

**SALINITY TMDL
FOR
SAGE CREEK, MONTANA
(HUC 10050006)**

JANUARY 16, 2002



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SECTION 1.0

INTRODUCTION AND PURPOSE

The water body addressed in this document is Sage Creek (MT40G001_010) which is found in the Sage hydrologic unit (HUC 10050006). Sage Creek flows from the East Butte of the Sweetgrass Hills in Liberty County through Hill County to its confluence with Big Sandy Creek in north central Montana. The reach addressed in this plan is 110 miles long and extends from the confluence with Laird Creek to the mouth of Sage Creek (Figure 1).

In large part, this document is a summary of the **Water Quality Restoration Plan for Sage Creek** submitted to the Montana Department of Environmental Quality (DEQ) on November 19, 2001 by the Sage Creek Watershed Alliance and the Hill and Liberty County Conservation Districts (Appendix A). This summary document has been prepared by the Department of Environmental Quality to fulfill the requirements of Section 303(d) of the Federal Clean Water Act and Montana Water Quality Act (Chapter 75, Part 7) regarding Total Maximum Daily Loads (TMDL). A TMDL is *the total amount of a pollutant that a water body may receive from any source without exceeding state water quality standards*. A TMDL may also be defined as *a reduction in pollutant loading that results in meeting water quality standards*. This document specifically addresses water quality impairments associated with nutrients and salinity/TDS/chlorides.

Unless noted otherwise, the conclusions presented in this TMDL are based on the **Water Quality Restoration Plan for Sage Creek**. The following sections of this document provide a summary of the Sage Creek Watershed characteristics followed by an overview of each of the required components of the TMDL development process. Background information regarding the Sage Creek Watershed and the technical basis for many of the conclusions presented in this document can be found in Appendix A.

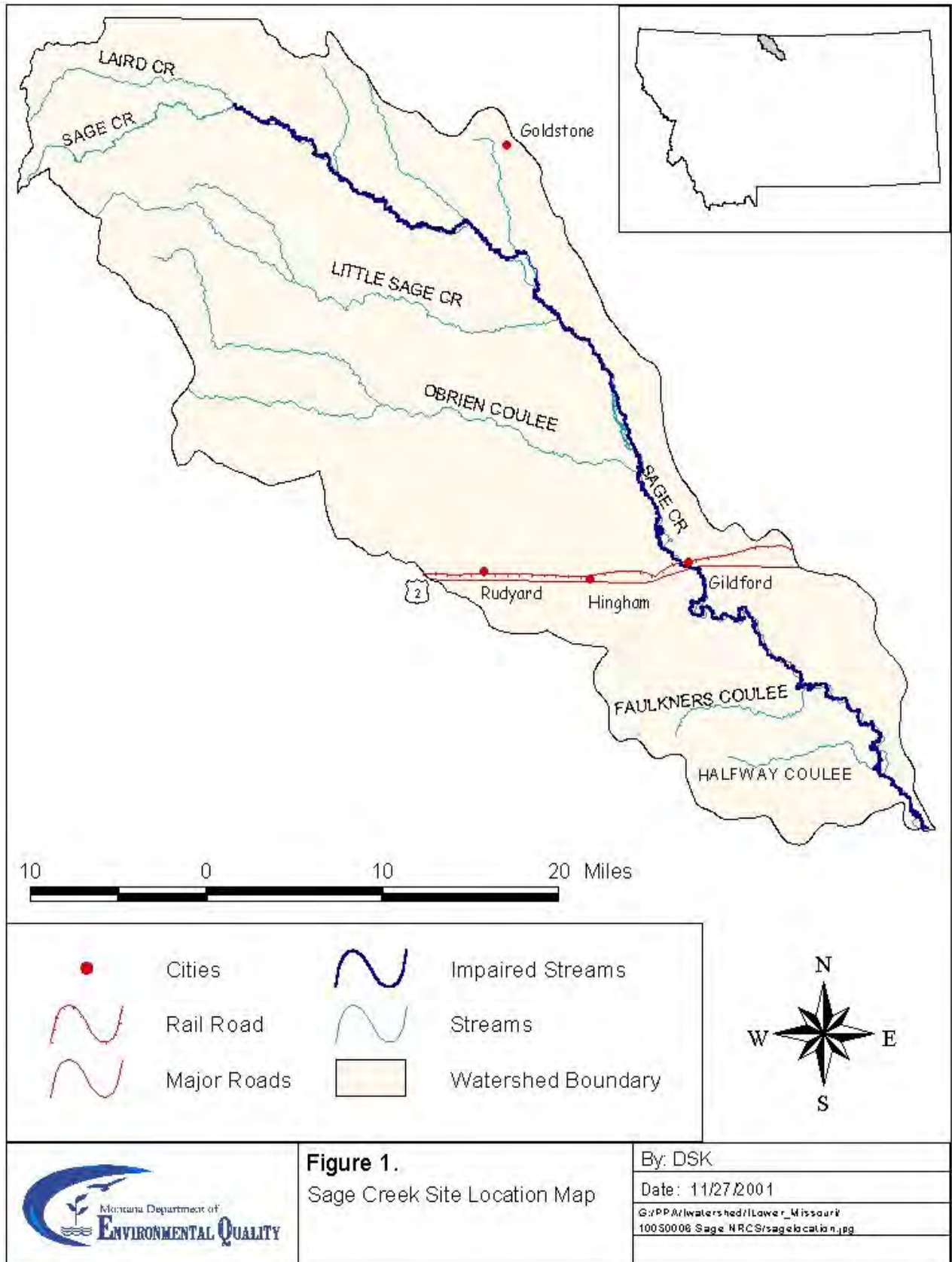


Figure 1.
Sage Creek Site Location Map

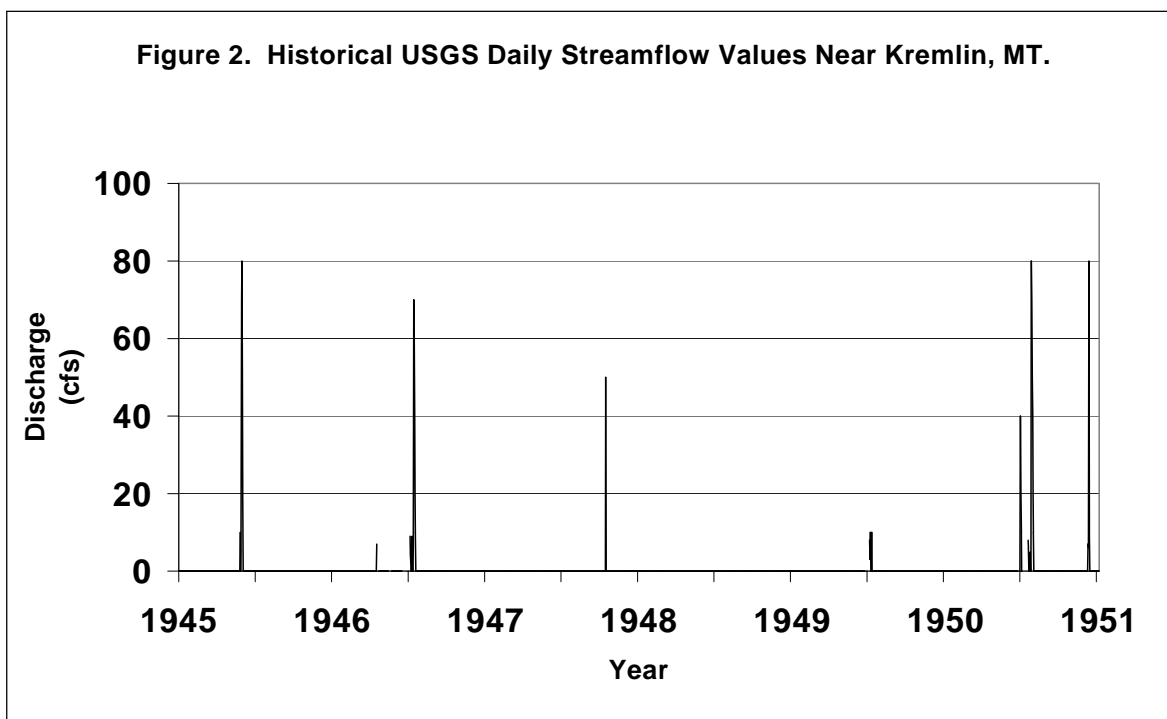
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SECTION 2.0

RELEVANT WATERBODY/WATERSHED CHARACTERISTICS

The impaired reach of Sage Creek is an intermittent stream as defined by the Administrative Rules of Montana (17.30.602): “a stream or reach of a stream that is above the local water table at least some part of the year, and obtains its flow from both surface run-off and ground water discharge.” Streamflow values collected from lower Sage Creek near Kremlin from 1945 through 1951 demonstrate the intermittent nature of flow in Sage Creek (Figure 2).



Latitude: 48°28'00" Longitude: 110°06'00" NAD27

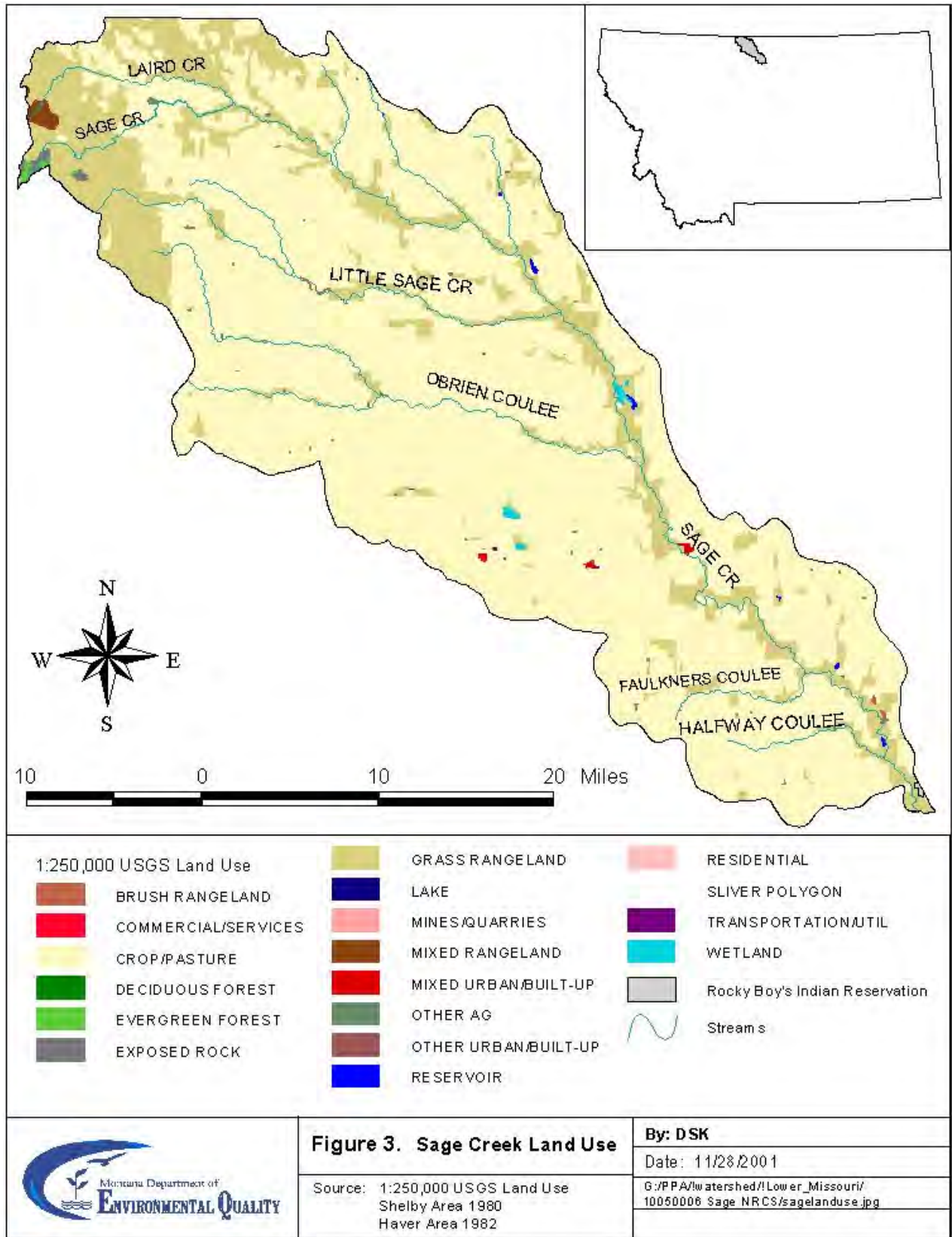
Drainage Area 914.00 square miles

Gage datum: 2680.00 ft msl NGVD29

The major land use in the Sage Creek watershed is dryland farming (71%) with some native range and pasture (23%), farmsteads (4%), and irrigated hay production (1%). Water and forest comprise the remaining one-percent (Figure 3). Most of the land in the watershed is privately owned (93%) (Figure 4). State lands are dispersed throughout the watershed (7%).

Surveys conducted in July and August 1997 found nine species of fish in the drainage. All nine species are common to north-central Montana waters and all are native except northern pike and yellow perch (Gilge, 1997). The five families represented by these species are Catostomidae (suckers), Cyprinidae (minnows), Gasterosteidae (sticklebacks), Esocidae (pike), and Percidae (perch). All nine species can survive low levels of oxygen and a wide range of temperatures .

Section 2.0 Relevant Waterbody/Watershed Characteristics



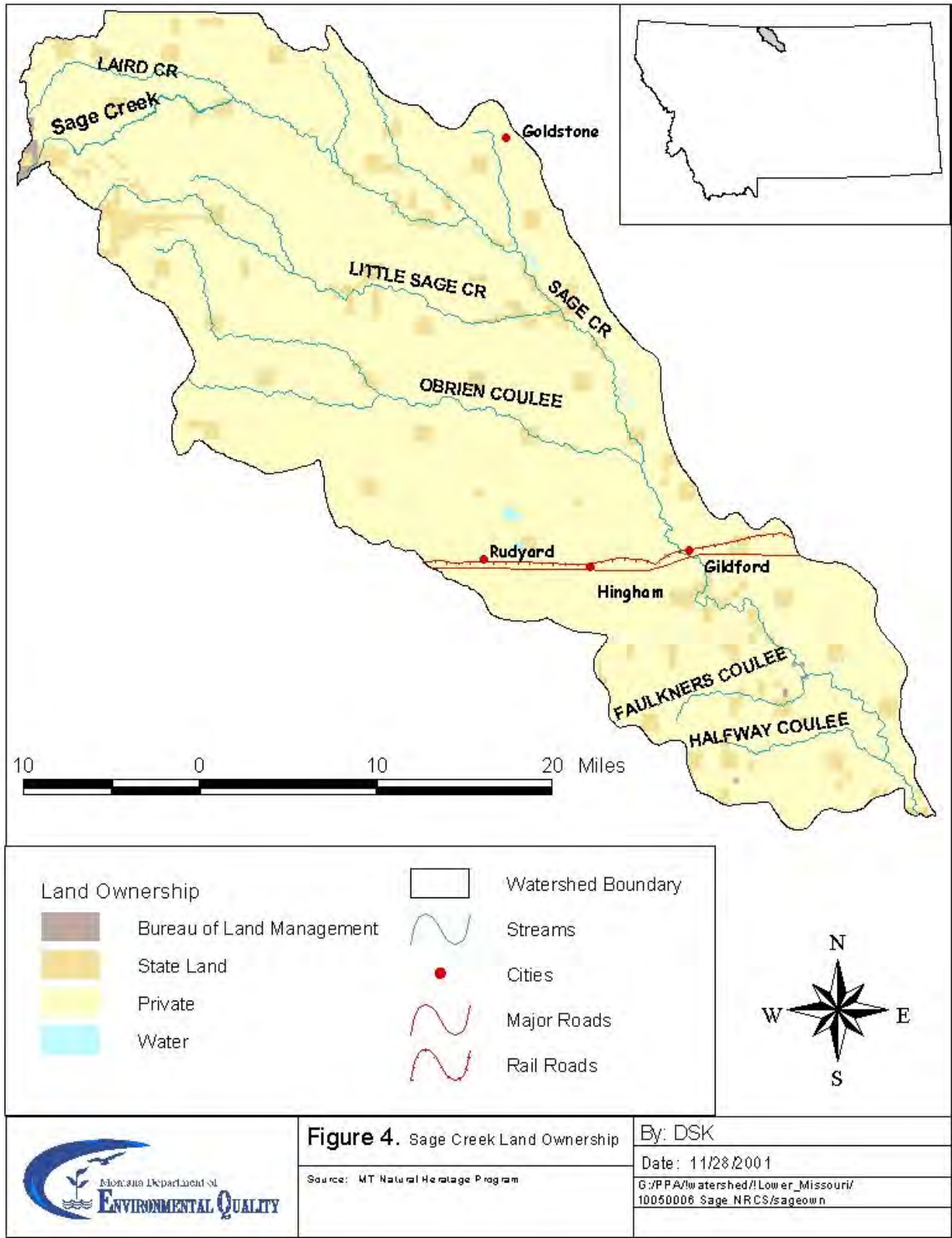


Figure 4. Sage Creek Land Ownership

Source: MT Natural Heritage Program

By: DSK

Date: 11/28/2001

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SECTION 3.0

WATER QUALITY IMPAIRMENT STATUS AND APPLICABLE WATER QUALITY STANDARDS

3.1 Water Quality Impairment Status

A Federal court order requires DEQ to develop "all necessary TMDLs" for rivers, lakes and streams on the **1996 303(d) List of Impaired Water bodies**. In 1996 Sage Creek was listed as impaired by nutrients and salinity. The most recent EPA-approved 303(d) List also cites nutrients and salinity as causes of impairment. Although riparian degradation was listed as a cause of impairment in 2000, it is the U.S. Environmental Protection Agency's position that TMDLs are required only for "pollutants." EPA defines pollutants as "materials discharged into water." Table 1 summarizes the 1996 and 2000 303(d) list impairments for Sage Creek.

*Table 1 – Sage Creek HUC 1005006 – Comparison of 303(d) listed impairments, causes, and sources**

303(d) List Year	Probable Impaired Uses	Probable Causes	Probable Sources
1996	Aquatic Life Support Warm Water Fishery	Nutrients Salinity/TDS/chlorides	Irrigated Crop Production Non-irrigated Crop Production Agriculture
2000	Aquatic Life Support Warm Water Fishery	Nutrients Riparian degradation Salinity/TDS/sulfates	Irrigated Crop Production Non-irrigated Crop Production Agriculture

*Listing sequence in this table does not denote restoration priority, degree of impairment, or extent of impairment.

3.2 Waterbody Classification

Montana Water Quality Standards classify this segment of Sage Creek as a B-3 water. B-3 waters are suitable for “*drinking, culinary and food processing purposes, after conventional treatment, and for bathing, swimming and recreation, growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers, and agricultural and industrial water supply*” (ARM 17.30.625). Surface water in the impaired reach of Sage Creek is not used for human consumption. In spite of its intermittent flow characteristics, as described in Section 2.0, Sage Creek supports a warm-water fishery and is used extensively as a source for stock water.

3.3 Nutrient Standards

Current standards relating to nutrients state that, “*State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create undesirable aquatic life*” (ARM 17.30.637(e)). In the case of nutrients, nuisance algae growth is usually the undesirable aquatic life produced.

When compared to other streams in the Northwestern Glaciated Plains ecoregion with similar runoff characteristics, total nitrate+nitrite, dissolved nitrate, and total Kjeldahl nitrogen data indicate that Sage Creek has similar or lower concentrations of bio-available nitrogen, as well as nitrogen incorporated into organic substances (Appendix B). This limited data suggests that there is no water

Section 3.0 Water Quality Impairment Status and Applicable Water Quality Standards

quality impairment associated with nutrients. Therefore, neither a water quality restoration target nor a TMDL are presented herein for nutrients. Nutrient conditions in Sage Creek may be re-evaluated as additional information on prairie stream nutrients is gathered through DEQ's current effort to develop regional nutrient criteria.

3.4 Salinity Standards

The applicable water quality standard for TDS/salinity/chlorides is: *"State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life"* (ARM 17.30.637(1)(d)).

SECTION 4.0

SOURCE ASSESSMENT

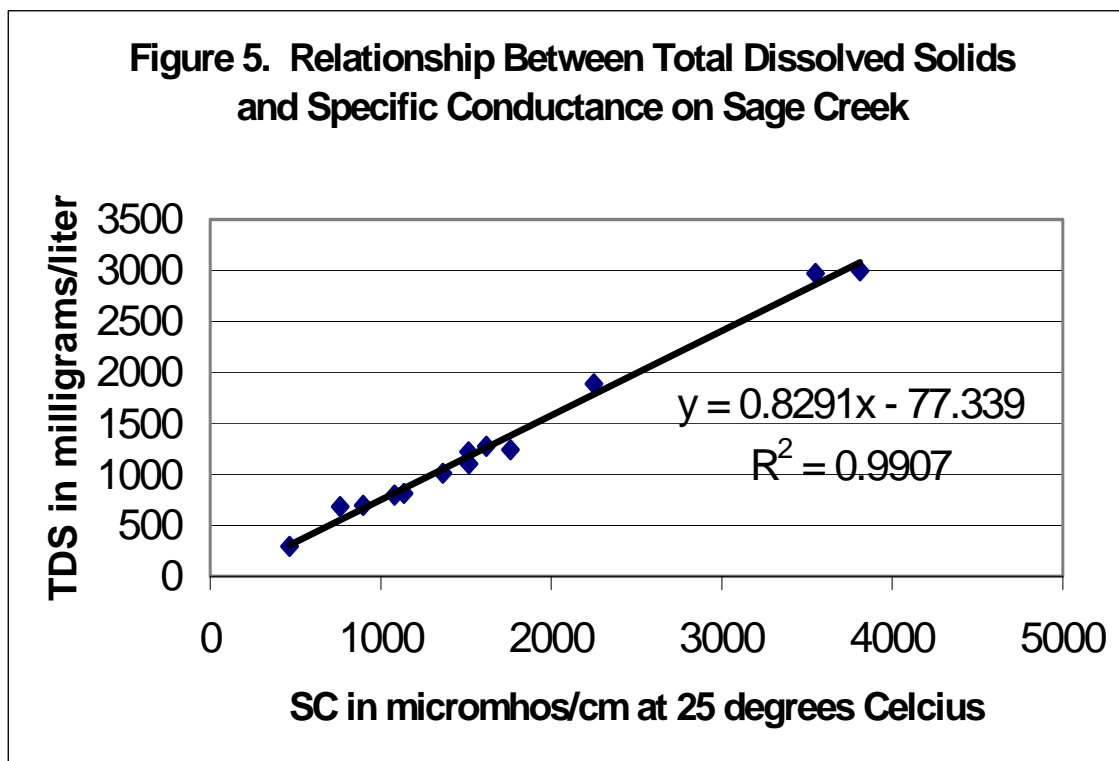
The major source of salinity in the Sage Creek watershed is from naturally occurring salts in the glacial deposits. The causes of increased salinity in Sage Creek are attributed to the erodibility and chemical composition of the glacial deposits and dryland cropping practices. In a recharge area, excess ground water moves through the soil profile, dissolves and transports salts in the glacial deposits, and eventually discharges near the surface. Capillary action and evaporation then take over and draw the saline water to the soil surface leaving the salts behind and forming a saline seep. The Montana Bureau of Mines and Geology (MBMG) has demonstrated the water quality effects of ground-water discharge to Upper Sage Creek (Miller, 1997). Water quality changes from calcium-bicarbonate type water at the headwaters to sodium-sulfate type water downstream. This trend of increasing sodium and sulfate suggests that Sage Creek receives ground-water discharge associated with saline seeps. These saline seeps are caused by the crop/fallow farming system on ground-water recharge areas. This ground water subsequently discharges to the Sage Creek channel.

In 1982, the Triangle Conservation District estimated there was a total of 7,073 acres affected by saline seep; this represented a doubling of damaged acreage in dryland crops since 1972. About seventy percent of the Sage Creek Watershed is either dryland farmed or placed in the Conservation Reserve Program. In the upper third of the watershed, color infrared photography showed the effects of saline seep formation on approximately seven percent of the cropland in 1985. The Environmental Quality Incentive Program (EQIP) Sage Creek Priority Area was designed to address 3,225 acres affected by saline seep. The goals were to reduce the seeps to 2,145 acres, decrease the specific conductance of the water by 35 percent, increase soil organic matter by 1.25 percent and decrease the elevation of the water table by eight feet.

SECTION 5.0

WATER QUALITY RESTORATION TARGETS

The target concentration under flowing conditions for Specific Conductance (SC) is 1600 $\mu\text{mhos/cm}$ or 1250 mg/L Total Dissolved Solids (TDS). Figure 5 shows the relationship between these two parameters in Sage Creek.



Mount et al., (1997) presented a statistical model to estimate the acute toxicity of major ions to biota. This model was used by DEQ to evaluate the level of protection provided by the proposed specific conductance and TDS targets (i.e., 1600 $\mu\text{mhos/cm}$ and 1250 mg/L TDS). Toxicity associated with major ions at the specific conductance and TDS targets are predicted at 5.5 percent mortality in 96-hour exposures to fathead minnows (*Pimephales promelas*). Therefore, these targets are considered very protective and should provide an adequate margin of safety relative to toxicity to biota.

The target for non-flowing conditions is a reduction in the overall number of saline seep discharge areas in the impaired reach and a decreasing overall trend in ground water levels in the Quaternary aquifer over a period of 15 years.

The Montana Water Quality Act (MCA 75-5-703(9)) requires that DEQ evaluate the progress of the plan after five years. If, after five years, the targets have not been achieved, the Act provides a mechanism for adaptive management to allow for achievement of the target. This mechanism could include implementing a new or improved phase of voluntary management practices or allowing more time to pass for the system to respond to those management practices that may have been implemented. Alternatively, if future data indicate that Sage Creek does not, in fact, have the potential to achieve the targets, the targets can be modified based on the best available data.

SECTION 6.0

TOTAL MAXIMUM DAILY LOAD

A TMDL is not presented in the *Water Quality Restoration Plan for Sage Creek* (Appendix A). The following TMDL has been developed by DEQ to satisfy the requirements of Section 303(d) of the Federal Clean Water Act and Montana Water Quality Act (Chapter 75, Part 7).

The TMDL can be expressed as follows:

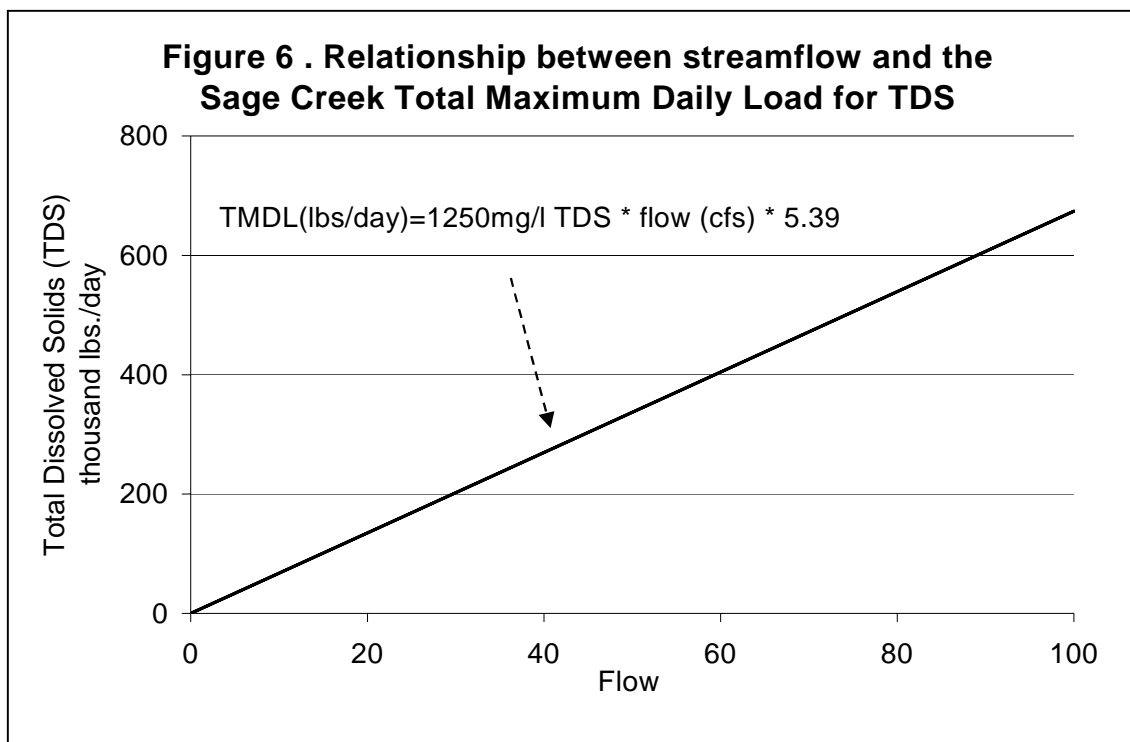
$$\text{TMDL (lbs/day)} = \text{water quality standards target} * \text{flow} * 5.39$$

where

water quality restoration target	= 1250 mg/L TDS
flow	= surface water flow in cfs
5.39	= conversion factor to pounds per day

Figure 6 provides a graphical representation of the Total Maximum Daily Load relative to flow in Sage Creek. The TMDL is based upon a target of 1250 mg/L TDS. Variability in TDS concentration, and therefore load, is expected because of the natural buildup of saline conditions during dry weather periods. It is recognized herein, therefore, that there may be short periods of time associated with the “first flush”, on the rising limb of the hydrograph, that this TMDL may be exceeded.

When Sage Creek has no surface flow, the TMDL is expressed as a reduction in saline seep discharge acreage near the creek and a decreasing trend in ground water discharge into the impaired stream segment during the next 15 years.



SECTION 7.0

ALLOCATION

The primary anthropogenic source of increased salinity in Sage Creek is the crop/fallow farming system on groundwater recharge areas within the watershed. The necessary load reductions, therefore, will focus on this land use type. The actual load reductions will be facilitated through the development of local educational efforts, development and implementation of agricultural BMPs, and the continuing efforts of the Conservation Districts and landowners to reduce groundwater levels in saline seep recharge areas.

SECTION 8.0

MARGIN OF SAFETY AND SEASONAL CONSIDERATIONS

Based on the DEQ analysis of the toxicity of the proposed Specific Conductance and TDS targets presented in Section 5.0, the proposed targets, and therefore the TMDL, is very protective of aquatic life. The monitoring strategy, summarized in Section 9.0, will also provide another implicit margin of safety with the inclusion of a feedback mechanism to trigger modification in the implementation plan, if necessary, to achieve water quality standards. The conceptual framework of the adaptive management approach described in Section 10.0 allows for the modification of management practices based upon the evaluation of the effectiveness monitoring data.

Seasonal variation is considered in both the Water Quality Restoration Targets and in the TMDL. As discussed previously and shown in Figure 2, flow in Sage Creek is not perennial. Flow only occurs during some spring runoff events and infrequent summer storms. Throughout most of the year Sage Creek is a series of disconnected pools. The flowing and non-flowing conditions may differ greatly in terms of water chemistry. During periods of flow, Sage Creek is dominated by surface water inputs. During the non-flowing and extreme low flow periods, groundwater inflow dominates. This is the reason that separate Water Quality Restoration Targets are presented in Section 5 for the two flow scenarios. The TMDL is based on flow and, therefore, directly considers all potential seasonal conditions.

SECTION 9.0

MONITORING STRATEGY

The monitoring strategy proposed in the *Water Quality Restoration Plan for Sage Creek* (Appendix A) includes a Best Management Practice (BMP) effectiveness monitoring plan as well as a monitoring plan for surface and groundwater. Specific details of the effectiveness-monitoring plan will be developed as BMPs are implemented. The surface and groundwater monitoring plan will include the following elements:

- Establishment of surface water gauging and sampling locations.
- Monitor ground-water elevations in saline seep wells in identified recharge and discharge areas to determine impact of BMP implementation and verify acceptance of TMDL criteria.
- Collection of surface water chemistry and stream gaging data, simultaneously. Water chemistry to include analysis of total phosphorous, total Kjeldahl nitrogen, nitrate plus nitrite, specific conductance, and total dissolved solids.
- Based upon available resources monitoring may also be performed for chlorophyll a, fish communities, macroinvertebrates and, during the cold weather months, nitrates.

SECTION 10.0

ADAPTIVE MANAGEMENT STRATEGY

A phased, or adaptive management, approach to water quality restoration and TMDL development is proposed due to the lack of an exhaustive data set upon which to base current conclusions, uncertainty in the pollutant loading, and uncertainty in the load reductions that need to occur and targets that need to be met, in order to satisfy water-quality standards. This document constitutes Phase I, wherein the numeric targets and TMDL are based on the best available information and the hypothesis that achieving these targets and TMDL will result in restoring full support of the beneficial uses. A monitoring strategy will be developed and implemented in Phase 2 to test the hypothesis and provide information necessary to adaptively manage the system in the future. Pollutants associated with salinity and nutrients will be monitored. The implementation of BMP's established from the results of the continued monitoring should result in the water quality of Sage Creek approaching the natural, pre-impact state.

SECTION 11.0

PUBLIC INVOLVEMENT

Public outreach and education are important in reaching the goals set by the Sage Creek Watershed Alliance. The alliance has held public meetings, conducted a survey of landowners to identify issues and willingness to participate, held annual watershed tours, and made personal contacts with landowners.

A public notice of availability of an earlier draft of this document and opportunity for providing comments was published on the DEQ home page <http://www.deq.state.mt.us> on January 9, 2001. A meeting to take public comment was held at the Hingham Catholic Church at 1:30 pm on Tuesday, January 23, 2001. A 30-day public comment period ended February 9, 2001.

The earlier draft has been modified substantially since the prior public comment period. The public comment period for this document is December 15, 2001 to January 16, 2002. See Appendix D for a summary of comments and responses.

References

Gilge, Kent. 1997. *Big Sage Creek Aquatic Investigations – Fishery Inventory*. Montana Fish, Wildlife, and Parks.

Mount, D.A, D.D. Gulley, J.Russel Hockett, T.D. Garrison, and J.M. Evans. 1997. “Statistical Models to Predict the Toxicity of Major Ions to *Ceriodaphnia dubia*, *Daphnia magna*, and *Pimephales promelas* (Fathead Minnows).” *Environmental Toxicology and Chemistry*. Vol. 16. No. 10, pp. 2009-2019.

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