundwater tile drainage entering the ditch at various locations from the west and north portions of the Helena Valley.

Prickly Pear Creek is severely dewatered during the irrigation season beginning at a major diversion just below East Helena and continuing downstream to Lake Helena. Prickly Pear Creek and many of its tributary drainages, as well as the Tenmile and Silver Creek subwatersheds, have undergone many changes over the last 140 years. Extensive placer and lode mining, minerals smelting, agricultural development, timber harvest, road construction, livestock grazing, other land uses, and wildfires have

altered the natural hydrology of the Lake Helena watershed. These changes and their implications to water quality are discussed in more detail in Section 3.0 of this report.

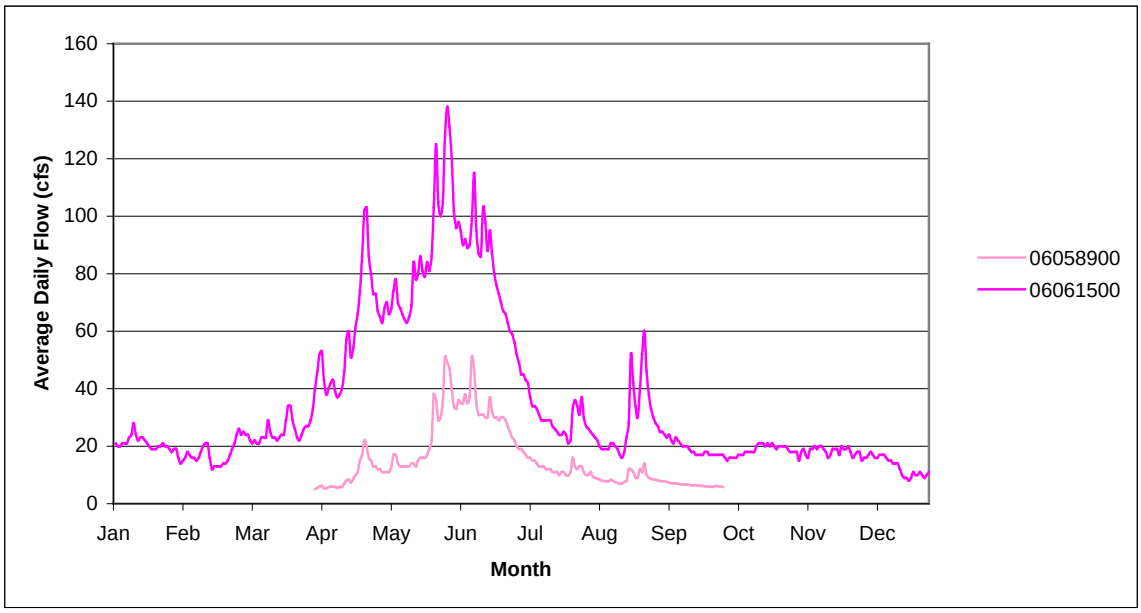

Figure A-17. Average daily flow for year 1990 at USGS gages 06058900 and 06061500 on Prickly Pear Creek.

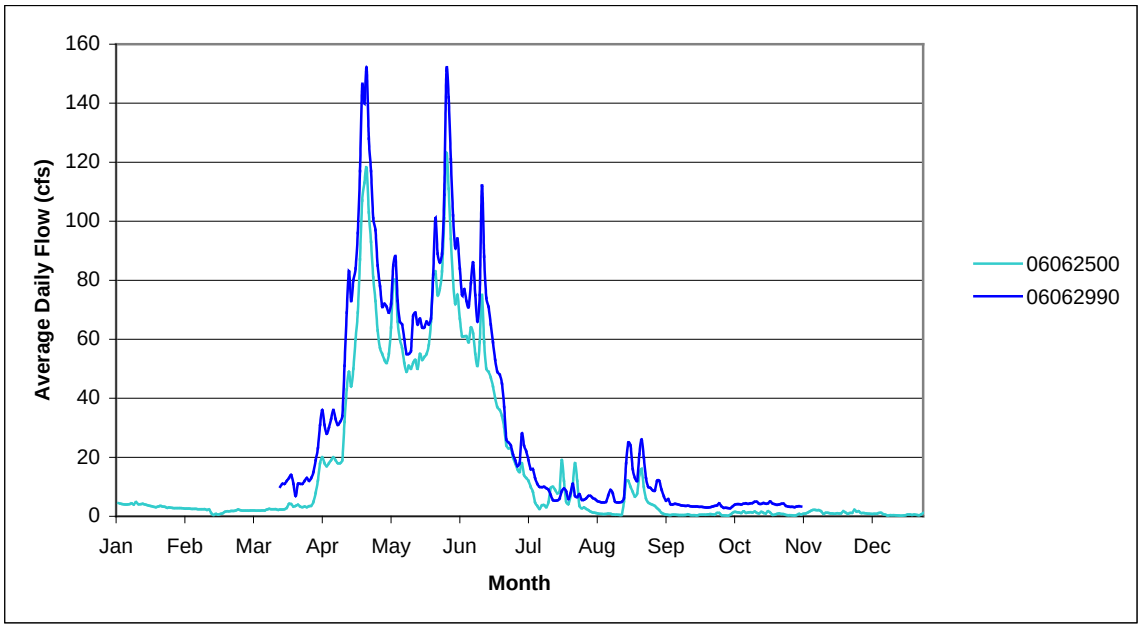

Figure A-18. Average daily flow for year 1990 at USGS gages 06062500 and 06062990 on Tenmile Creek.

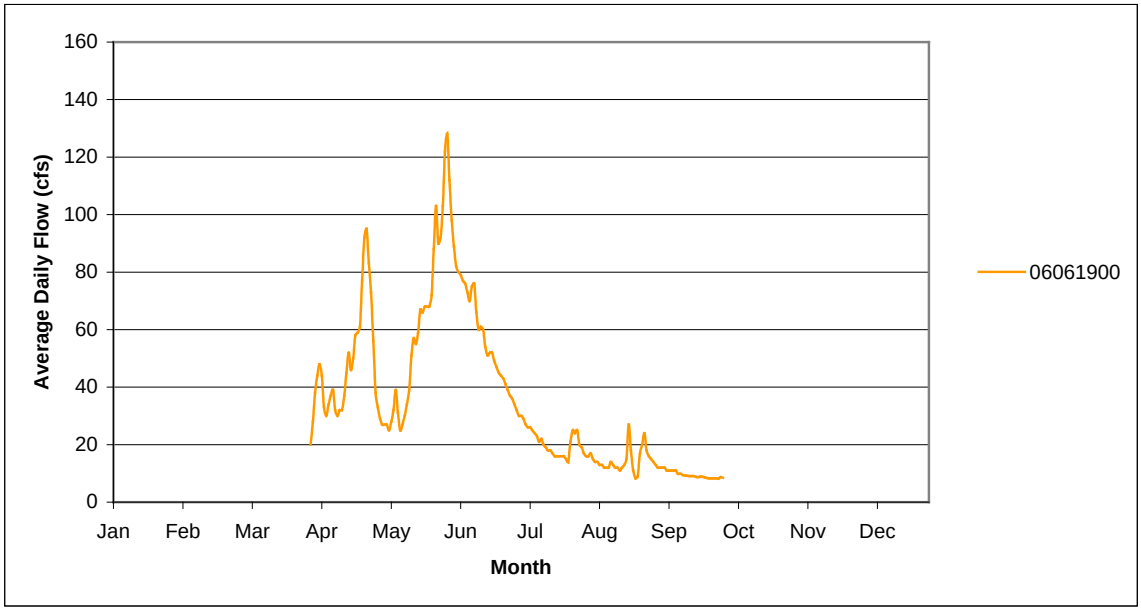

Figure A-19. Average daily flow for year 1990 at USGS station 06061900 on McClellan Creek.

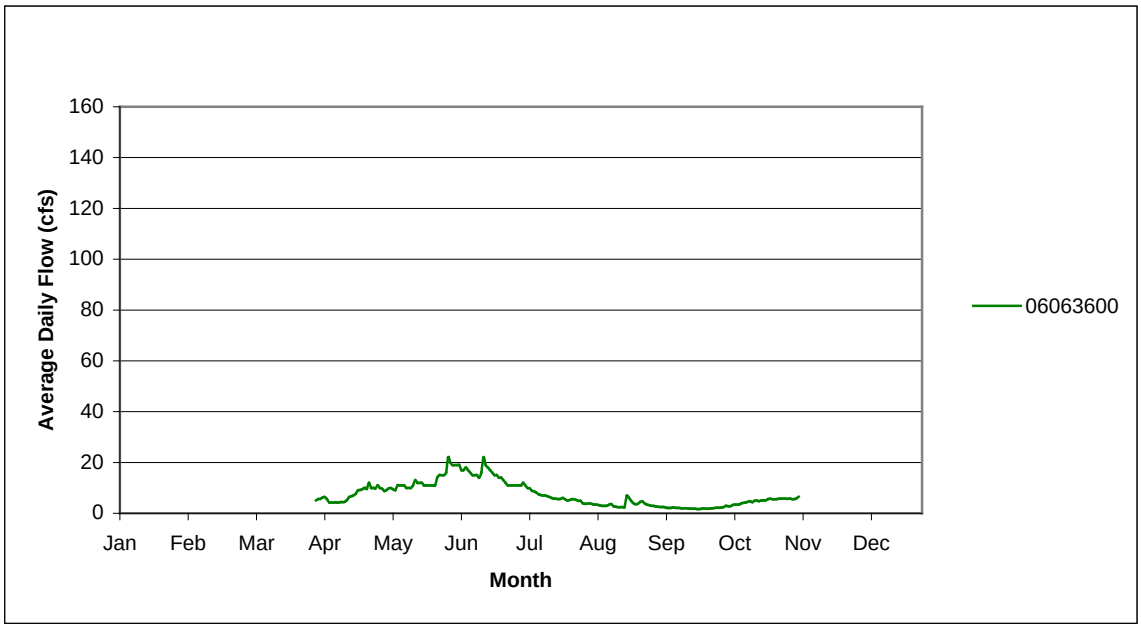

Figure A-20. Average daily flow for year 1990 at USGS gage 06063600 on Sevenmile Creek.

A.1.10 Stream Types

The Helena Valley is drained by a network of intermittent and perennial streams. Prickly Pear, Tenmile, and Silver creeks converge at Lake Helena, which drains into the Missouri River. The National Hydrography Dataset (NHD) provided by USEPA and USGS identified four major stream types in the Lake Helena watershed. Table A-4 and Figure A-21 present a summary of the stream types in the Lake Helena watershed. Most of the streams in the watershed were classified as either perennial (45%) or intermittent (44%). Other stream types include canals/ditches and pipelines. Intermittent streams have flow only for short periods during the course of a year, and flow events are usually initiated by rainfall. Perennial streams flow throughout the entire year. The main stem of the major tributaries and most headwater streams were classified as perennial. However, seasonal dewatering occurs in the lower sections of Silver, Tenmile, and Prickly Pear creeks as a result of irrigation withdrawals and losses to groundwater. Mountain streams of varying sizes have perennial flow due to snowmelt, precipitation, and discharge from bedrock aquifers, while many of the smaller tributaries located in the valley regions of the watershed are intermittent. All of the canals and ditches are concentrated in agricultural areas surrounding Lake Helena.

Table A-4. Summary of stream types in the Lake Helena watershed.

Stream Type	Stream Length (miles)	Percent
Perennial	426	45.4
Intermittent	418	44.5
Canal/Ditch	91	9.7
Pipeline	4	0.5
Total	940	100.0

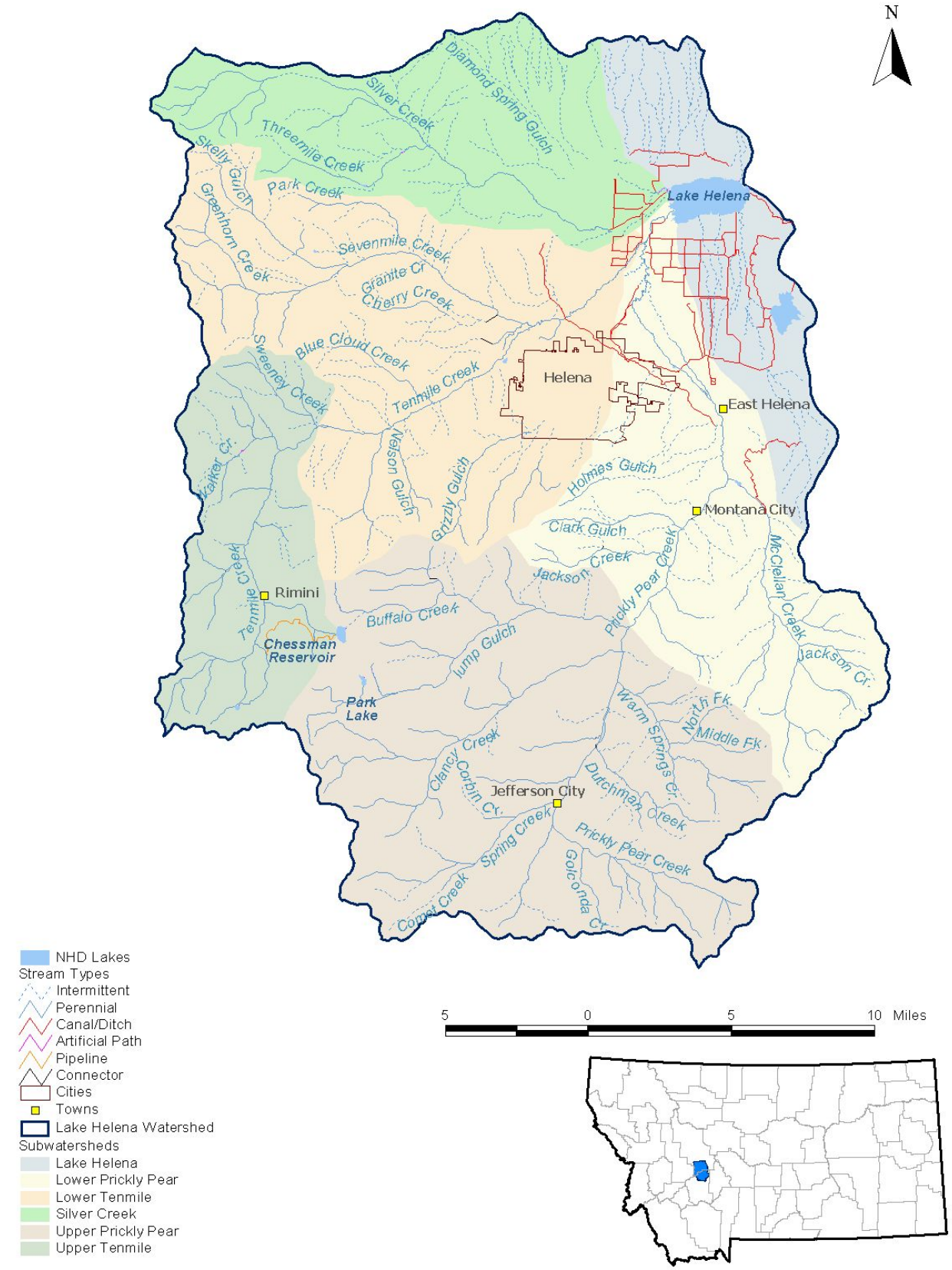

Figure A-21. Stream types in the Lake Helena watershed.

A.1.11 Groundwater

Groundwater in the Helena area is the sole source of drinking water for more than 27,000 people, approximately 55 percent of the area population. The Helena Valley alluvial aquifer provides water through approximately 5,600 domestic wells and 71 public water supplies (Lewis and Clark County, 2004).

A relatively high groundwater production capability exists in the central portion of the Helena Valley. In general, water supply wells in the central portion of the valley produce over 100 gallons per minute (gpm), while significantly lower groundwater production capacity ($\leq$ 20 gpm) is common near the margins of the valley. Major surface water features such as Prickly Pear, Tenmile Creek, and Sevenmile creeks contribute water to some degree to the groundwater system. Water levels in general are less than 10 feet below the ground surface in the southwestern portion of the Helena Valley, and are closer to the surface in several areas. The presence of springs in the valley indicates groundwater discharge zones, and near-surface groundwater flows (Wetlands Community Partnership, 2002). Another factor influencing shallow groundwater elevations in the Helena Valley is the extensive network of tile drains, which have artificially lowered the water table.

The hills and mountains adjacent to the Helena Valley collect precipitation that eventually recharges aquifers in the Helena Valley. The recharge to the shallow aquifer system alluvial materials originates from infiltration of precipitation (rain and snow), irrigation water, and streamflow. Recharge from bedrock surrounding the valley contributes a significant amount of water to the Helena Valley. Approximately 44 percent of recharge to the valley is estimated to come from inflow from the underlying bedrock. Water migrates from the upper elevations surrounding the valley through fractures and joints towards the valley and stream drainages (Table A-5) (Wetlands Community Partnership, 2002).

Table A-5. Sources of Groundwater Recharge in the Helena Valley (Wetlands Community Partnership, 2002).

Source	Amount Acre feet/year	Percent
Infiltration-streamflow	2,900	14
Leakage-irrigation canal	7,060	8
Infiltration-excess irrigation	27,000	30
Infiltration-precipitation	---	<1
Inflow from bedrock	39,800	44

Groundwater information was obtained from a GIS layer titled *Principal Aquifers of the 48 Conterminous United States* prepared by the USGS. This data set contains the shallowest principal aquifers of the conterminous United States, portrayed as polygons. The data set was developed using information from the *Ground Water Atlas of the United States*.

The mountainous areas contain bedrock aquifers that surround and are hydraulically connected to the aquifers in the Helena Valley. The Helena Valley contains part of the Northern Rocky Mountains Intermontane Basins Aquifer System, which is composed of unconsolidated sand and gravel aquifers. The aquifer in the western part of the valley is composed mostly of Quaternary alluvium, although the upper few hundred feet are composed of Tertiary sediments. The eastern part of the valley is underlain by fine-grained, poorly consolidated Tertiary sediments, which form the only available aquifer in that area (Briar and Madison, 1992).

In general, unconsolidated sand and gravel aquifers have intergranular porosity, and contain water primarily under unconfined or water table conditions. The hydraulic conductivity of the aquifers is usually high. Groundwater in these aquifers flows along relatively short flow paths typical of local flow systems. Basin-fill or valley-fill aquifers were deposited in depressions formed by faulting or erosion or both. Fine-grained deposits of silt and clay form local confining units in these aquifers, and thick sequences of the unconsolidated deposits become more compact and less permeable with depth.

The water wells map provided in Figure A-22 gives a good indication of growth and groundwater development in the Lake Helena watershed over the last century. The data set used to make the map contains point locations and selected attributes for water wells within Montana abstracted from databases maintained at the Ground-Water Information Center (GWIC) at the Montana Bureau of Mines and Geology. Original data sources include water rights filings, water well logs, visits to water wells, and publications of the Montana Bureau of Mines and Geology, the U.S. Geological Survey, and others. The databases are maintained at the Ground-Water Information Center. Data from GWIC are useful for describing the groundwater resources of Montana, land use planning, determining well drilling depths, and understanding groundwater flow. These data are currently intended to provide information on the distribution of wells in general rather than the locations of specific wells. The map shows all public supply wells and other wells in the Lake Helena watershed.

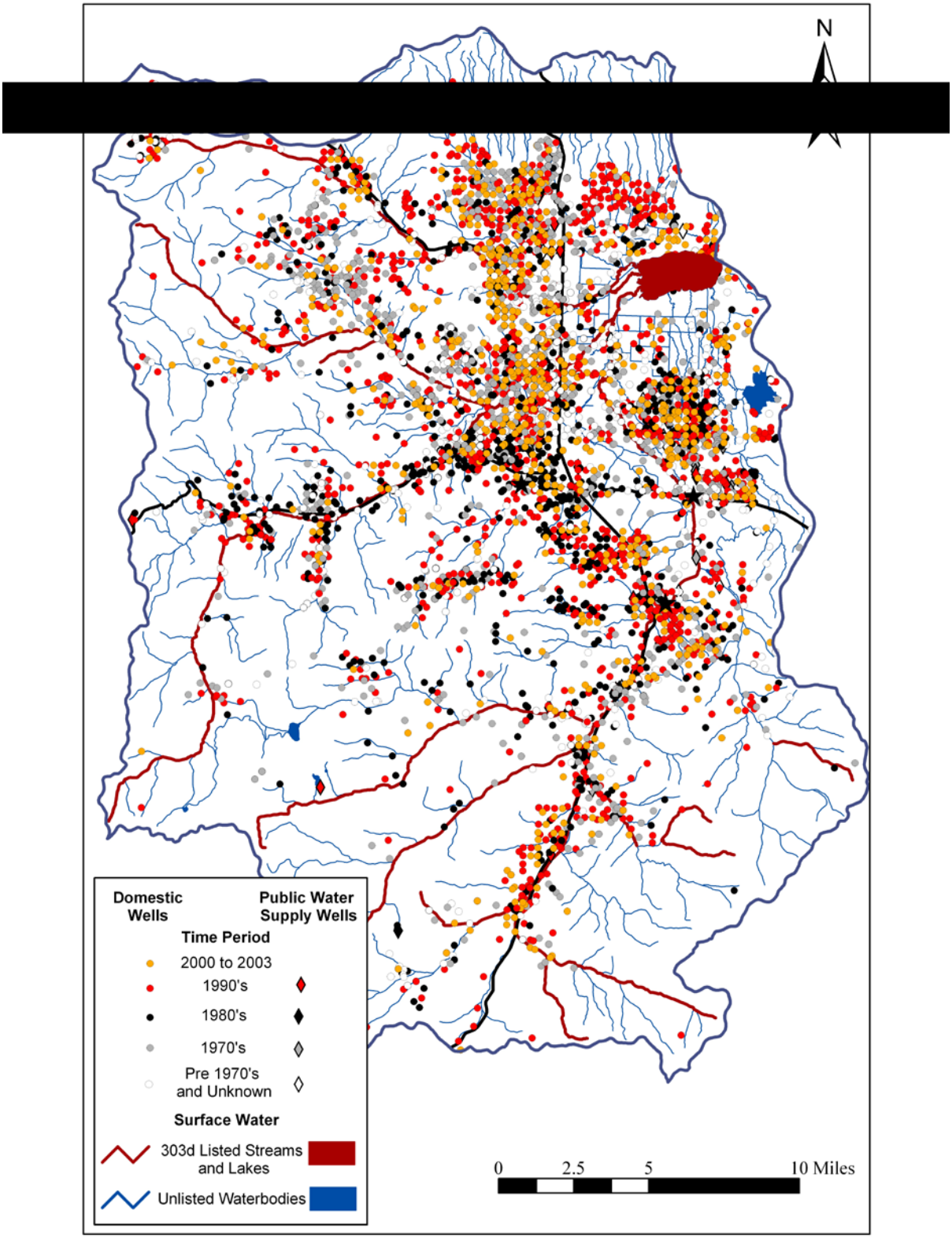

Figure A-22. State inventoried wells in the Lake Helena watershed by time period of completion.

A.1.12 Irrigation

Irrigation in the Helena Valley began in the 1880s. Water from Prickly Pear, Tenmile, and Silver creeks was diverted for irrigation purposes concurrent with the granting of land claims. Water shortages were noted as early as 1866 (Kendy et al., 1998). Canyon Ferry Dam was completed in 1953 to improve irrigation facilities (USBR, 2004a). The construction of the present irrigation system began in 1957 and was completed in 1959. By 1950, more than 8,000 acres of formerly productive land in the low-lying areas of the Helena Valley became saturated due to seepage from irrigation canals and infiltration from flood irrigated fields. The Bureau of Reclamation installed several irrigation drains beginning in 1958, in part to drain previously saturated land but also to accommodate the additional irrigation water imported from the Missouri River. Portions of some canals in the valley are lined with PVC, compacted earth, asphalt, or concrete (Kendy et al., 1998).

The Helena Valley Irrigation District receives about 81,300 acre-feet of water diverted from the Missouri River annually. The water is diverted from Canyon Ferry Dam located about 15 miles east of Helena. Turbine driven pumps below the dam (the Helena Valley Pumping Plant) lift water to the Helena Valley Canal Tunnel and feeder canal. The feeder canal flows 8.3 miles across the Spokane Bench to the 5,900 acre-ft Helena Valley Regulating Reservoir. The reservoir discharges water into the valley section of the Helena Valley Canal, which nearly encircles the Helena Valley alluvial plain and distributes water into the central part of the Helena Valley through an extensive network of lateral canals (Figure A-21). The length of the Helena Valley Canal is 31.7 miles, of which 10.2 miles are lined and 21.5 miles are unlined. Of the 64.4 miles of lateral canals, 51.9 are lined and 12.5 are unlined. A 56.6 mile drainage system consisting of 26.6 miles of open drains and 29.9 miles of pipe drains prevents irrigated land from becoming saturated (Kendy et al., 1998). This manmade drainage system has resulted in the draining of numerous acres of historic wetlands and loss of natural infiltration and groundwater recharge areas (Wetlands Community Partnership, 2001).

Irrigation practices in the Lake Helena watershed help to sustain crops through the arid summer growing season. The Helena Valley Irrigation District manages irrigation in the Helena Valley totaling 15,608 acres, of which 12,500 acres are flood irrigated. The District is proposing to increase the total irrigated acreage by 2,600 acres (Foster, 2004; USBR, 2004).

Prickly Pear Creek is severely dewatered from below East Helena nearly to Lake Helena during the irrigation season. Diversions for municipal water supply in the upper Tenmile Creek watershed, and for irrigation in lower Tenmile Creek, deplete streamflow in lower Tenmile Creek during the summer months. Some reaches go entirely dry in most years (USGS, 2001). Water from lower Tenmile Creek was first diverted for irrigation when land grants were claimed in the late 1800s (USGS, 2001). Due to irrigation diversions and other withdrawals, as well as channel and hydrologic alterations, Silver Creek is intermittent in it lower reaches.

Estimates of water leakage from the entire Helena Valley irrigation system are estimated to be about 7,060 acre-feet from mid-April through early October. The total volume of irrigation water applied to fields from all sources in 1990 was estimated to be about 57,000 acre-ft. In comparison, precipitation on irrigated areas during the 1990 irrigation season was estimated to be about 8,920 acre-ft (Briar and Madison, 1992). The previously described tile drain system in the Helena Valley is part of an extensive network of open and buried drains designed to decrease waterlogging of fields in the downgradient areas of the valley by collecting shallow groundwater and channeling it into Lake Helena. The average aquifer drainage system discharge to streams and drains is estimated to be about 50 cubic feet per second or 36,000 acre-ft/yr. Discharge from the aquifer occurs through direct upwards leakage into Lake Helena, through the bed of the lake. Because of the abundance of surface water in the Helena Valley, relatively few wells are used for large-scale irrigation. Conversely, a significant volume of water is returned to the

Helena Valley aquifer system through infiltration of excess water applied to irrigated fields (Briar and Madison, 1992).

In summary, the recharge to the Helena valley fill aquifer system is through infiltration of streamflow (12,900 acre ft/yr), leakage from irrigation canals (7,060 acre ft/yr), infiltration of excess water applied to irrigated fields (27,000 acre ft/yr), and inflow from fractures in the surrounding bedrock (39,800 acre-ft/yr). Evaporation and transpiration from non-irrigated parts of the valley exceed precipitation. Therefore, recharge from precipitation occurs only in response to infrequent periods of sustained precipitation or as part of excess water applied to irrigated fields. Discharge from the aquifer system is through leakage to streams and drains (36,200 acre/ft-year), upward leakage to Lake Helena (50,000 acre/ft-year), and withdrawals by wells (2,220 acre-ft year) (Briar and Madison, 1992).

There is a recent proposal from the City of Helena to rely on more water stored in Canyon Ferry Reservoir for its municipal supply, and less on the City's Tenmile Creek municipal supply and system of storage reservoirs. The Helena Valley Irrigation District is also involved in these discussions. The District delivers water to the City's Missouri River Treatment Plant via the Canyon Ferry Dam/Helena Valley Regulating Reservoir distribution system described earlier. At the present time, only about three percent of the water pumped out of the river is bound for the City's treatment plant.

A.1.13 Ecoregions

Omernik (1995) has defined ecoregions as areas with common ecological settings that have relatively homogeneous features including potential natural vegetation, geology, mineral availability from soils, physiography, and land use and land cover. MDEQ uses ecoregions to establish a variety of water quality targets, such as for macroinvertebrate populations and nutrient concentrations. The Lake Helena watershed contains parts of two ecoregions (see Table A-6 and Figure A-23).

Table A-6. Ecoregions in the Lake Helena Watershed.

Ecoregion	Area (acres)	Area (square miles)	Percentage
Northern Rockies	244,683	382.3	61.75
Montana Valley and Foothill Prairies	151,553	236.8	38.25
Total	352,814	619.1	100.00

Figure A-23. Ecoregions in the Lake Helena Watershed.

A.1.14 Land Use and Land Cover

General land use and land cover data for the Lake Helena watershed was extracted from the Multi-Resolution Land Characterization (MRLC) database for the State of Montana (MRLC, 1992) and is shown in Figure A-24. This database was derived from satellite imagery taken during the early 1990s and is the most current detailed land use data known to be available. Each 30-meter by 30-meter pixel contained within the satellite image is classified according to its reflective characteristics and is placed within one of several land use/land cover designations. A complete description of the MRLC land use/land cover categories is given in Appendix B. Table A-7 summarizes land characterization information for the Lake Helena watershed. Evergreen forest is the dominant land cover type, comprising approximately 41.0 percent of the total land area. Grasslands/herbaceous vegetation and shrubland make up 34.3 percent and 9.5 percent of the land area, respectively. Other important land use/land cover categories include small grains (5.5 %), pasture/hay (3.4 %), commercial/industrial/transportation (1.8 %), and fallow (1.0 %). All other categories combined make up less than one percent of the total Lake Helena watershed area.

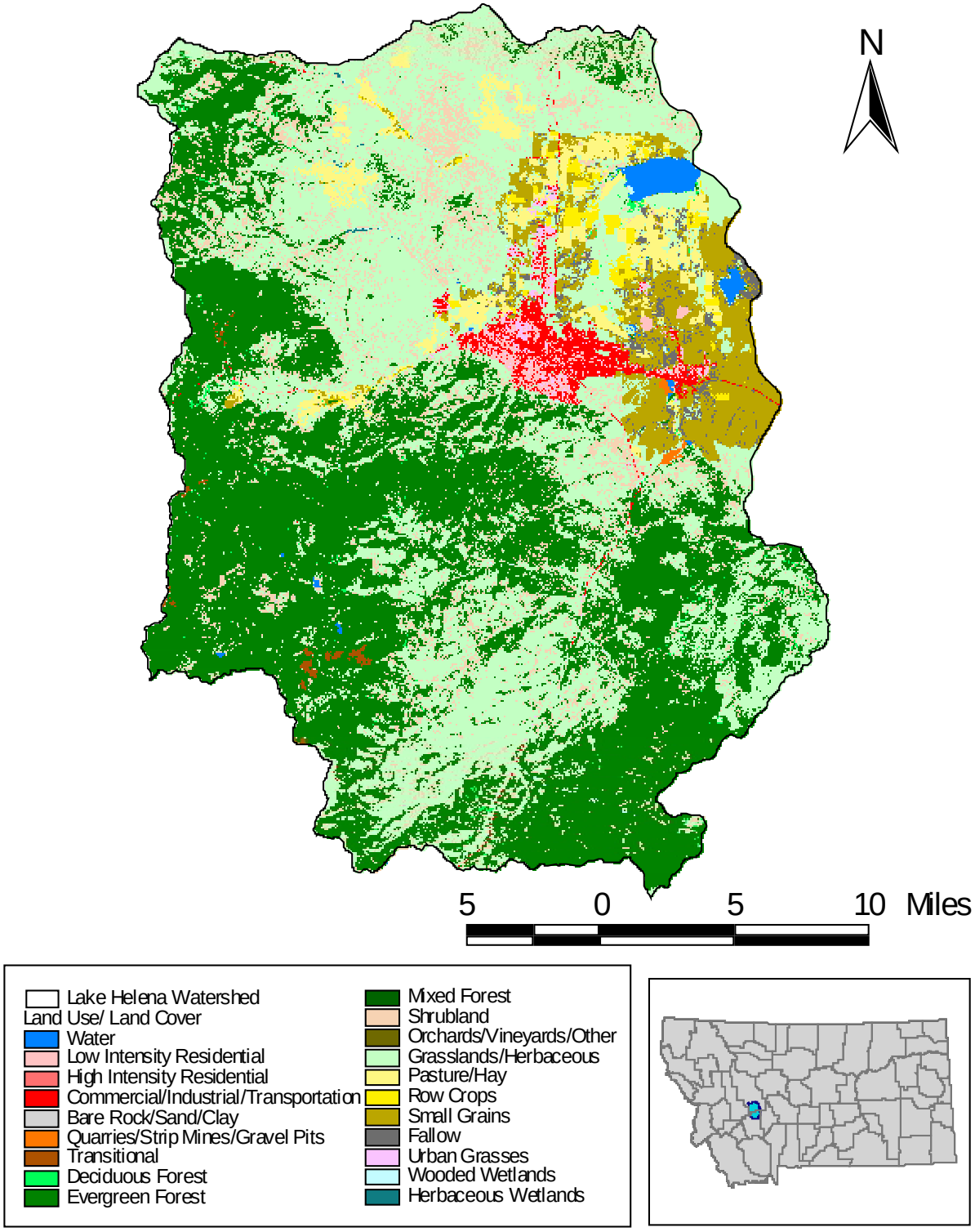

Figure A-24. Land use and land cover in the Lake Helena watershed.

Table A-7. Land use and land cover in the Lake Helena watershed.

Type of Land Use/ Land Cover	Area		Percent
	Acres	Square Miles	
Evergreen Forest	162,319	253.6	41.0
Grasslands/Herbaceous	135,833	212.2	34.3
Shrubland	37,485	58.6	9.5
Small Grains	21,781	34.0	5.5
Pasture/Hay	13,518	21.1	3.4
Commercial/Industrial/Transportation	7,071	11.0	1.8
Fallow	3,793	5.9	1.0
Row Crops	3,485	5.4	0.9
Low Intensity Residential	3,012	4.7	0.8
Water	2,844	4.4	0.7
Urban/Recreational Grasses	1,519	2.4	0.4
Deciduous Forest	1,417	2.2	0.4
Transitional	745	1.2	0.2
Woody Wetlands	687	1.1	0.2
Quarries/Strip Mines/Gravel Pits	300	0.5	< 0.1
Emergent Herbaceous Wetlands	122	0.2	< 0.1
Bare Rock/Sand/Clay	82	0.1	< 0.1
Mixed Forest	32	0.1	< 0.1
High Intensity Residential	16	< 0.1	< 0.1
Perennial Ice/Snow	6	< 0.1	< 0.1
Total	396,068	618.9	100.0

A.1.15 Vegetative Cover

Vegetative cover data were gathered from the Gap Analysis Project (GAP) completed for the State of Montana. The Gap Analysis is a nationwide program conducted under the guidance of the USGS for the purpose of assessing the extent of conservation of native plant and animal species. Since an important part of the analyses is the identification of habitat, detailed vegetative spatial data are usually available for states that have completed their analyses. Like the MRLC data, the spatial database for Montana was derived from satellite imagery taken during the early 1990s. However, the vegetative classification is much more detailed than that of the MRLC. The GAP data include vegetative species, rather than general land cover classes. The vegetative cover information for the Lake Helena watershed provided by the GAP data is shown in Figure A-25 and is summarized in Table A-8.

Table A-8 shows that the dominant vegetation cover types in the Lake Helena watershed include low/moderate cover grasslands, comprising 30.3 percent of the watershed area, and Douglas-fir which comprises 17.5 percent of the area. The grasslands are found mostly along the foothills of the mountains and in the Helena Valley. Douglas-fir vegetation areas are found primarily in the mountainous regions of the watershed. Ponderosa pine, mixed xeric forest, and lodgepole pine comprise 8.5 percent, 8.4 percent, and 6.8 percent of the area, respectively. Agricultural lands are concentrated in the valley in the northeastern portion of the watershed. Dryland crops represent 3.4 percent of the watershed, and irrigated crops account for 2.5 percent.

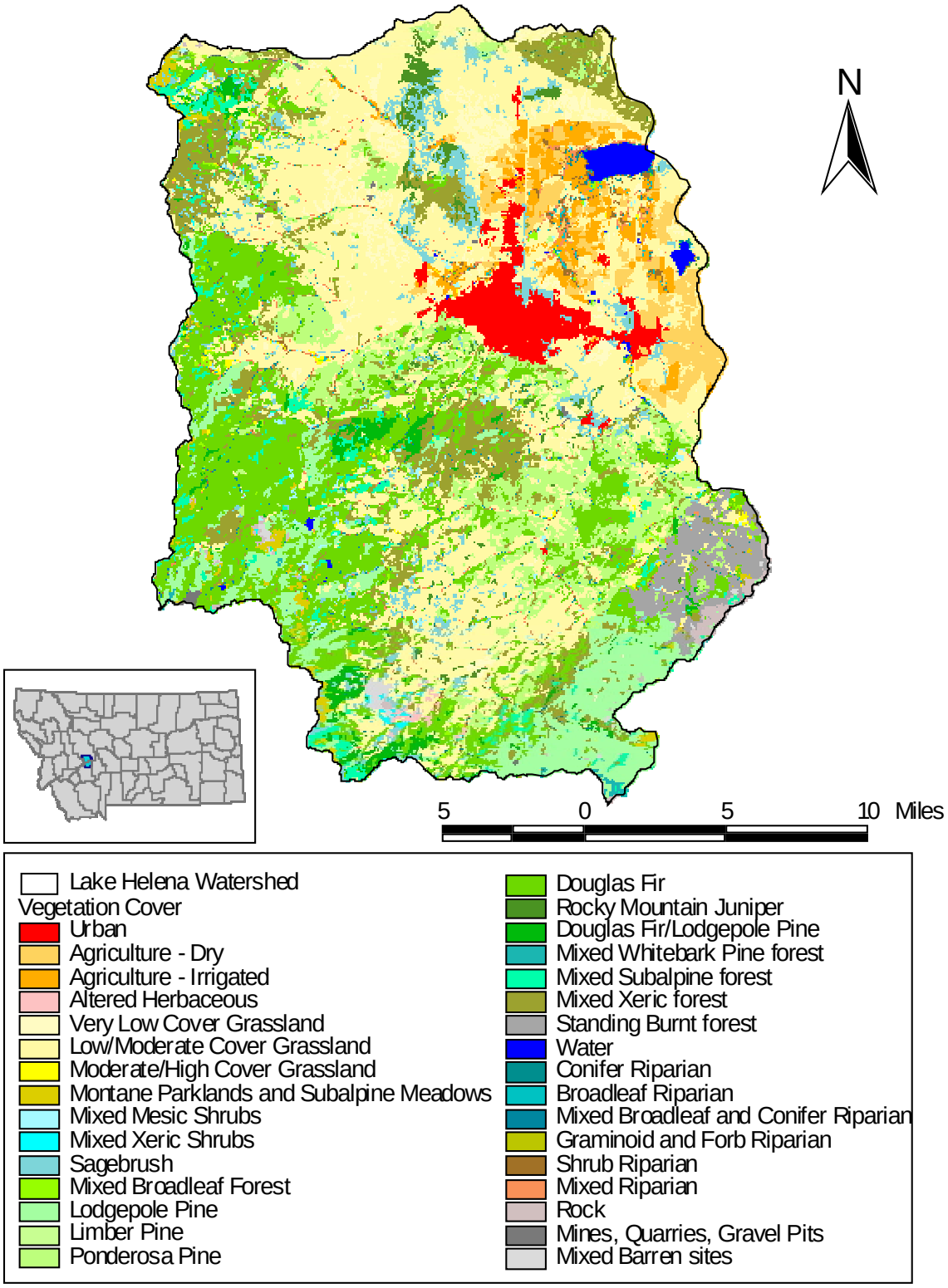

Figure A-25. Vegetative cover for the Lake Helena watershed.

Table A-8. Vegetative cover according to GAP analysis for the Lake Helena watershed.

	Area of Watershed		
Vegetative Cover Type	**Acres**	**Square Miles**	**Percent**
Low/Moderate Cover Grasslands	120,161	187.8	30.32
Douglas-fir	69,141	108.0	17.45
Ponderosa Pine	33,828	52.9	8.54
Mixed Xeric Forest	33,132	51.8	8.36
Lodgepole Pine	26,883	42.0	6.78
Sagebrush	14,319	22.4	3.61
Agricultural Lands – Dry	13,376	20.9	3.38
Urban or Developed Lands	12,035	18.8	3.04
Very Low Cover Grasslands	10,512	16.4	2.65
Agricultural Lands – Irrigated	9,711	15.2	2.45
Standing Burnt Forest	9,271	14.5	2.34
Mixed Subalpine Forest	7,390	11.5	1.86
Douglas-fir/Lodgepole Pine	6,681	10.4	1.69
Rocky Mountain Juniper	4,251	6.6	1.07
Montane Parklands and Subalpine Meadows	3,247	5.1	0.82
Mixed Riparian	3,080	4.8	0.78
Water	2,990	4.7	0.75
Shrub Riparian	2,656	4.2	0.67
Mixed Mesic Shrubs	2,122	3.3	0.54
Rock	1,996	3.1	0.50
Conifer Riparian	1,799	2.8	0.45
Mixed Broadleaf Forest	1,729	2.7	0.44
Mixed Broadleaf and Conifer Riparian	1,275	2.0	0.32
Mixed Barren Sites	1,009	1.6	0.25
Moderate/High Cover Grasslands	911	1.4	0.23
Broadleaf Riparian	640	1.0	0.16
Altered Herbaceous	598	0.9	0.15
Mines, Quarries, Gravel Pits	530	0.8	0.13
Mixed Xeric Shrubs	470	0.7	0.12
Mixed Whitebark Pine Forest	436	0.7	0.11
Limber Pine	46	0.1	< 0.1
Graminoid and Forb Riparian	28	0.0	< 0.1
Total	396,256	619.2	100.00

A.1.16 Channel Morphology

Channel morphology data for the Lake Helena watershed is limited, except for streams within the Helena National Forest portion of the watershed. A review of the available channel morphology data for the 303(d) listed streams is located in the preliminary source assessment (Appendix C), and in the discussion of sediment impaired streams in the water quality impairment status review section of this report (Section 3). High gradient step-pool streams are generally found in the mountainous areas of the watershed, with pool-riffle streams in the valley bottoms. In many parts of the watershed, channel morphology has been disrupted due to placer and hydraulic mining, and the creation of transportation networks.

A.2 Socio-Economic Characteristics

The following sections of the document provide information on the population of the watershed, occupations, land ownership, and important industries that can affect water quality.

A.2.1 Population

The population of the Lake Helena watershed is not directly available but can be estimated using U.S. Census data. The 2000 U.S. Census data were downloaded for all block groups whose boundaries lie wholly or partially in the watershed (Census, 2000). Census block groups are the smallest geographic unit for which demographic information is available from the Census Bureau. In the instance where a census block is located partially in the watershed, a population weighting method was used to estimate the block's contribution to the watershed population. The resulting analysis found that approximately 55,000 people live within the Lake Helena watershed, and that approximately 70 percent of the total population live in areas classified as "urban" and 30 percent live in areas classified as "non-urban".

Figure A-26 displays population densities within the watershed. Outside of municipal areas, the majority of census blocks have less than one person per square mile. However; along the I-15 corridor and in the Helena Valley, census block population densities range from 100 to well over 5,000 persons per square mile.

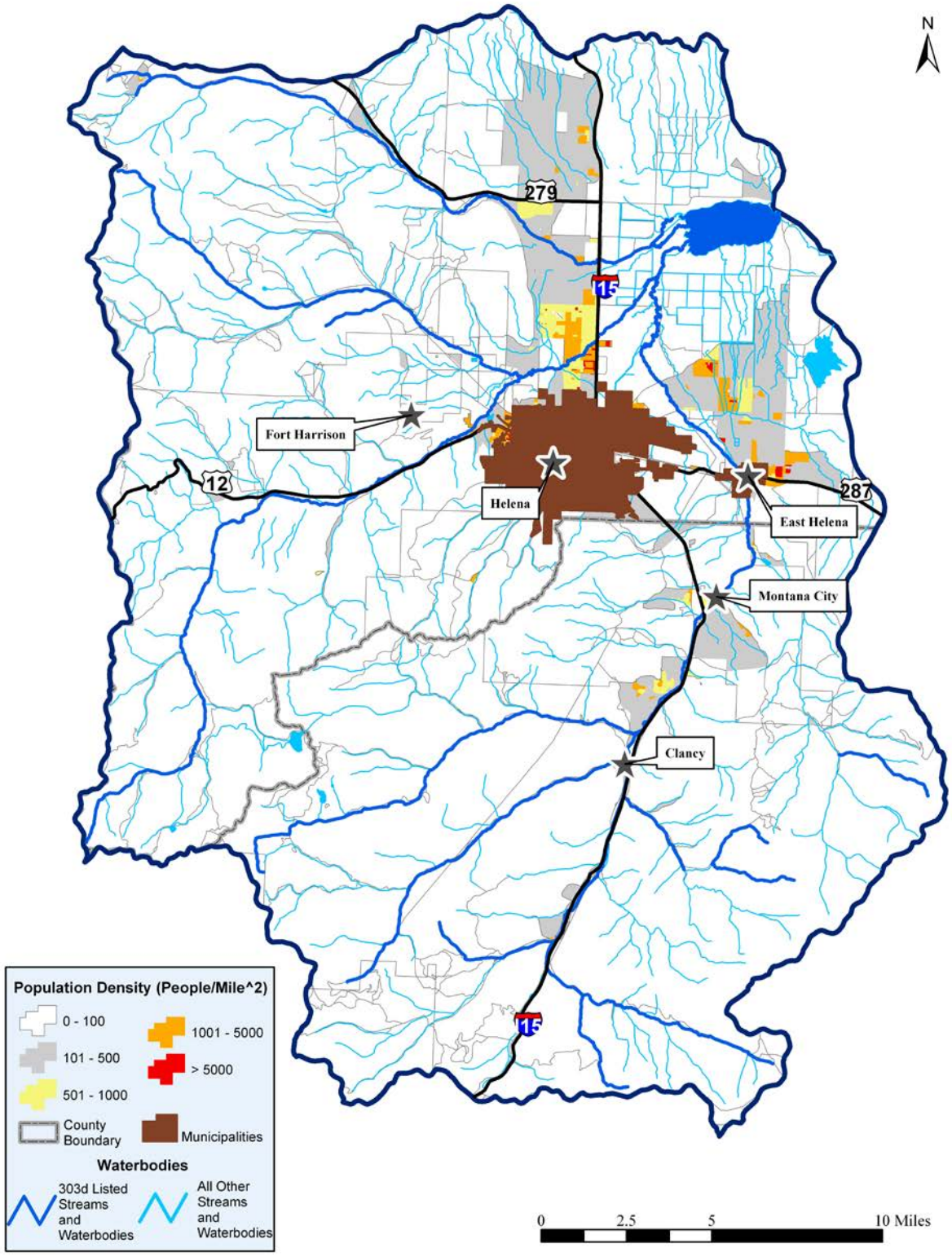

Figure A-26. Population density in the Lake Helena watershed based on the 2000 Census Blocks.

According to the most recent U.S. Census (2000), Lewis and Clark County's population was 55,716 persons in 2000, which is more than double the 1950 population of 24,540 people. The rate of population growth in the County, like the Helena Valley, has fluctuated significantly over the years, varying with the economy and other factors as shown below:

- 1950s: 14 percent increase
- 1960s: 19 percent increase
- 1970s: 29 percent increase
- 1980s: 10 percent increase
- 1990s: 17 percent increase

The projected 2010 population for Lewis and Clark County is 63,316, a nearly 14 percent increase over the 2000 population. From 1970 to 2000, the population growth rate in unincorporated portions of Lewis and Clark County (outside of Helena and East Helena) was the highest of any unincorporated area in Montana at 218 percent (Lewis and Clark County, 2004). Jefferson County is also one of the fastest growing rural counties in Montana, and is the 19th most populous with 10,049 residents according to the 2000 Census. From 1970 to 2000, Jefferson County grew by 4,796 people, a 91 percent increase in population (Jefferson County Planning Board, 2003).

Figure A-26 displays the locations of the larger cities and towns in the Lake Helena watershed, as well as the census designated urban and non-urban areas. Table A-9 summarizes area population by urban and non-urban classification and by population density within each of those classes. This table shows that the urban areas are much more densely populated than the non-urban areas. Urban areas have an average of approximately 1,661 people per square mile and non-urban areas have an average of 28 people per square mile. Table A-10 summarizes the populations of thirteen cities and towns within the Lake Helena watershed. Helena is the most populated city in the watershed, with nearly 16 times the population of East Helena, the second most populated town. Approximately 90 percent of the total urban population (44 percent of the total watershed population) resides in Helena. The population distribution is not uniform, with the majority of the population residing in urban areas surrounding Helena and East Helena. Helena is classified as an incorporated city and East Helena is classified as an incorporated town.

Table A-9. Urban population and population density in the Lake Helena watershed.

	Area		Estimated		Density	
Classification	Acres	Sq. Miles	Population	Percent	Per Acre	Per Sq. Mile
Urban	14,812.14	23.14	38,451	70	2.60	1,661.38
Non-urban	381,424.05	595.98	16,694	30	0.04	28.01
Total	396,236.19	619.12	55,145	100	0.14	89.07

Table A-10. Urban population centers in the Lake Helena watershed.

City/Town	Population	County
Helena	24,346	Lewis and Clark
East Helena	1,538	Lewis and Clark
Clancy	548	Jefferson
Unionville	160	Lewis And Clark
Fort Harrison	124	Lewis and Clark
Montana City	104	Jefferson
Alhambra	100	Jefferson
Jefferson City	40	Jefferson
Marysville	40	Lewis And Clark
Corbin	20	Jefferson
Rimini	20	Lewis And Clark
Austin	5	Lewis And Clark
Wickes	5	Jefferson
Total	27,050	

The Helena Valley is the primary population center and economic hub for Lewis and Clark County, and northern Jefferson and Broadwater Counties. The Valley continues to encompass the largest percentage of Lewis and Clark County's population and growth. The majority of the growth is occurring in unincorporated areas within the Valley (Lewis and Clark County, 2004).

The number of parcels in Lewis and Clark County created through subdivision review has increased substantially since the 1980s. In 1986, for example, 94 lots were granted through subdivision review (via either preliminary or final plat approval) in the County. By 2002, that number increased to 685. Additionally, unreviewed land divisions have added to this total (Lewis and Clark County, 2004).

The housing stock in Lewis and Clark County has increased considerably during the past 30 years, more than doubling between 1970 and 2000. During this period, the most rapid growth in housing occurred during the 1970s, when 6,212 housing units were built in the County, an increase of 50 percent. As the economy slowed during the 1980s, the growth in new housing decreased considerably before rising again during the 1990s (Lewis and Clark County, 2004).

There are a number of reasons for the dramatic increase in the number of Helena Valley residences. Undeveloped land in the Valley has generally been less expensive than vacant land in Helena. Many people wanted a country-type atmosphere in which to live. Some were avoiding what were perceived as higher building costs in Helena. Some felt there were fewer development restrictions and regulations in the unincorporated area of the County. Higher property taxes in Helena may also have been a consideration.

The movement of growth from Helena to the Helena Valley has increased the burden on Lewis and Clark County for providing public services. In the more densely populated areas of the Valley, the demand for public facilities and services has increased beyond what is typically found in rural areas (Lewis and Clark

County, 2004). The population in Lewis and Clark County is expected to continue to grow, with a projected 2010 population of 63,316 and a projected 2020 population of 70,430.

These projections are based on an annual growth rate of 1.67 percent, which is slower than the annual growth rate experienced in the early 1990s (2.2 percent) but greater than the annual growth rate in the later part of the 1980s (1 percent). According to another forecast made by the City of Helena, the population of the greater Helena Valley will increase to approximately 70,000 by 2020. This constitutes an increase of 23,000 people in twenty years, nearly the equivalent of adding the population of another City of Helena to the Valley (Lewis and Clark County, 2004).

Jefferson County is also one of the fastest growing rural counties in Montana and is the 19th most populous with 10,049 residents, according to the 2000 Census. Until recently, a third of the population lived within one or two miles of the county's two towns — Whitehall and Boulder. Today, more than half of the county's residents live in the unincorporated northern part of the county and commute to Helena for work. In the 1990s, the county grew by 27 percent, adding approximately 2,000 new residents. The final Jefferson County Growth Policy was unanimously adopted by the county commission in June 2003 (Sonoran Institute, 2003). The population density is approximately 6 residents per square mile in Jefferson County. From 1970 to 2000, Jefferson County grew by 4,796 people, a 91 percent increase in population (Jefferson County, 2003). In the last 10 years, the towns of Montana City and Clancy have sprouted so rapidly that they have catapulted Jefferson County into the fourth fastest-growing county in the State. From 1990 to 2000, the county gained 26.6 percent more residents (Great Falls Tribune, 2003).

A.2.2 Occupation

Table A-11 and Table A-12 show the occupation and industry of residents in Jefferson County and Lewis and Clark County, respectively. Estimates are based on a one-in-six sample of housing units that received the long form as part of the 2000 Census. The Lake Helena watershed is comprised of portions of each county, so the data are not specific to the population within the watershed but rather include people who live in surrounding areas as well as within the watershed.

Table A-11 and Table A-12 show that the majority of people in both counties (approximately 39 %) hold management, professional, and related occupations. Sales and office occupations and service occupations are also significant. The least amount of people in both counties (approximately one percent) participates in farming, fishing, and forestry occupations. Other occupation fields include construction, extraction, and maintenance occupations, and production, transportation, and material moving occupations.

The top three industries in both Jefferson County and Lewis and Clark County, in terms of people employed, are education, health and social services, public administration, and retail trade (Table A-11 and Table A-12). In Jefferson County, other major industries are construction (8.4 %), agriculture, forestry, fishing and hunting, and mining (8.4 %), and arts, entertainment, recreation, accommodation and food services (7.9 %). In Lewis and Clark County, other important industries include arts, entertainment, recreation, accommodation and food services (8.9 %), professional, scientific, management, administrative, and waste management services (8.4 %), and finance, insurance, real estate, and rental leasing (7.6 %).

Table A-11. Occupation and employment industry of residents in Jefferson County.

OCCUPATION	People	Percent
Management, professional, and related occupations	1,925	39.3
Sales and office occupations	1,129	23.1
Service occupations	797	16.3
Construction, extraction, and maintenance occupations	583	11.9
Production, transportation, and material moving occupations	384	7.8
Farming, fishing, and forestry occupations	77	1.6
INDUSTRY	**People**	**Percent**
Educational, health and social services	1,015	20.7
Public administration	754	15.4
Retail trade	424	8.7
Construction	411	8.4
Agriculture, forestry, fishing and hunting, and mining	410	8.4
Arts, entertainment, recreation, accommodation and food services	388	7.9
Professional, scientific, management, administrative, and waste management services	321	6.6
Finance, insurance, real estate, and rental and leasing	320	6.5
Transportation and warehousing, and utilities	236	4.8
Other services (except public administration)	218	4.5
Manufacturing	186	3.8
Wholesale trade	120	2.5
Information	92	1.9
Total number of people (employed civilian population 16 years and older)	4,895	100.0

Table A-12. Occupation and employment industry of residents in Lewis and Clark County.

OCCUPATION	People	Percent
Management, professional, and related occupations	11,350	39.6
Sales and office occupations	7,886	27.5
Service occupations	4,217	14.7
Production, transportation, and material moving occupations	2,548	8.9
Construction, extraction, and maintenance occupations	2,358	8.2
Farming, fishing, and forestry occupations	292	1.0
INDUSTRY	**People**	**Percent**
Educational, health and social services	5,418	18.9
Public administration	4,934	17.2
Retail trade	3,086	10.8
Arts, entertainment, recreation, accommodation and food services	2,540	8.9
Professional, scientific, management, administrative, and waste management services	2,405	8.4
Finance, insurance, real estate, and rental and leasing	2,185	7.6
Construction	1,870	6.5
Other services (except public administration)	1,559	5.4
Manufacturing	1,073	3.7
Information	1,052	3.7
Transportation and warehousing, and utilities	1,011	3.5
Agriculture, forestry, fishing and hunting, and mining	857	3.0
Wholesale trade	661	2.3
Total number of people (employed civilian population 16 years and over)	28,651	100.0

A.2.3 Land Ownership

Various private, tribal, state and federal agencies hold title to portions of the watershed, as shown in Figure A-27. Land ownership is summarized for the watershed as a whole in Table A-13. The majority of the land is privately owned, totaling 231,974 acres or 58.5 percent of the watershed area. Federal land holdings, represented by agencies such as the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM), comprise a total of 159,911 acres or roughly 40 percent of the watershed area. The Forest Service is the largest federal landowner in the watershed, and represents the second largest land ownership in the watershed overall with responsibility for 118,718 acres, or about 30 percent of the total watershed area. Land holdings by the BLM, the Montana Department of Natural Resources and Conservation (DNRC), and the Department of Defense represent 8.1 percent, 1.4 percent, and 0.8 percent of total watershed area, respectively.

Table A-13. Land ownership in the Lake Helena watershed.

	Area		
Land Ownership Description	**Acres**	**Square Miles**	**Percent**
Private land	231,974	362.5	58.5
US Forest Service	118,718	185.5	30.0
Bureau of Land Management	32,264	50.4	8.1
Department of Natural Resources & Conservation	5,696	8.9	1.4
Other Department of Defense	3,233	5.1	0.8
Water	2,832	4.4	0.7
City parks or open space	775	1.2	0.2
Bureau of Reclamation	467	0.7	0.1
Montana Fish, Wildlife & Parks	264	0.4	0.1
Prickly Pear Land Trust	13	0.0	< 0.1
Total	396,236	619.1	100.0

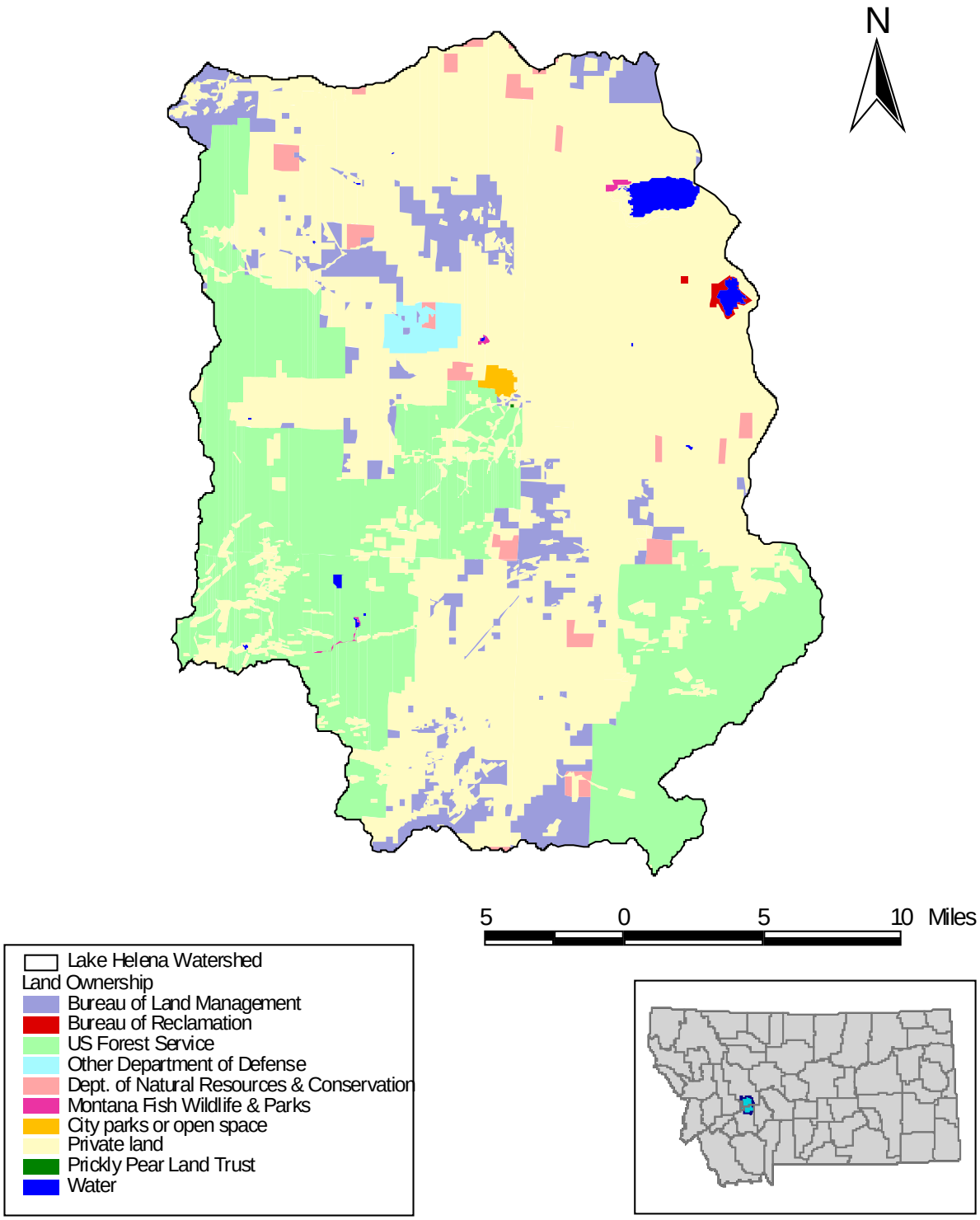

Figure A-27. Land ownership in the Lake Helena watershed.

A.2.4 Industry

Several industries within the Lake Helena watershed are important for their potential impact to water quality. These include mining, agriculture, and forestry.

A.2.5 Mining

Helena began as a small mining town following the discovery of gold in 1864, and mining remains an active industry in the Lake Helena watershed area. Gold, silver, and copper are the primary minerals that are mined in the Lake Helena watershed and surrounding areas. Other common minerals mined within the watershed and vicinity include lead, zinc, manganese, and uranium. The mining districts within the Lake Helena watershed include the following: Missouri River, Marysville, Scratch Gravel Hills, Austin, Blue Cloud, Helena, Rimini, Montana City, McClellan, Clancy, Alhambra, Colorado, and Elkhorn. These districts were delineated by the Montana Abandoned Mines Reclamation Bureau in 1935 and were revised in 1995.

Metal and Limestone Mines

Table A-14 lists the names, types, sizes and locations of metal and limestone mines in the Lake Helena watershed. This information was obtained from Montana DEQ's Environmental Management Bureau. There are a total of 37 metal and limestone mines within the Lake Helena watershed, however not all these mines are currently active.

Table A-14. Metal and limestone mines in the Lake Helena watershed.

Name	Mineral	Acres	County	Location
Private Owner	Gold, Silver	**	Lewis and Clark	Sec. 32 and 33, T9N, R5W
DEQ, Mine Waste Cleanup	Gold	1.0	Lewis and Clark	Sec. 1 and 2, T9N, R4W
EcoSafe Gold Recovery LLC	Gold	2.2	Lewis and Clark	Sec. 10, T9N, R4W
Private Owner	Gold	**	Lewis and Clark	Sec. 21 and 22, T11N, R2W
Private Owner	Gold, Copper, Silver	.5	Lewis and Clark	Sec. 34 and 33, T12N, R6W
Private Owner	Gold	.5	Lewis and Clark	Sec. 27 and 28, T11N, R4W
Private Owner	Lead, Silver	**	Lewis and Clark	Sec. 6, T8N, R5W
Private Owner	Gold	.25	Lewis and Clark	Sec. 11 and 13, T11N, R6W
Private Owner	Gold, Lead, Silver, Zinc	2.0	Lewis and Clark	Sec. 20, 21, 28 and 29, T8N, R5W
Private Owner	Gold	.10	Lewis and Clark	Sec. 17, T10N, R5W
Private Owner	Gold	2.0	Lewis and Clark	Sec. 2 and 3, T9N, R4W
Private Owner	Gold	.10	Lewis and Clark	Sec. 11, T9N, R4W
Private Owner	Gold, Silver	2.0	Lewis and Clark	Sec. 20, T8N, R5W

Name	Mineral	Acres	County	Location
Private Owner	Gold	.50	Lewis and Clark	Sec. 6 and 7, T10N, R4W Sec. 36, T11N, R5W
Private Owner	Gold, Silver	**	Lewis and Clark	Sec. 16, 20, 22 and 23, T9N, R4W
Private Owner	Gold	.25	Lewis and Clark	Sec. 1, T10N, R4W
Private Owner	Copper, Gold, Silver	1.50	Lewis and Clark	Sec. 36, T11&12N, R6W
Private Owner	**	.10	Lewis and Clark	Sec. 2 and 11, T9N, R4W
Private Owner	Gold	1.0	Lewis and Clark	Sec. 22 and 23, T11N, R4W
Private Owner	Gold	2.0	Lewis and Clark	Sec. 23, T11N, R4W
Private Owner	Gold	*	Lewis and Clark	Sec. 23N, T11N, R4W
Westmark International Corp.	Gold	1.0	Lewis and Clark	Sec. 1, T11N, R5W
Whitehawk Mineral Co.	Limestone	4.0	Lewis and Clark	Sec. 5, T10N, R5W
Private Owner	Gold	**	Lewis and Clark	Sec. 2, T8N, R5W
Ash Grove Cement Co.	Limestone	145.0	Lewis and Clark Jefferson	Sec. 7 and 8, T9N, R2W Sec. 12 and 13, T9N, R3W
Montana Tunnels Mining Inc.	Gold, Silver	6,125	Lewis and Clark Jefferson	Sec. 4, 5, 8, 9, 16, 17 and 20, T7N, R4W
Pegasus Gold Montana	Gold, Silver	1,804	Lewis and Clark Jefferson	Sec. 24, 25 and 35, T8N, R6W Sec. 19 and 20, T8N, R5W
Private Owner	Gold, Silver	1.0	Jefferson	Sec. 17, T8N, R4W
Private Owner	Gold	.25	Jefferson	Sec. 23 and 26, T9N, R3W
Private Owner	Gold	.25	Jefferson	Sec. 17, T8N, R2W
Private Owner	Gold, Silver	4.0	Jefferson	Sec. 13 and 14, T8N, R4W
Lindsay & Son Drilling	Silica	.20	Jefferson	Sec. 2, T7N, R3W
Private Owner	Gold, Copper, Lead, Silver	2.0	Jefferson	Sec. 29, T7N, R3W
Mineral Rights Unlimited	Gold	5.1	Jefferson	Sec. 1, 2 and 11, T9N, R3W
Private Owner	Gold	5.0	Jefferson	Sec. 7, 8, 17 and 18, T9N, R3W
Private Owner	Gold	Not listed	Jefferson	Sec. 18, T9N, R3W

Name	Mineral	Acres	County	Location
Xanudu Mining Co. LLC	Gold, Platinum	Not listed	Jefferson	Sec. 28, T7N, R4W

* These sites are inactive.
** These sites have been shut down.

Sand and Gravel Mines

Table A-15 lists the names, sizes and locations of sand and gravel mines in the Lake Helena watershed. This information was obtained from Montana DEQ's Environmental Management Bureau. There are a total of 20 sand and gravel mines mines located within the boundaries of the Lake Helena watershed.

Table A-15. Sand and gravel mines in the Lake Helena watershed.

Name	Acres	County	Location
Big Sky Ready Mix	100.00*	Lewis and Clark	NW¼SE¼ & N½SW¼, Sec. 7, T10N, R2W
Fisher Sand & Gravel	19.5	Lewis and Clark	SW¼NE¼, Sec. 7, T12N, R5W
Gilman, Jim Excavating	4.5	Lewis and Clark	NW¼NW¼, Sec. 36, T10N, R2W
Helena Sand & Gravel	16	Lewis and Clark	SE¼SW¼, Sec. 23, T10N, R3W
Helena Sand & Gravel	16.2	Lewis and Clark	NE¼SW¼, Sec. 23, T10N, R3W
Helena Sand & Gravel	304.00*	Lewis and Clark	W½W½E½, Sec. 17, T10N, R2W
Helena Sand & Gravel	30	Lewis and Clark	NW¼NW¼, N½SE¼, NW¼, Sec. 23, T10N, R3W
Helena Sand & Gravel	35	Lewis and Clark	SE¼NE¼, Sec. 23, T10N, R3W
Helena Sand & Gravel	80	Lewis and Clark	E½SE¼, Sec. 14, T10N, R3W
Jim Clark & Sons Contracting	10.5	Lewis and Clark	SE¼NW¼, Sec. 32, T11N, R2W
Private Owner	141.75	Lewis and Clark	W½SE¼, Sec. 13, T11N, R4W
Lewis & Clark County	2.5	Lewis and Clark	Sec. 16, T10N, R3W
Lewis & Clark County	40	Lewis and Clark	W½SW¼, Sec. 18, T11N, R3W
Lewis & Clark County	0.5	Lewis and Clark	SW¼, Sec. 16, T9N, R5W
Menth Excavating Inc	10	Lewis and Clark	SW¼SE¼, Sec. 34, T11N, R3W
Riverside Contracting	9.9	Lewis and Clark	SW¼, Sec. 35, T10N, R5W
SK Construction	18.90**	Lewis and Clark	NW¼, Sec. 22, T10N, R3W
Bluffs Company	7.50	Jefferson	SW¼SW¼, Sec. 34, T9N, R3W
Jefferson County	1.00	Jefferson	SW¼SW¼, Sec. 13, T9N, R3W
Jefferson County	1.50	Jefferson	SW¼SW¼, Sec. 15, T9N, R3W

* These sites have not been mined to date.
** This site is reclaimed and released.

Small Mines

Table A-16 and Table A-17 show the types, sizes and land ownership of small mines in Jefferson and Lewis and Clark counties. This information was obtained from Montana DEQ's Environmental Management Bureau. There are a total of 44 small mines within both counties, however not all these mines are located within the boundaries of the Lake Helena watershed. The majority of the land where the mines are located is owned by the Helena National Forest or by private owners.

Table A-16. Small mines in Jefferson County.

Operation Type	Acres	Landowner	Within watershed ?
Open Pit	0.2	Forest Service	N/A
Open Pit	N/A	N/A	N/A
Open Pit	N/A	BLM	N/A
Open Pit	2	Private	N/A
Open Pit	N/A	Private	N/A
Placer	5.1	Private	Yes
Placer	4	BLM	Yes
Placer	1	Private	Yes
Placer	0.1	Forest Service	No
Placer	0.25	BLM	Yes
Placer	0.1	Forest Service	No
Placer	0.7	Forest Service	N/A
Placer	5	Private	Yes
Underground	N/A	Private	N/A
Underground	0.25	Forest Service	No
Underground	N/A	Forest Service, Private	N/A
Underground	4	Forest Service	No
Underground	N/A	Forest Service	No
Underground	0.25	Forest Service	N/A
Underground, Open Pit	0.25	Forest Service, Private	N/A
Underground, Open Pit	3	Private	N/A
Underground, Open Pit	3	Private	N/A
Underground, Placer	0.33	Forest Service	N/A

Table A-17. Small mines in Lewis and Clark County.

Operation Type	Acres	Landowner	Within watershed?
Open Pit	N/A	Private	Yes
Open Pit	0.1	Forest Service	Yes
Open Pit	0.1	Forest Service	Yes
Open Pit	2	Forest Service	N/A
Open Pit	2	Forest Service	N/A
Open Pit	1.5	BLM, Forest Service	N/A
Open Pit	4	BLM	Yes
Open Pit, Placer	2	Private	Yes
Open Pit, Underground	0.5	Forest Service	N/A
Placer	1	Private	Yes
Placer	0.1	Private	Yes
Placer	N/A	Private	N/A
Placer	1	BLM	Yes
Placer	2	BLM	Yes
Placer	0.5	BLM	Yes
Prospecting	0.5	Forest Service, State	Yes
Underground	0.25	BLM	Yes
Underground	N/A	Forest Service	Yes
Underground	N/A	Private	N/A
Underground	N/A	Forest Service, Private	Yes
Underground	N/A	Forest Service	N/A

Abandoned Mines

The Montana Department of Environmental Quality's Abandoned Mine Reclamation Section of the Mine Waste Cleanup Bureau oversees the reclamation of abandoned mines in Montana. Abandoned mines are ranked in a priority order for reclamation based on the protection of public health, safety, welfare and property from: 1) extreme danger, 2) adverse effects of mineral mining and processing, and 3) the restoration of land and water resources. The Mine Waste Cleanup Bureau's priority list ranks all the known abandoned mines and mine affected sites in the state in need of remediation. Table A-18 shows the abandoned mines in the Lake Helena watershed which have undergone reclamation. In many of instances where no mineral is listed, a structural hazard such as an adit, has been reclaimed. In the Lake Helena watershed, 74 abandoned mine sites have undergone clean-up, while 335 remain on the list for remediation.

Table A-18. Reclaimed abandoned mines in the Lake Helena watershed.

Name	Mineral	County	Location
96 Phoenix	NA	Lewis and Clark	Sec.36, T10N, R4W
Aster	NA	Lewis and Clark	Sec.33, T11N, R4W
Bald Mountain Marysville Dist.	Gold, Silver	Lewis and Clark	Sec.35, T12N, R6W
Blue Cloud I	NA	Lewis and Clark	Sec.30, T10N, R4W
Blue Cloud II	NA	Lewis and Clark	Sec.12, T10N, R5W
Bonanza Gray Rock	Lead	Lewis and Clark	Sec.36, T11N, R4W
Broadwater	NA	Lewis and Clark	Sec.28, T10N, R4W
Chaucer Quarry	NA	Lewis and Clark	Sec.31, T10N, R3W
Colorado Gulch	Tungsten	Lewis and Clark	Sec.13, T9N, R5W
Contention	NA	Lewis and Clark	Sec.15, T9N, R4W
Crossroads	NA	Lewis and Clark	Sec.1, T11N, R6W
Cycle	NA	Lewis and Clark	Sec.35, T10N, R4W
Davis Gulch I	NA	Lewis and Clark	Sec.31, T10N, R3W
Davis Gulch III	NA	Lewis and Clark	Sec.1, T9N, R4W
Dry Gulch Helena Dist.	Calcium	Lewis and Clark	Sec.12, T9N, R4W
Elma	NA	Lewis and Clark	Sec.27, T11N, R4W
Gray Rock	Zinc, Copper, Gold	Lewis and Clark	Sec.11, T9N, R4W
Grizzly Gulch II	Calcium	Lewis and Clark	Sec.3, T9N, R4W
Grizzly Gulch III	Calcium	Lewis and Clark	Sec.36, T10N, R4W
Hawkeye Helena Dist.	NA	Lewis and Clark	Sec.31, T10N, R3W
Head Lane	NA	Lewis and Clark	Sec.34, T11N, R4W
Howard Grizzly Gulch I	NA	Lewis and Clark	Sec.35, T10N, R4W
Independence Helena Dist.	Copper, Gold, Uranium, Zinc	Lewis and Clark	Sec.11, T9N, R4W
John G Mine I	NA	Lewis and Clark	Sec.26, T11N, R4W
John G Mine II	NA	Lewis and Clark	Sec.26, T11N, R4W
Julia Scratchgravel Dist.	NA	Lewis and Clark	Sec.2, T10N, R4W
Justice Rimini Dist.	Lead, Silver, Zinc, Gold	Lewis and Clark	Sec.6, T8N, R5W
Le Grand Canyon	NA	Lewis and Clark	Sec.27, T10N, R4W
Lexington Scratchgravel Dist.	Silver	Lewis and Clark	Sec.35, T11N, R4W
Lombardy	NA	Lewis and Clark	Sec.27, T10N, R4W

Name	Mineral	County	Location
May Be So	NA	Lewis and Clark	Sec.4, T9N, R3W
McLeod	NA	Lewis and Clark	Sec.2, T10N, R4W
Mount Helena Park	NA	Lewis and Clark	Sec.36, T10N, R4W
Mt Ascension Heights	NA	Lewis and Clark	Sec.31, T10N, R3W
North Star Marysville Dist.	NA	Lewis and Clark	Sec.36, T12N, R6W
Northside	NA	Lewis and Clark	Sec.36, T12N, R6W
Oompaul	NA	Lewis and Clark	Sec.35, T11N, R4W
Orofino Ridge	NA	Lewis and Clark	Sec.1, T9N, R4W
Pearson	NA	Lewis and Clark	Sec.1, T10N, R4W
Red Letter	NA	Lewis and Clark	Sec.4, T9N, R3W
Scratchgravel I	Gold	Lewis and Clark	Sec.1, T10N, R4W
Shannon	Gold, Silver	Lewis and Clark	Sec.3, T11N, R6W
South Saddle	NA	Lewis and Clark	Sec.1, T10N, R4W
Spring Hill Tailings	Lead, Copper, Gold	Lewis and Clark	Sec.3, T9N, R4W
Susie	NA	Lewis and Clark	Sec.6, T9N, R3W
War Eagle Austin Dist.	Lead, Silver, Iron	Lewis and Clark	Sec.10, T10N, R5W
Witch Of Ender	NA	Lewis and Clark	Sec.1, T10N, R4W
Sparta	NA	Lewis and Clark	Sec. 36, T10N, R4W
Touchstone II	NA	Lewis and Clark	Sec. 31, T10N, R3W
Alta	Gold, Lead, Silver, Zinc	Jefferson	Sec.10, T07N, R4W
Diehl I	NA	Jefferson	Sec.5, T9N, R3W
Diehl II	NA	Jefferson	Sec.5, T9N, R3W
Dike	NA	Jefferson	Sec.18, T9N, R2W
Euclid	Gold, Silver	Jefferson	Sec.17, T8N, R2W
Haynes II	NA	Jefferson	Sec.17, T8N, R3W
Kaiser Augusta	NA	Jefferson	Sec.18, T9N, R2W
Lump Gulch	NA	Jefferson	Sec.32, T9N, R3W
Marks Lump Gulch	NA	Jefferson	Sec.4, T8N, R3W
Marks Ridge Line	NA	Jefferson	Sec.7, T8N, R3W
Maupin Creek	NA	Jefferson	Sec.17, T8N, R2W
McClellan Creek	NA	Jefferson	Sec.32, T9N, R2W
Meadow	Lead, Silver, Zinc	Jefferson	Sec.34, T9N, R3W
Mill Creek McClellan Dist.	NA	Jefferson	Sec.7, T8N, R2W
Moonlight Clancy Dist.	NA	Jefferson	Sec.33, T9N, R3W
Nancy Hanks Faith Hope	NA	Jefferson	Sec.9, T9N, R3W
Nellie Grant	Lead, Silver, Gold	Jefferson	Sec.14, T8N, R5W
New Stake	Silver, Zinc	Jefferson	Sec.9, T8N, R3W
Old Abe	NA	Jefferson	Sec.33, T9N, R3W
Overland	NA	Jefferson	Sec.18, T9N, R2W
Strawberry Creek	NA	Jefferson	Sec.7, T8N, R2W
Tick City	NA	Jefferson	Sec.8, T8N, R3W
Tycoon	NA	Jefferson	Sec.33, T9N, R3W
Walker I	NA	Jefferson	Sec.4, T9N, R3W
Walker II	NA	Jefferson	Sec.3, T9N, R3W

Figure A-28 shows the distribution of abandoned mines within the Lake Helena watershed. The locations of these mines were obtained from a GIS coverage published by the Montana State Library in cooperation with the Montana Bureau of Mines and Geology. The data was generated from the U.S. Bureau of Mines' Minerals Industry Location System (MILS) database in October 2002. According to this source, there are 427 abandoned mines within the Lake Helena watershed.

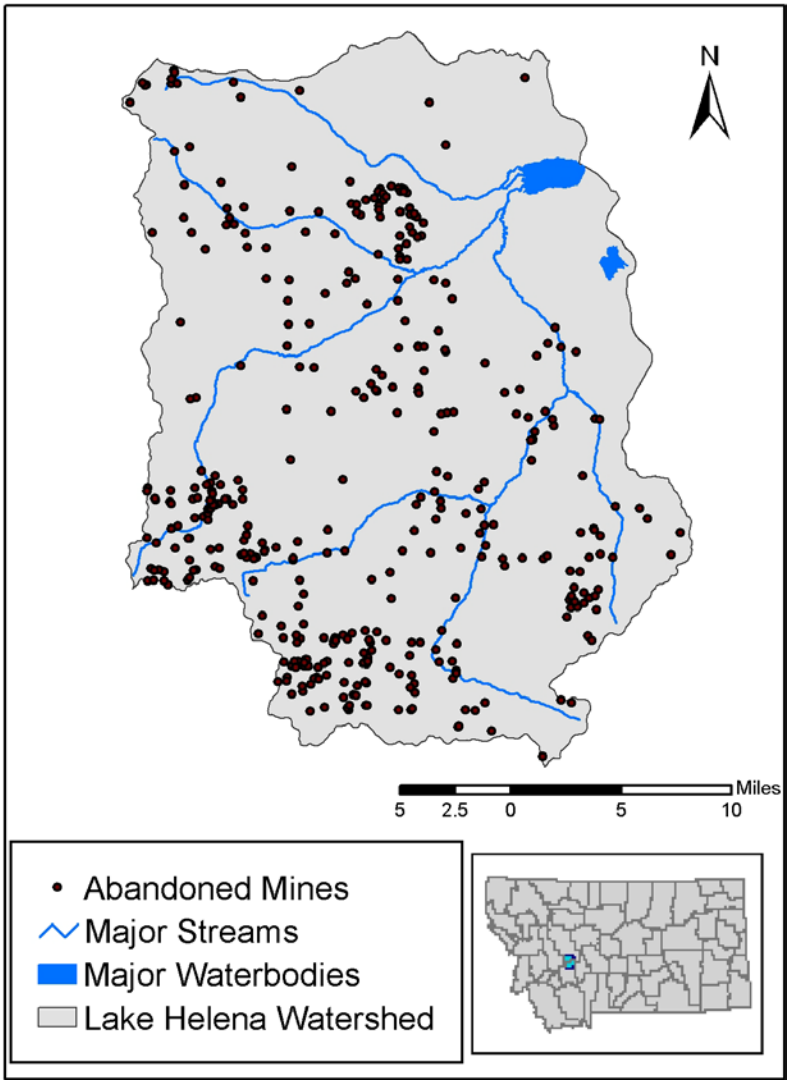

Figure A-28. Location of abandoned mines within the Lake Helena watershed.

A.2.6 Agriculture

According to the U.S. Department of Agriculture's 1997 Agricultural Census, there are a total of 768 farms in Jefferson and Lewis and Clark counties (USDA, 1997). Of those, 502 are located in Lewis and Clark County and 266 are in Jefferson County. They cover approximately 1,853 square miles of land in total. In both counties, the number of farms has increased from 1987 to 1997, but the average sizes of the farms and the total amount of farmland have decreased.

A.2.7 Forestry

Forestry is another important industry in the Lake Helena watershed. According to the U.S. Forest Service Forest Inventory and Analysis Database Retrieval System, there are approximately 833 square miles of forestland in Jefferson and Lewis and Clark counties. Table A-19 shows the estimated area of forested land in square miles by county. Although the majority of the land (70 %) in the two counties is non-forest, nearly 93 percent of the forest land is timberland.

Table A-19. Forested area in Jefferson County and Lewis and Clark County.

County	All land (sq. mi.)	Total forest (sq. mi.)	Timberland (sq. mi.)	Other forest (sq. mi.)	Reserved Timberland (sq. mi.)	Non-forest land (sq. mi.)
Jefferson	856.1	202.3	199.7	2.7	0.0	653.9
Lewis & Clark	1978.4	631.4	574.8	6.7	49.8	1347.0
Total	2834.5	833.8	774.5	9.4	49.8	2000.9

A.2.8 Point Sources

In 2003, the Montana DEQ's Water Protection Bureau provided information on the active permitted point source wastewater discharges in the Lake Helena watershed. There are approximately twenty-one active point sources in the watershed, including standard Montana Pollution Discharge Elimination System (MPDES) permitees, individual or general permits, stormwater discharge permits, and general industrial or general mining permits. Active permits are described in Table A-20.

Table A-20. Active point source discharge permits in the Lake Helena watershed.

Permit ID	Permit Holder	Type of Permit
MT0000426	AIR LIQUIDE AMERICA CORP	STANDARD
MT0030147	ASARCO INC. (EAST HELENA)	STANDARD
MTR000072	ASARCO INCORPORATED	STORMWATER
MT0000451	ASH GROVE CEMENT COMPANY	STANDARD
MTR300113	ASH GROVE CEMENT COMPANY	STORMWATER
MT0028690	BASIN CREEK MINING INC	STANDARD
MTR000418	BUILDING MATERIALS HOLDING COR	STORMWATER
MT0022560	EAST HELENA - CITY OF	STANDARD
MT0023566	EVERGREEN NURSING HOME	STANDARD
MTG790002	EXXON - HELENA TERMINAL	GENERAL
MTR000271	HELENA REGIONAL AIRPORT	STORMWATER
MT0028720	HELENA, CITY OF (WTP)	STANDARD
MT0022641	HELENA-CITY OF	STANDARD
MT0000949	HELENA-CITY OF (WTP)	STANDARD
MTR000363	LEWIS & CLARK COUNTY LANDFILL	STORMWATER
MTR000006	AIR LIQUIDE AM CORP	STORMWATER
MT0025020	MONTANA GOLD & SAPPHIRES INC	STANDARD
MTR000361	MONTANA RAIL LINK	STORMWATER
MT0028428	MONTANA TUNNELS MINING, INC	STANDARD
MTR000430	PACIFIC STEEL AND RECYCLING	STORMWATER
MTR000334	UPS HELENA CENTER	STORMWATER