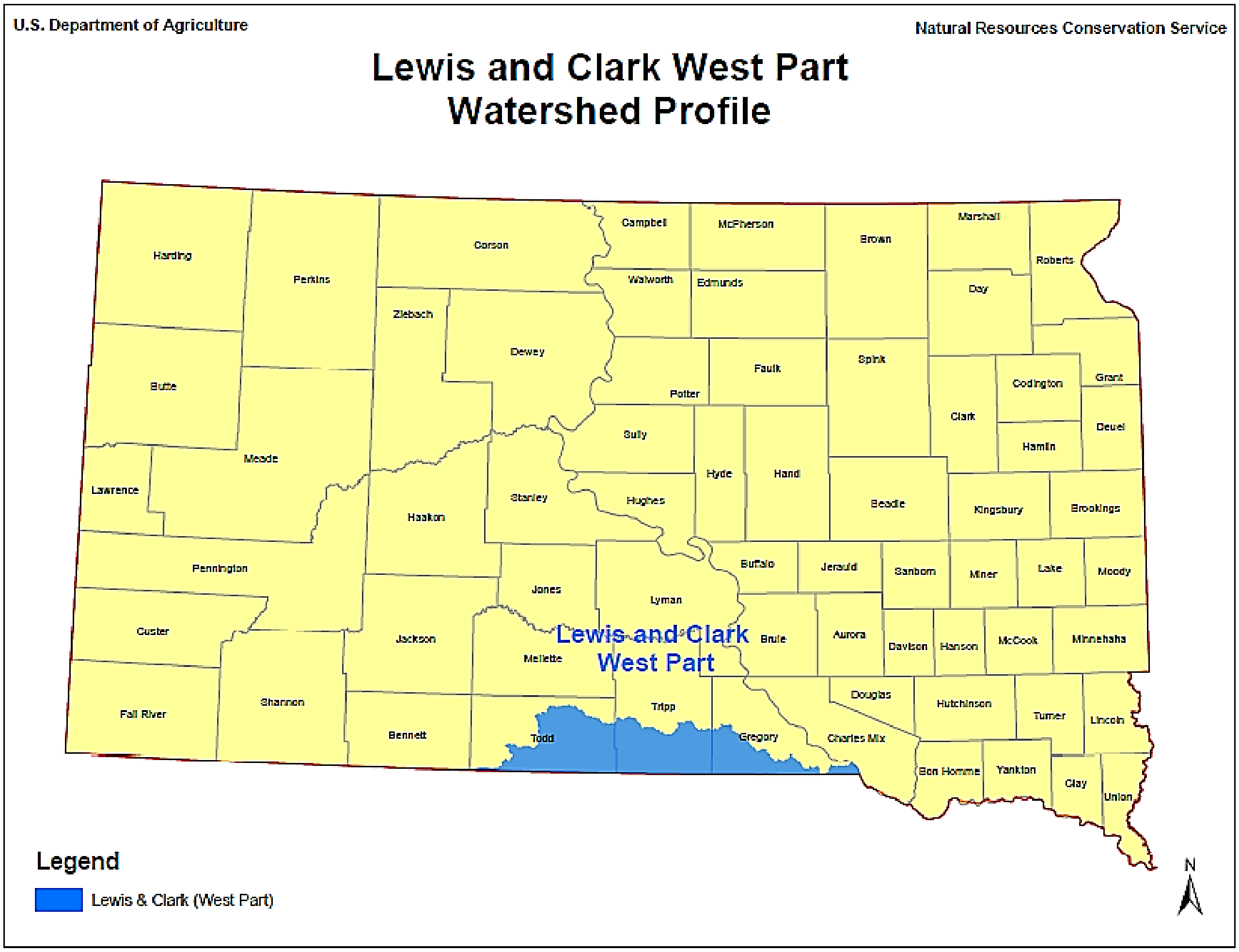

LEWIS & CLARK STRATEGIC PLAN
MISSOURI RIVER WEST

In Cooperation With:
Randall Resource Conservation & Development Association, Inc.
South Central Resource Conservation & Development Association, Inc.
South Central Water Development District
South Dakota Conservation Districts
South Dakota Association of Conservation Districts
South Dakota Department of Environment and Natural Resources
USDA Natural Resources Conservation Service

Date: March 2013

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Executive Summary

Lewis and Clark Lake is the most downstream dam in a series of six main stem Missouri River impoundments that is besieged with siltation problems. Sediment buildup presents hazards to boaters, impairs fisheries, creates marshy areas, and jeopardizes recreation facilities and infrastructure. The Missouri River watershed encompasses one-sixth of the contiguous United States flowing from the Rocky Mountains, through the Great Plains to the Central Lowlands, and joins the Mississippi River near St. Louis, Missouri. In South Dakota the Missouri River enters the state in the north-central region, near Pollock, flowing south and southeast through the center of the state, forming a portion of the boundary with Nebraska, and leaves the state in the southeast corner near the town of Jefferson. The Missouri River continues southward through the central United States, out-letting into the Mississippi river near Saint Louis, Missouri.

The early concerns of the Missouri River watershed were focused on flood control with the first flood control dam authorized by Franklin D. Roosevelt in 1933 and constructed near Fort Peck, Montana, in 1940. Congress then passed the Flood Control Act of 1944 that authorized the Pick-Sloan Missouri Basin Program; which was a comprehensive plan for the conservation, control, and use of water resources in the entire Missouri River Basin. The Pick-Sloan Plan called for the construction of five additional dams along the main stem of the Missouri River. Four large dams were constructed in South Dakota; the Fort Randall Dam, the Gavins Point Dam, the Oahe Dam, and the Big Bend Dam. The fifth dam was the Garrison Dam constructed in North Dakota.

Water quality issues became a concern when local citizens noticed the increasing amount of sediment loading in Lewis and Clark Lake, above the Gavins Point Dam, which threatened the storage capacity and lifespan of the Lewis and Clark Lake reservoir. The U.S. Army Corps of Engineers projected the reservoir to be at 50% of its design volume by the year 2045. Public meetings were held in 2002 with local organizations and citizens to address their concerns. These efforts led the Randall Resource Conservation and Development Association Inc. to administer a watershed assessment project from 2003 to 2005 with support and assistance from the SD Department of Environment and Natural Resources, both the Lower James and South Central Resource Conservation and Development Districts', local Conservation Districts, and the South Central Water Development District.

Although the original scope of the assessment was on sedimentation, modifications to the Lewis & Clark Watershed Improvement Project (LCWIP) were made to assess the presence of animal feeding operations and to establish Total Maximum Daily Loads for several smaller lakes, creeks, and rivers located in the watershed. Analysis revealed water quality issues of temperature, pH, dissolved oxygen, fecal coliform bacteria, total suspended solids, total phosphorous, and sedimentation. The assessment led to the two year Corsica Lake Watershed project where monies were used to implement Best Management Practices with landowners in the watershed. The watershed project was expanded in 2007 to include most of the Lewis and Clark Lake and Fort Randall Hydrological Units. During the year 2008 the Lake Andes watershed and the west river counties of Gregory, Tripp, and Todd Counties were added. In 2011 additional watersheds were incorporated into the LCWIP bringing the watershed to its current size of 2,465,500 acres. As of March 20, 2013, $2,890,309 of local, state, and federal funds has been spent on the implementation of BMP's within the LCWIP West River area; $1,580,819 in Gregory County; $209,502 in Todd County; and $1,100,259 in Tripp County.

This Strategic Plan concerns only the portion of the LCWIP whose watershed lies west of the Missouri River. There is almost a reversal in the percentages of land use between the west and east sides of the Missouri River; with approximately two thirds of the acres in rangeland/pasture and one-third in cropland west of the Missouri River. Water quality studies in the LCWIP area evaluated both point and nonpoint pollution and determined that point pollution was not a major contributor to these 303(d) listings. Nonpoint sources of pollution, identified in the TMDL studies, were mainly agricultural in nature arising from animal feeding operations, the improper application of animal manures, over grazing of pastures, excessive grazing in the riparian zones, direct livestock access to water bodies, livestock trampling of stream banks and shorelines, excessive erosion on crop fields, and stream channel erosion. Water quality studies in the LCWIP area resulted in information that led to the U.S. Environmental Agency 303(d) water quality impairment listing in the SD DENR Integrated Report of 2012 for Roosevelt Lake, Rahn Lake, Ponca Creek, and the Keya Paha River for Chlorophyll-*a*, Mercury, *Escherichia coli,* Total Suspended Solids, and Fecal Coliform bacteria.

To solve pollutant loading, Best Management Practices were selected that successfully reduced pollutants and, after implementation in the watershed, would result in the delisting of the impaired water bodies. The LCWIP completed Segments 1 and 2 that aided in this selection, as many installed BMPs were evaluated by AGNPS and STEPL for load reductions. The BMPs identified were animal waste storage facilities, nutrient management plans, prescribed grazing systems, managed grazing on riparian areas, conservation tillage, conservation rotation and the use of conservation cover crops, grassed waterways, stream bank stabilization, wetland restoration, pond and sediment control basins, the conversion of cropland to grass land, grassed filter strips, terraces, and tree plantings. Local county field offices personnel were contacted to identify the BMPs and to give their best estimates of the total number and/or acres of BMPs necessary to meet complete resource protection. In most instances, the attainment of these BMP goals will require additional years beyond this five year Strategic Plan.

This Strategic Plan includes the estimates of costs of the actual BMPs and the administrative costs to implement the Lewis & Clark Watershed Implementation Project west of the Missouri River over a five year project period. Cost estimates were based on USDA-NRCS cost lists and BMP projects completed through the project implementation plans. The goal of this Strategic Plan is to evaluate all water quality studies, identify the impaired resource concerns, select BMPs that reduce pollutant loadings to water bodies, and complete a practice and administrative cost analysis, and time schedule for installation of the BMPs.

1.0 INTRODUCTION

1.1 Project Background and Scope

This Strategic Plan is written for the portion of the Lewis & Clark Watershed Implementation Project (LCWIP) that lies on the west side of the main stem of the Missouri River in the south central portion of the State of South Dakota. See Figure 1-1 for the LCWIP area. The west river portion of the LCWIP encompasses approximately 1,332,300 acres and starts in the western part of Todd County near Mission and ends near Fairfax in Gregory County. The project area includes portions of the watersheds in Hydrological Unit's (HU) Lewis and Clark 10170101, Ponca 10150001, Keya Paha 10150006, and the Middle Niobrara 10150004; that lie west of the Missouri River just north of the South Dakota and Nebraska state borders. See Figure 1-2 for HU boundaries. The counties within this watershed project are Todd, Tripp, and Gregory. This watershed eventually drains into Lewis and Clark Lake which forms the border between the States of South Dakota and Nebraska. Lewis and Clark Lake is a man-made reservoir on the Missouri River between Springfield and Yankton, South Dakota, created by the Gavin's Point Dam. The dam was constructed by the U.S Army Corps of Engineers (USACE) as one of a series of six flood control structures on the mainstem of the Missouri River. The lake, at its maximum normal operating pool elevation of 1,208 feet above mean sea level, has a pool length of 25 miles, a maximum depth of 45 feet, and a surface area of 31,400 acres.

The major drainages in this portion of the project area are Antelope Creek, Sand Creek, Ponca Creek, Rock Creek, and the Keya Paha River. These drainages empty south into the Niobrara River just inside the State of Nebraska. However, only the portions of these watersheds within the State of South Dakota are in the LCWIP area. The Niobrara River contributes 7.41 million additional acres to the Lewis and Clark Lake watershed.

The climate of the Lewis & Clark Project area is classified as Sub-humid Continental. The maximum mean temperature at Mission in July is 87.6 degrees Fahrenheit (^{o}F), while the minimum mean temperature in January is 8.1 ^{o}F; the average mean annual temperature is 59.7 ^{o}F. The maximum mean temperature at Bonesteel in July is 84.8 ^{o}F, while the minimum mean in January is 7.4 ^{o}F; the average mean annual temperature is 57.9 ^{o}F. The annual precipitation in Mission and Bonesteel is 21.00 and 26.64 inches, respectively. The project area has a wide variety of weather through the year, with very cold, harsh winters and very hot, humid summers. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow. The region is periodically subjected to extended periods of drought and high winds that may generate devastating dust storms. Strong surface winds patterns across the watershed persist principally blowing from the north and northwest during the colder part of the year. The region experiences severe weather episodes such as tornadoes, hail storms, and blizzards in their respective seasons.

Figure 1-1. Lewis & Clark Watershed West Implementation Project.

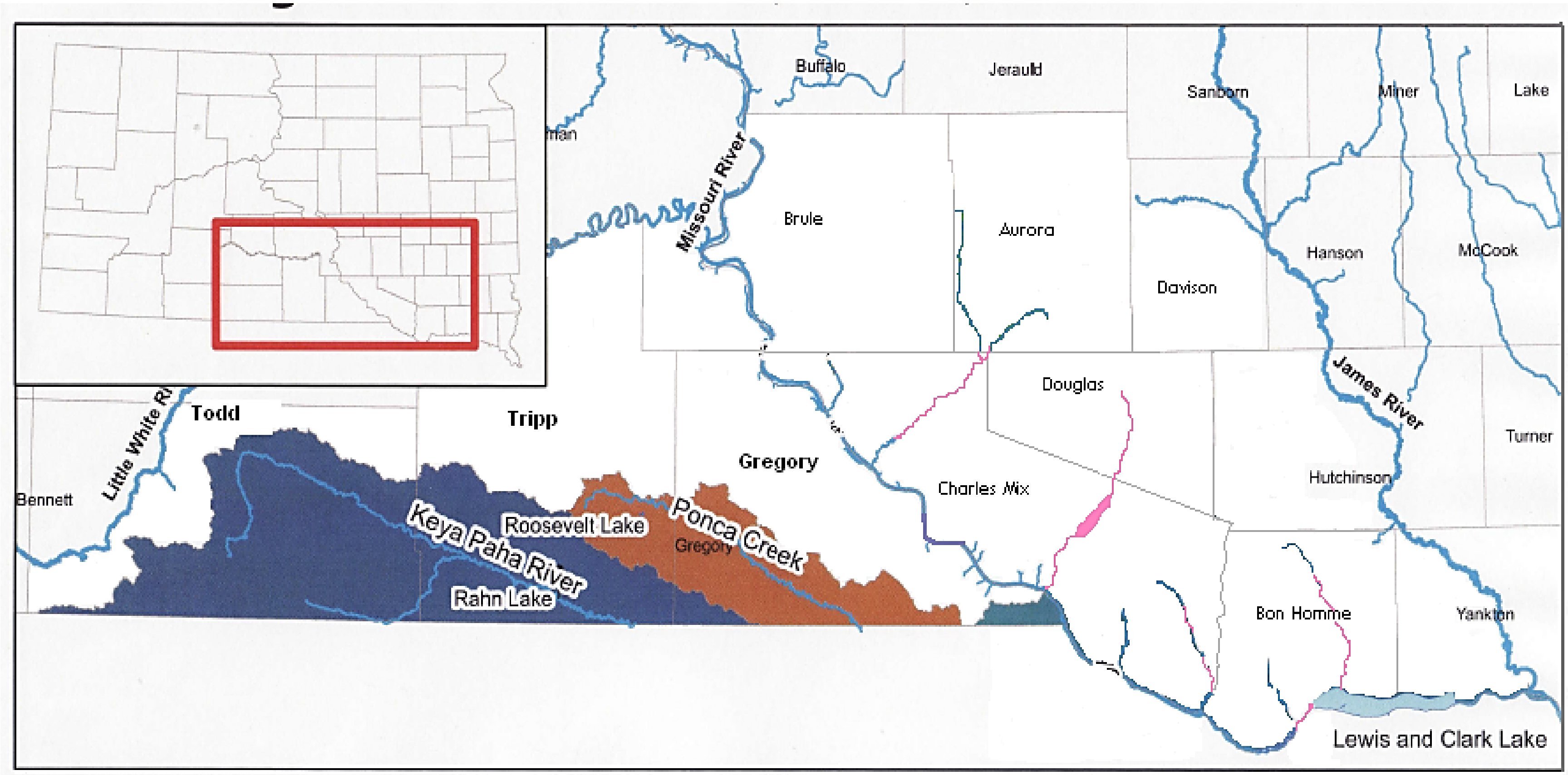


Figure 1-2. Lower Missouri River HUs in South Dakota

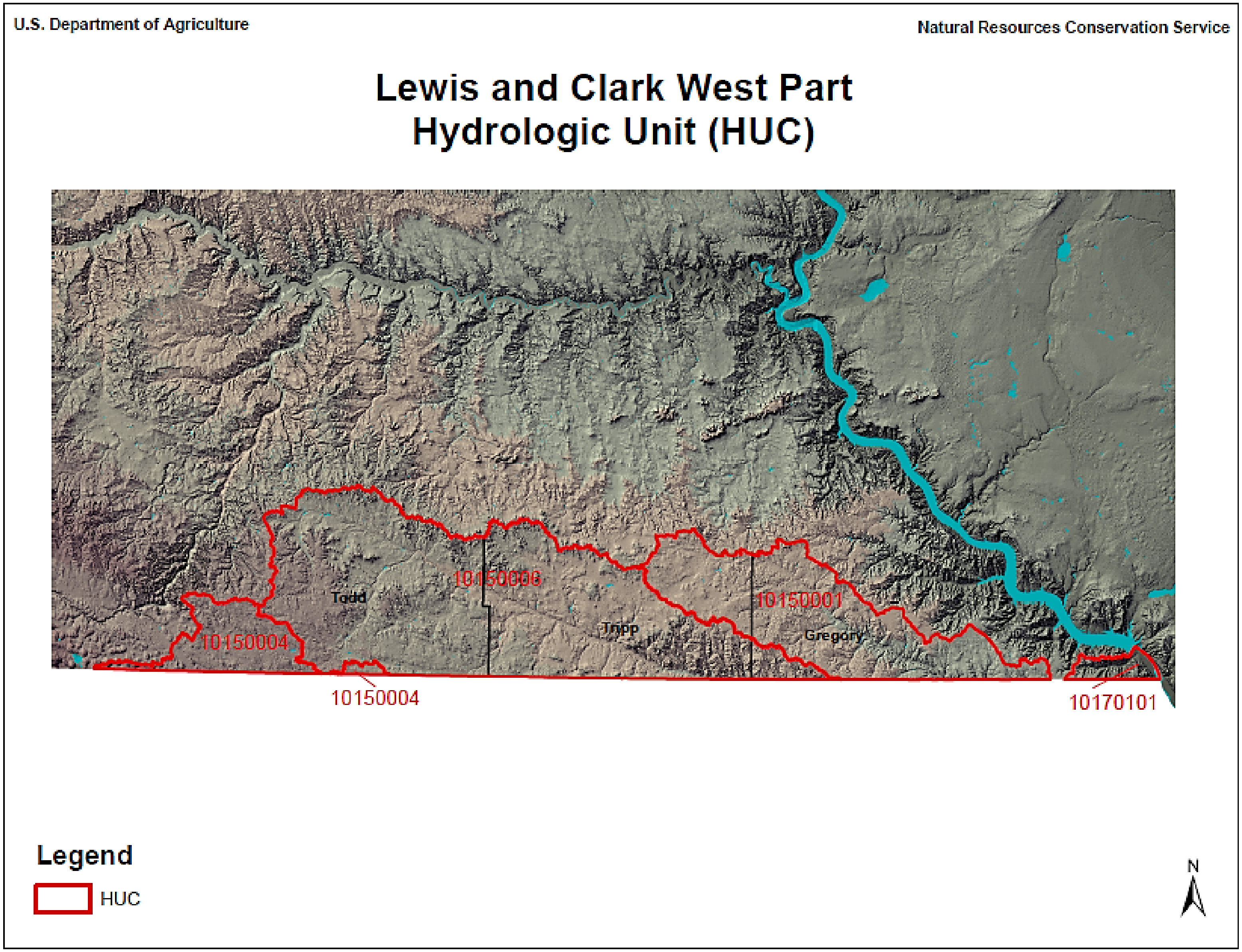
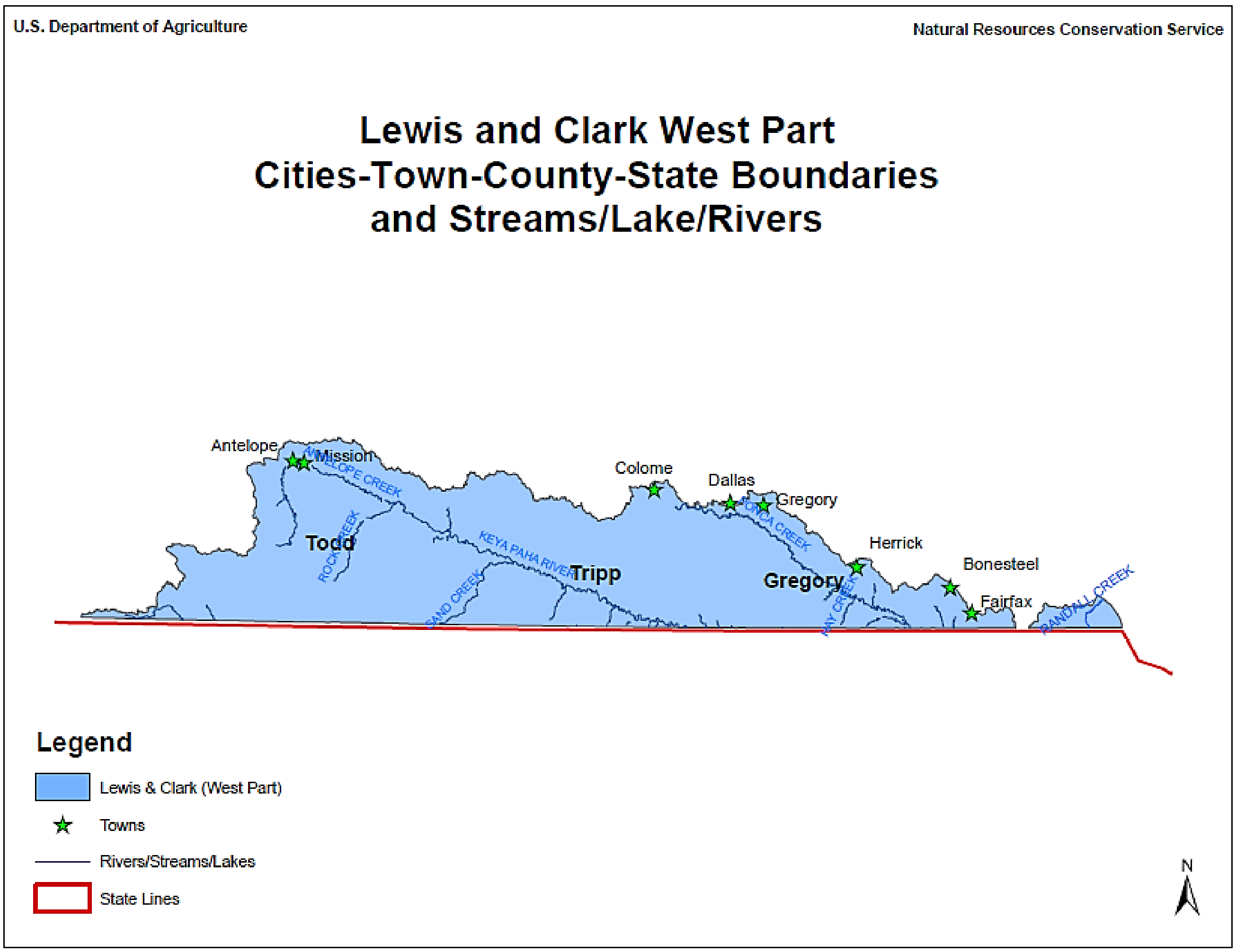


Table 1-1. Population Statistics of the Lewis & Clark West Project in SD

Population Statistics of the LCWIP in SD. US Census Bureau 2010				
Cities with Populations Over 100			Total County Populations	
City	County	Population	County	Population
Gregory	Gregory	1,295	Gregory	4,271
Mission	Todd	1,182	Todd	9,612
Antelope	Todd	826	Tripp	5,644
Burke	Gregory	604		
Colome	Tripp	296		
White Horse	Todd	276		
Bonesteel	Gregory	275		
Dallas	Gregory	120		
Fairfax	Gregory	115		
Herrick	Gregory	105	Total	19,527

Figure 1-3. Cities, Counties, Water Bodies of the Lewis & Clark Watershed



The LCWIP area west of the Missouri River is largely rural in nature with the City of Gregory having the largest population at 1,295 residents. The second largest city is Mission with a population of 1,182 residents. There are approximately 11 incorporated and unincorporated cities and villages within the watershed. Table 1-1 lists the cities with populations over 100 and the County populations in the watershed. A map of the cities and counties locations and State boundaries is shown in Figure 1-3.

1.2 Lewis & Clark Project, Lower Missouri River, Watershed History

In South Dakota, the Missouri River enters the State in the north-central region near Pollock and flows generally south. The river turns southeast near Pickstown, in south-central South Dakota, flowing in that direction and forming a common boundary with the state of Nebraska, until it leaves South Dakota at the southeast corner near Jefferson. As it flows through South Dakota, the Missouri River is fed by eight major tributary rivers and streams; the Grand, Moreau, Cheyenne, Bad, White, James, Vermillion, and Big Sioux Rivers'.

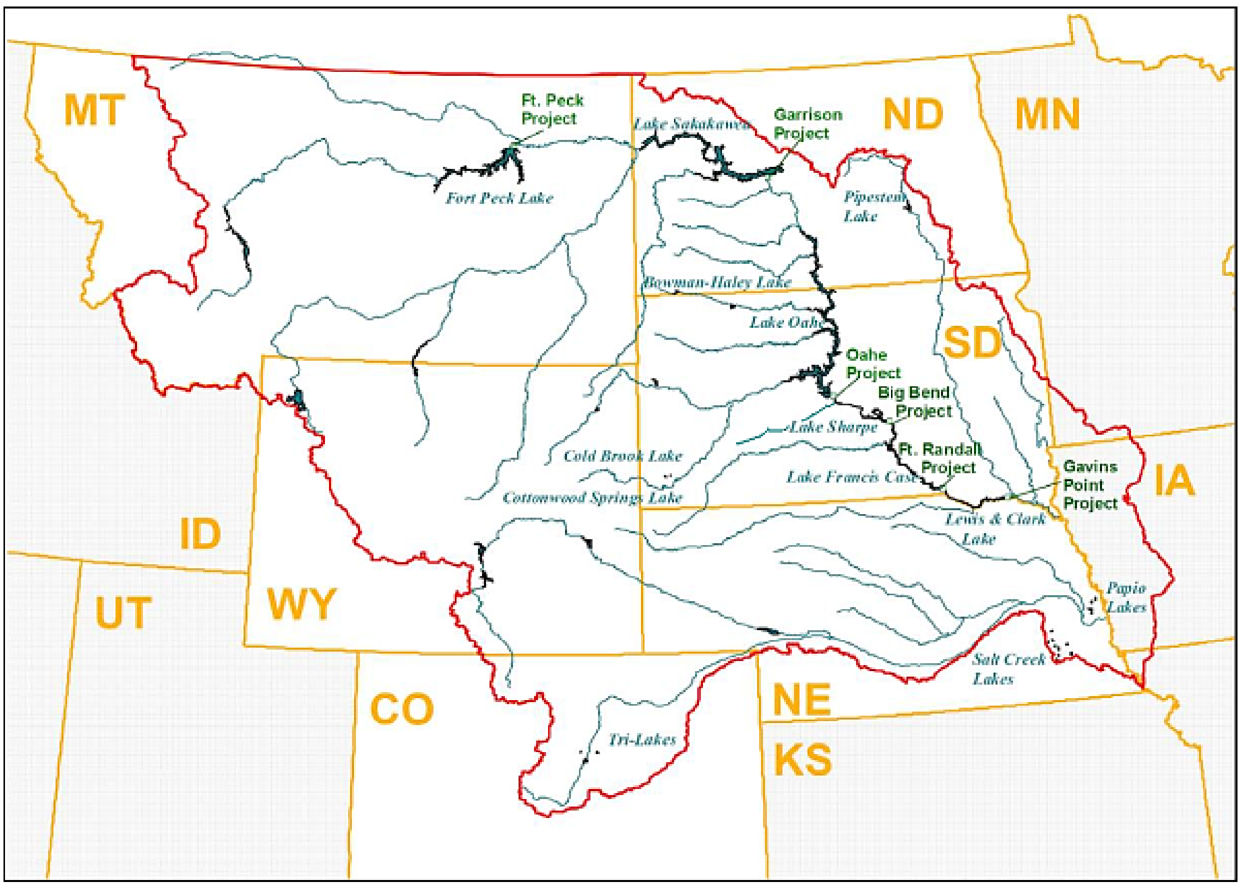
The Missouri River was a free flowing river until the first flood control dam was constructed at Fort Peck, Montana, which forms Fort Peck Lake. President Franklin D. Roosevelt authorized the Fort Peck project in 1933, during the Great Depression, and the dam was completed in 1940. Congressional passage of the Flood Control Act in 1944 authorized the Pick–Sloan Missouri Basin Program which was a general comprehensive plan for the conservation, control, and use of water resources in the entire Missouri River Basin. The Pick-Sloan Plan was a cooperative effort between the U.S. Army Corps and U.S. Bureau of Reclamation that called for the construction of five more dams along the main stem of the Missouri River.

Four large dams impound the Missouri River in South Dakota. The Fort Randall Dam, impounding Lake Francis Case near Pickstown, was the first dam completed in 1952. Gavins Point Dam, finished in 1955, forms Lewis and Clark Lake near Yankton and is the smallest impoundment on the main stem Missouri River. Oahe Dam, forming Lake Oahe near Pierre, is one of the largest rolled earthen dams in the world and was completed in 1958. The Big Bend Dam, finished in 1963, forms Lake Sharpe near Fort Thompson, was the last of the Missouri River impoundments to be finished. The sixth main stem dam built on the Missouri River was the Garrison Dam, in North Dakota, which forms Lake Sakakawea. See Figure 1-4 for Missouri River Flood Control Reservoirs.

The five dams upstream of the Gavins Point dam and Lewis & Clark Lake project control 263,480 square miles of drainage system. The immediate Lewis and Clark Lake drainage area, controlled by the Gavins Point Dam, is approximately 16,000 square miles in size, and is operated to provide stabilized flows for navigation. The dam was constructed primarily as a reregulation dam for releases from Fort Randall Dam. Reregulated releases assist navigation on the lower Missouri River by supplying a steady flow of water. Although navigation on the Missouri River originally passed through South Dakota, there is no commercial navigation through this reach of the river today. Commercial navigation on the Missouri River is largely confined to the river at and downstream from Sioux City, Iowa.

The reservoir system on the Missouri River was designed for the multipurpose uses of hydroelectric power, flood control, navigation, municipal water, irrigation, fish and wildlife habitat, and recreation. However, the main mission of the dams is flood control and all the other authorized purposes and functions are subordinate to the flood control mission of the project. The Gavins Point Dam project provides 59,000 acre-feet of exclusive flood control storage. Flood control projects in the entire Missouri River basin are estimated to have prevented over

Figure 1-4. USACE Flood Control Reservoirs along the Missouri River



$26.0 billion in flood damages in the period 1938-2002 indexed to 1997 dollars; during which the Gavins Point project is credited with preventing $322 million in damages. Three generators generate 754 million kilowatt-hours of electrical energy at Gavins Point each year. Hydroelectric power generated at this project is used by industries, farms, municipalities, and homes in the Pick-Sloan Missouri Basin marketing area.

Two semi-natural segments of the regulated free-flowing Missouri River remain in South Dakota; a 45-mile stretch below Fort Randall Dam that flows into Lewis and Clark Lake and a second 58 miles stretch below Gavins Point Dam, that flows into the channelized portion of the Missouri River near Sioux City, Iowa. These river sections have received protection under the Wild and Scenic Rivers Act.

The initial water concerns on the Missouri River were with flood control and activities started with the construction of the Fort Peck Dam as early as 1933. However, water quality concerns on Lewis and Clark Lake did not begin until around 2002. Public meetings were held to address the concerns of local organizations and citizens who were worried about the amount of sediment loading in Lewis and Clark Lake and the reduction in the storage capacity and lifespan of the reservoir behind the Gavins Point Dam. Lewis and Clark Lake is threatened by sedimentation to the level that it is estimated to lose 50% of its original design volume by the year 2045. The LCWIP Segment 1 was started from the results of these efforts. The Randall Resource Conservation & Development District (RC&D) administered a watershed assessment project from 2003 to 2005 with the help of Lower James RC&D, local Conservation Districts, and the South Dakota Department of Environment and Natural Resources.

The original scope of the project was intended to identify areas and causes of sediment to the reservoir and begin developing remediation strategies to reduce the amount of sediment entering the impoundment. Although all six of the Missouri River Reservoirs in the Upper Missouri River Basin are experiencing storage losses due to sediment, the three smallest reservoirs (Lewis and Clark Lake, Lake Francis Case, and Lake Sharpe), located in the lower part of the basin, have been far more significantly impacted than the other reservoirs. As of 2009, Lewis and Clark Lake has had a storage loss of 30 percent. Using the USACE supplied sediment data, Lewis and Clark Lake, is projected to be at 50% of its design volume by the year 2045 (NRCS 2009). The South Dakota Department of Environment and Natural Resources (DENR) made an informal agreement with the Nebraska Department of Environmental Quality (NEDEQ) to share data collected in the watershed project and discuss mitigation activities upon completion of the assessment.

Additional concerns were discovered during the first year of the LCWIP assessment, and as a consequence, the monitoring strategy was modified to assess the presence of large numbers of animal feeding operations and establish Total Maximum Daily Loads (TMDL) for several smaller lakes, creeks, and rivers located within the drainage. The goal of the LCWIP was to restore the beneficial uses of the Lewis and Clark Lake watersheds through the installation of Best Management Practices (BMPs) that targeted sources of sediment, nutrients, and fecal coliform bacteria. The implementation projects of LCWIP became very successful, being well accepted by landowners, and surpassed assigned practice acreage and goals. The west river counties of Gregory, Tripp and Todd were added in 2008 along with the Lake Andes watershed and the watersheds of Geddes, Academy, and Platte Lakes' were added in 2011. This Strategic Plan document includes only that portion of the LCWIP located west of the Missouri River which includes Gregory, Todd, and Tripp counties.

1.3 Lewis & Cark Watershed Water Quality Studies

Water quality resources were not studied intensively in the LCWIP area until more recent times. The water resource concerns along the Missouri River had been initially focused on flood control and sources of irrigation water. Analysis has revealed water quality issues of temperature, pH, dissolved oxygen, fecal coliform bacteria, total suspended solids, total phosphorous, mercury, and sedimentation. The South Dakota Department of Environment and Natural Resources Integrated Report (SDDENR-IR) 2012 reported that of the identified six water bodies within the LCWIP area west of the Missouri River, Ponca Creek and the Keya Paha River have approved Total Maximum Daily Loads (TMDL). Rahn Lake and Roosevelt Lakes' are water quality impaired and will require a TMDL. The remaining water bodies of Antelope and Sand Creeks' either had no available data or insufficient data to make a TMDL determination. A short synopsis of each study within the LCWIP is as follows:

- The Roosevelt Lake watershed was studied in the *Phase I Watershed Assessment and TMDL Final Report Lewis and Clark Basin, Nebraska and South Dakota*, April 2011. It was determined that Roosevelt Lake was meeting all of the standards that affect its beneficial uses with the exception of collected pH values. The lack of historic supporting data and coinciding elevated values collected at other water bodies on the same dates suggested that the best course of action was to continue monitoring prior to restudying the water body to determine the validity of the high pH readings. The lake was 303 (d) listed as 'threatened' in the 2012 DENR Integrated report for Mercury; indicating the water body meets water quality standards, however, the support is borderline and may trend toward nonsupport. The SD Department of Health has issued a consumption advisory in 2011 and 2012 for northern pike over 24 inches in length and largemouth bass over 18 inches in length.

- Ponca Creek was evaluated in the *Total Suspended Solids Total Maximum Daily Load Evaluation for Ponca Creek, Gregory and Tripp Counties, South Dakota*, February, 2010, and the *Fecal Coliform Bacteria Total Maximum Daily Load Evaluation for Ponca Creek, Gregory and Tripp Counties, South Dakota.* April, 2010. The creek was listed as 303(d) impaired in the 2012 DENR Integrated Report for total suspended solids (TSS) which impaired the warm water fish life propagation uses and for fecal coliform which impaired recreational use.

- The Rahn Lake watershed was studied in the *Phase I Watershed Assessment and TMDL Final Report Lewis and Clark Basin, Nebraska and South Dakota, April 2011*. Rangeland composed 92% of the land use within the watershed, while cropland composed 2% and consisted of both row crops and close seeded grains. Reductions from the conversion of all cropland to range could yield as much as an 80% reduction, however a great deal of uncertainty surrounds this estimate and true reductions may be 40% or less. The lake was 303 (d) listed in the 2012 DENR Integrated report for Chlorophyll-*a*. The study concluded the watershed is one of the least impacted in the region and should be considered a high quality reference site. Reduction response modeling suggested that the listing criterion could be unattainable under any condition.

- The Keya Paha River was reported on in the *Total Suspended Solids Total Maximum Daily Load Evaluations for the Keya Paha River, Tripp County, South Dakota*, in May 2009; the *Fecal Coliform total Maximum Daily Load Evaluation for Keya Paha River, Tripp County, South Dakota*, in October 2009; and the Escherichia coli *Total maximum Daily Load Evaluation for the Keya Paha River, Tripp County, South Dakota*, in June of 2011. The river drains 1,092,300 acres of watershed in south central South Dakota. Sources of *E. coli* and fecal coliform bacteria contamination were identified as 33.1% from beef feedlots and 64.3% from livestock on grass. Sources of Total Suspended Solids were identified as unstable stream channels, as 12% of the stream channels were ranked as unstable and contributed to increased sediment loading.

- The Lewis & Clark Basin was studied in the *Phase I Watershed Assessment and TMDL Final Report Lewis and Clark Basin, Nebraska and South Dakota*, April 2011. The main purpose of this assessment was to locate the source of sediments entering Lewis and Clark Lake and determine the feasibility of reducing the amount of sediment and nutrients entering the reservoir through best management practices. An additional goal of the project included the development of TMDLs for all impaired water bodies located within the drainage.

- Sedimentation in Lewis & Clark Lake was reported on by the U.S. Army Corps of Engineers in the *Gavin's Point Dam/Lewis and Clark Lake Master Plan, Missouri River, Nebraska and South Dakota*, dated December 2004. This updated Master Plan guides the use and development of the natural and manmade resources of the project as it was authorized for flood control, navigation, hydropower, fish and wildlife, recreation, irrigation, municipal and industrial water supply, and other purposes. The main stem of the Missouri River is not listed as 303(d) impaired in the 2012 SDDENR Integrated Report.

- The effect of Best Management Practices (BMP) in the entire Missouri River Basin was studied by USDA- Natural Resources Conservation Service (NRCS) and reported on in the document *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Missouri River Basin*, June 2012. The primary focus of the study was on the 29 percent of the basin that is cultivated cropland. The study was designed to quantify the effects of conservation practices commonly used on cultivated cropland, evaluate the need for additional conservation treatment in the region on the basis of wind erosion and edge-of-field sediment and nutrient losses, and to estimate the potential gains that could be attained with additional conservation treatment.

1.4 Goals of the Lewis & Clark Watershed Strategic Plan

The goal of this strategic plan for the Lewis & Clark Watershed Implementation Project in the State of South Dakota is to identify the pollutant sources for the 303(d) listed water bodies and to find suitable Best Management Practices (BMP) that, when implemented, would result in helping to delist the 303(d) water bodies. The implementation of the BMPs will eliminate or reduce the nutrient, sediment, and fecal coliform bacteria loadings to the Missouri River from its watershed and tributaries. In addition to the 303(d) delisting, the implementation of this plan will allow the continued use of the water bodies for flood control, drinking water, livestock water, swimming, boating, recreation, irrigation, commerce, wildlife, and residential living.

2.0 CAUSES AND SOURCES OF IMPAIRMENTS

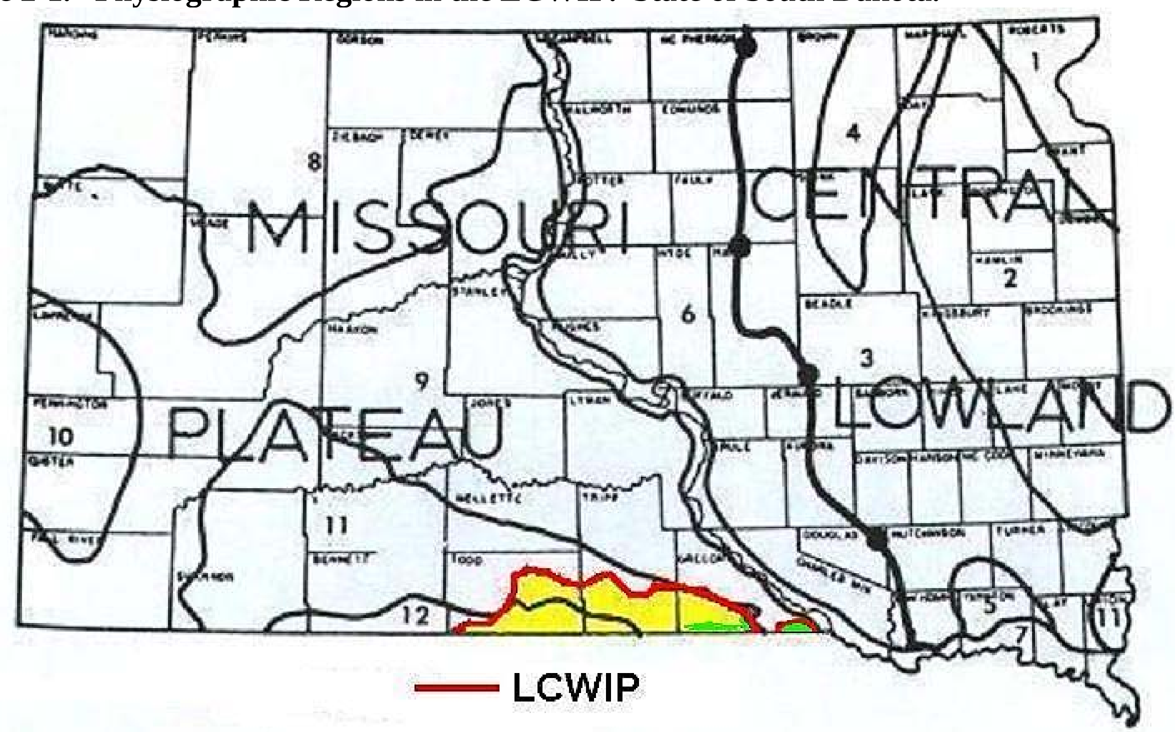
2.1 Geography

The Lewis & Clark Watershed Improvement Project west of the Missouri River is mostly located within the Level III Northwestern Great Plains ecoregion with a portion in the Nebraska Sand Hills ecoregion. The eastern boundary of the Northwestern Great Plains roughly coincides with the limits of continental glaciation. This region is an unglaciated rolling plain of short grass and mixed grass prairies punctuated by occasional buttes with some areas of dissected, badland terrain, and river breaks. Grasslands persist in rangeland areas, especially on broken topography, but have been replaced by cropland on some areas of level ground. Streams are mostly ephemeral and intermittent with a few larger perennial rivers crossing the region from the western mountains. Many small impoundments occur on these tributaries in addition to the large reservoirs on the Missouri River.

The Nebraska Sandhills ecoregion is one of the largest areas of grass stabilized sand dunes in the world consisting of both mid and tall grass prairie communities. The region is mostly treeless except for some riparian areas. The Nebraska Sandhills are a major recharge area for the massive Ogallala Aquifer. Thousands of temporary and permanent shallow lakes are common in low-lying valleys that both replenish the Ogallala Aquifer and feed the creeks and rivers such as the Niobrara.

The project area is located in the Missouri Plateau of the Great Plains physiographic province. See Figure 2-1. The Pierre Hills (Division 9) consist of a series of smooth hills and ridges with rounded tops. This region is underlain by the Pierre shale formations and has lower elevations from 1,800 to 2,800 feet above sea level and is lower than the plateau country to the north and the south. The Southern Plateaus (Division 11) is the large area in the southwestern part of the State which consists of a series of benches and buttes, underlain by Tertiary sandstones, siltstones, and shale. Elevations range from 2,800 to 3,600 feet. The Badlands comprise the northern part of the southwestern region. The Sand Hills (Division 12) is a South Dakota extension of the Sand Hills region of Nebraska. It consists of a series of rounded hills interspersed with low, swampy areas. The area is underlain with eolian sand. Elevations range from 3,000 to 3,600 feet above sea level.

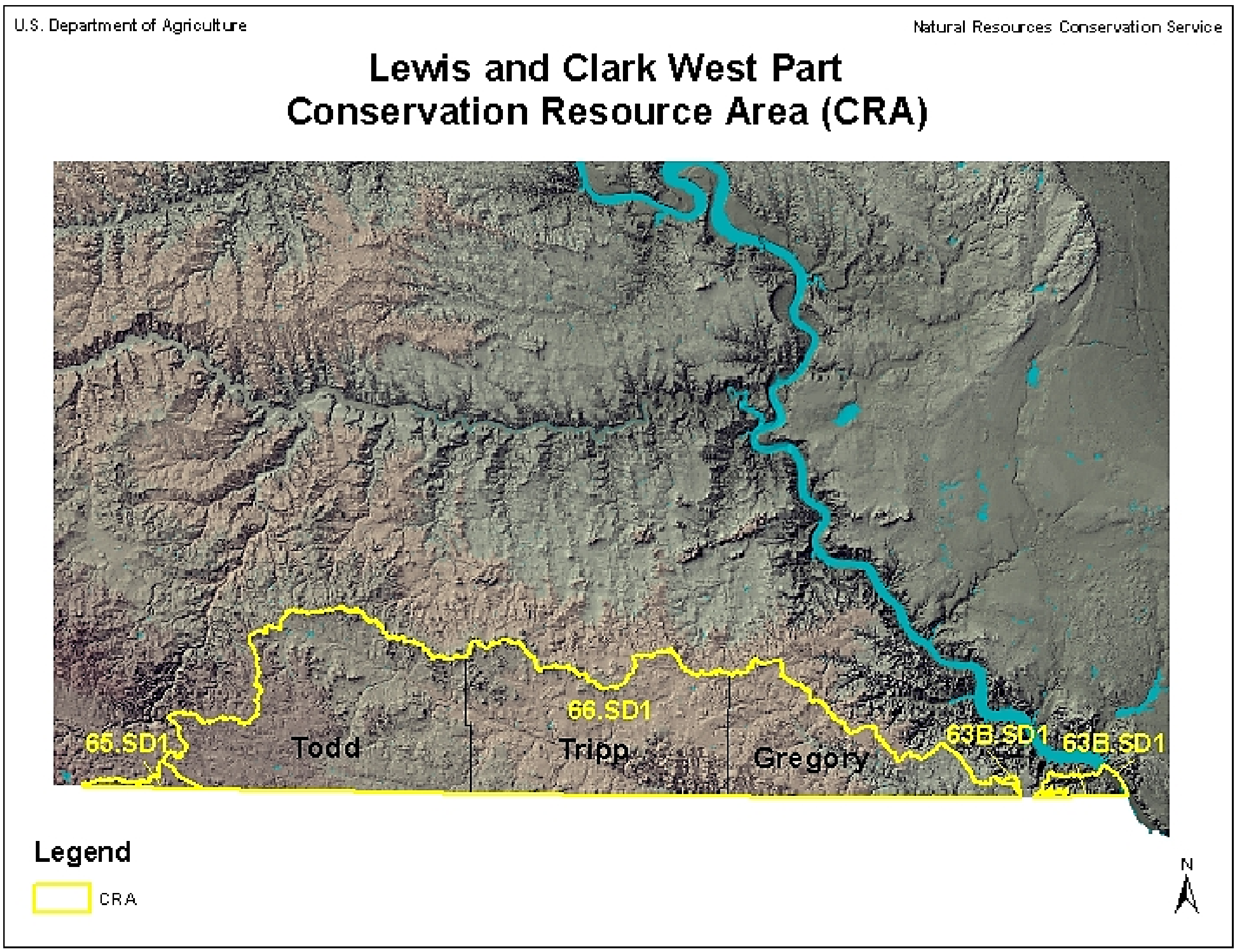
Figure 2-1. Physiographic Regions in the LCWIP. State of South Dakota.



The LCWIP-West River area for this strategic plan lies in the Western Great Plains Range and Irrigated Region G of the Major Land Resource Areas (MLRA). The MLRAs are part of a USDA classification system that defines land as a resource for farming, ranching, forestry, engineering, and other uses. The MLRA is a broad-based geographic area characterized by a uniform pattern of soils, elevation, topography, climate, water resources, potential natural vegetation, and land use. The large MRLA's are subdivided into smaller more homogeneous resource areas referred to a Common Resource Area's (CRA). The Dakota-Nebraska Eroded Tableland, area 66, comprises the major CRA within the LCWIP-West River area. Small portions of other CRA's included in the project boundaries are area 63B the Southern Rolling Pierre Shale; and area 65 the Nebraska Sandhills. See Figure 2-2.

This MLRA is part of the fluvial plain that built up to the east as the Rocky Mountains eroded. Broad inter-valley remnants of that smooth fluvial plain dominate the area. Some terraces and river breaks and local badlands are along the major drainages. The higher parts of the tableland are nearly level to moderately sloping. Steeper areas are on the sides of ridges and drainages. Stream valleys are well defined, except in some undulating areas. The Missouri River flows in a trench cut by glacial melt water from the adjacent western MLRA. A high terrace scarp separates the valley floor along the Missouri River from the surrounding land. The transitional area between the uplands and the valley floors of the Missouri River is deeply eroded to and referred to as the “Missouri Breaks”.

Figure 2-2. Common Resource Areas of the LCWIP

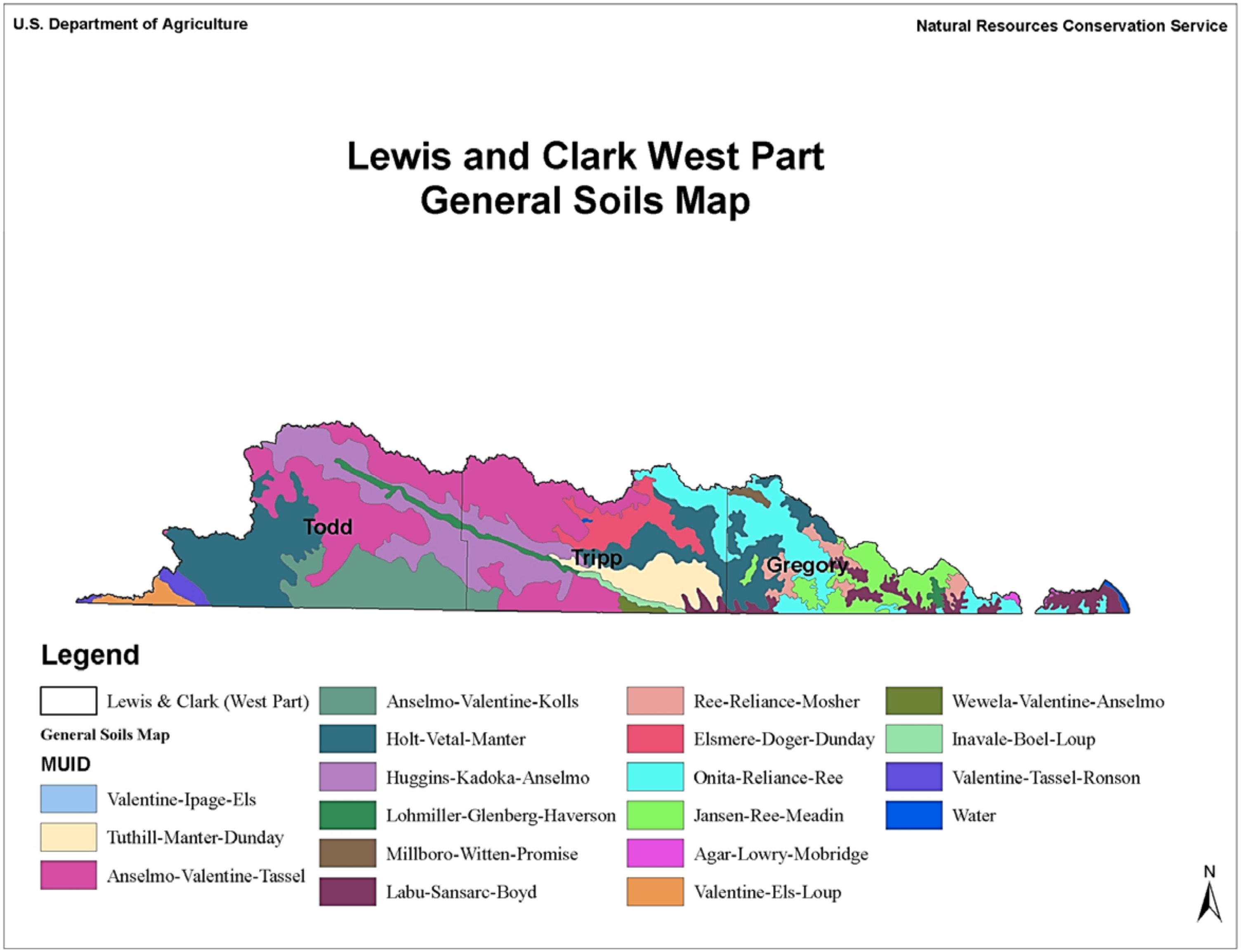


2.2 Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic or aridic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to excessively drained, and loamy or sandy. Haplustolls formed in eolian sediments (Anselmo and Dunday series) and loamy over sandy sediments (Meadin, O'Neill, and Pivot series) on stream terraces and uplands and in valleys. Argiustolls (Jansen series) formed in loamy sediments over alluvium on uplands. Ustipsamments (Valentine series) formed in sandy eolian material on dunes. The predominant soil associations in the watershed area are shown on Figure 2-3. Official Soil Series Descriptions or a Series Extent Map can be retrieved using the following link; https://soilseries.sc.egov.usda.gov/osdname.asp. Soil survey data can be obtained by visiting the online Web Soil Survey at http://websoilsurvey.nrcs.usda.gov for official and current USDA soil information as viewable maps and tables.

Most of this area supports native grasses and is grazed by cattle. Some of the more level areas are used for crops, mainly corn, forage and grain sorghum, and alfalfa for livestock feed. Winter wheat is grown as a cash crop in a few areas. The major resource concerns are erosion and the quality of surface water. The major soil resource concerns on cropland and hayland are wind erosion, water erosion, maintenance of the content of organic matter and tilth of the soils, and soil moisture management. The major soil resource concerns on pasture and rangeland are wind erosion and water erosion in areas where the plant cover has been depleted by overgrazing. The most important conservation practices on rangeland are prescribed grazing, livestock watering distribution, and brush management. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season, tame pastures are established to supplement forage production. Resource concerns on cropland are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, irrigation, soil wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or other conservation tillage systems that conserve moisture and contribute to soil quality. Other conservation practices include terraces, grassed waterways, and cropland nutrient management.

Figure 2-3 General Soils Map of the LCWIP



2.3 Land Use

The Missouri River dramatically divides the land uses in this MLRA. The area of the LCWIP-West River of the Missouri River is in the non-glaciated soils region. The land use is estimated at about 14.5% cropland (NRCS 2012) with the production of row crops, small grains, and hay land as the primary cropland uses. The principal crops are corn, soybeans, alfalfa, sorghum, sunflower, wheat, and oats. Grazing, permanent hay, and rangelands make up approximately 77.9% of the acres being used for livestock operations. Urban lands consist of about 2.0% of the watershed acres with Forest and Other uses comprising 5.4%. See Table 2-1 for the agricultural data for the counties within the watershed. Cropland and Rangeland productivity maps are presented in Figures 2-4 and 2-5, respectively. Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Recreational hunting and fishing are important land uses around the many water bodies within the watershed. The major resource concern during the early phases of the project in 2003 was the sedimentation of Lewis & Clark Lake. As the project progressed and water quality data was analyzed, the Project Implementation Plan (PIP) was drafted to address the identified loadings of nutrients, sediment, and coliform bacteria.

Table 2-1. Agricultural Data LCWIP Watershed, West River Counties

Agricultural Data for Counties in Lewis & Clark Watershed, West River				
	Todd	**Tripp**	**Gregory**	**Data Year**
Land Area Acres	888,464	1,014,336	650,224	2010
Number of Farms	258	624	511	2010
Total Cropland Acres	139,607	440,874	256,276	2010
Corn Acres	11,800	85,800	50,100	2010
Soybean Acres		39,000	33,300	2010
Sorghum Acres		26,300		2010
Sunflower Acres		10,500		2010
Small Grain Acres		80,900	11,900	2010
Hayland Acres	84,000	169,000	84,000	2010
Pasture/Range Acres	726,972	575,490	392,594	2007
Cattle	58,484	151,855	70,462	2007
Swine		17,691	7,263	2007
Sheep	964	10,119	701	2007

Data from USDA Agricultural Statistics Service

Figure 2-4. Cropland Productivity in the Lewis & Clark Project Watershed

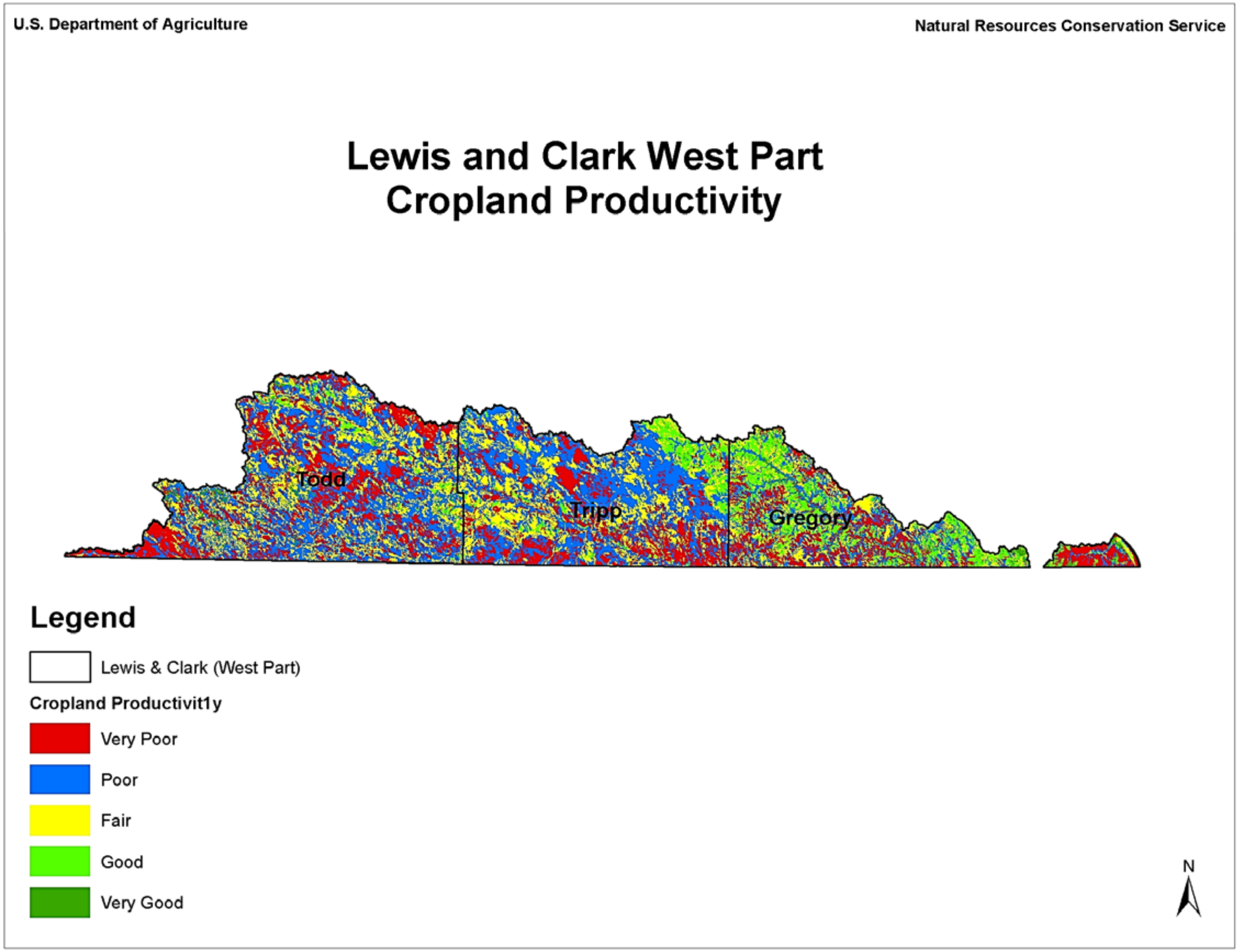
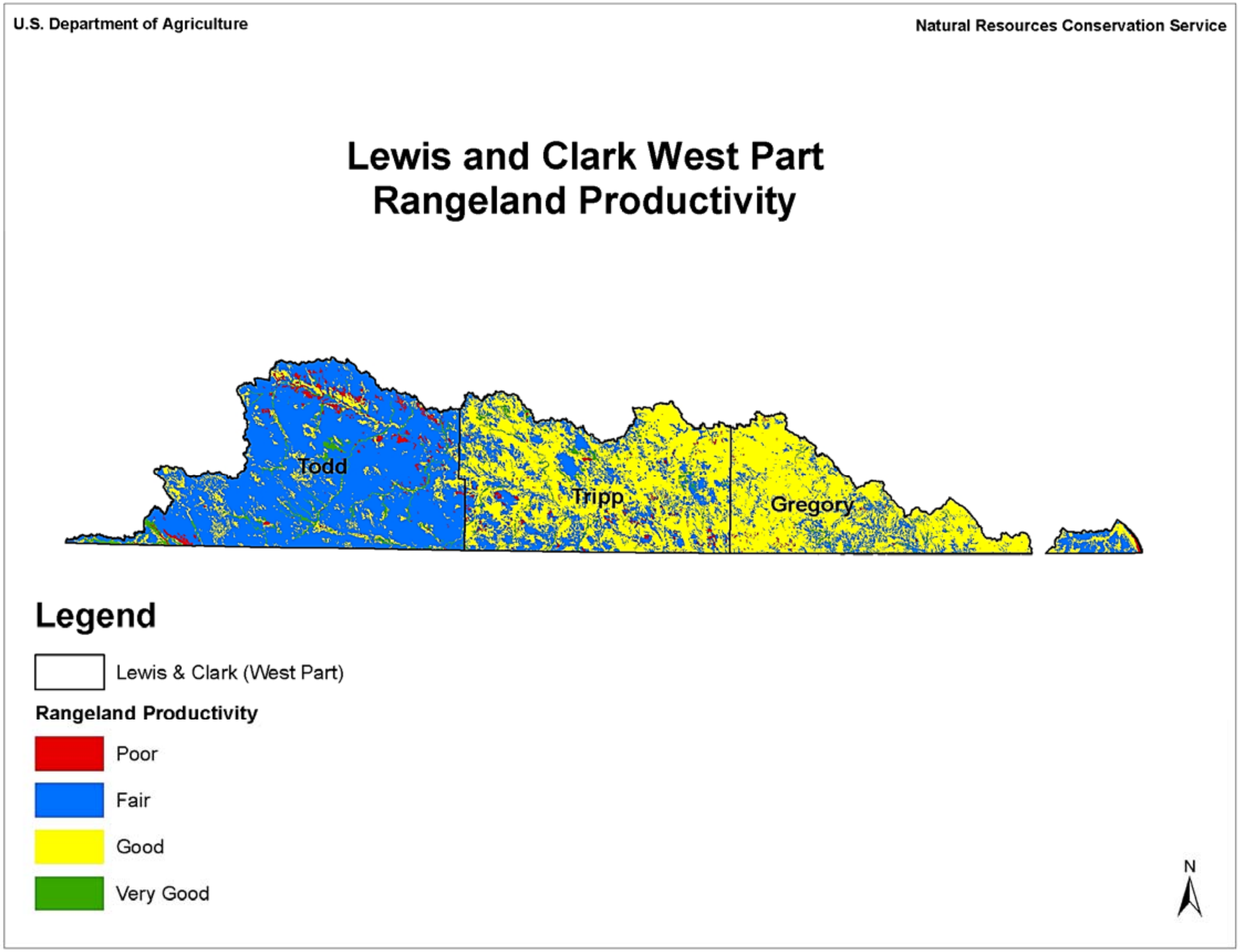


Figure 2-5. Rangeland Productivity in the LCWIP Watershed



2.4 Water Resources

Freshwater is a critical resource of this MLRA Region of the northern High Plains with the total withdrawal of freshwater averaging 13,830 million gallons per day. About 77 percent of this is from ground water sources and 23 percent from surface water sources. Of this amount, the public water supply uses 5.6% of the surface water and 6.9% of the groundwater. In most years precipitation is inadequate for maximum crop production. Irrigation is a common agricultural practice in the area with 84% of the water withdrawal used for irrigation; 21.5% of this percentage comes from surface water and 52.9% from ground water. Perennial streams are few and widely spaced and not adequate for irrigation; hence the importance of area reservoirs.

The major shallow groundwater sources in this area are from the High Plains Aquifer which consists of hydraulically connected geologic units of the White River, the Arikaree, and the Ogallala Aquifers'. The High Plains aquifer (SDGS 2004) includes an area of about 1,820 square miles in South Dakota. The saturated thickness of the aquifer ranges from 0 - 190 feet. The depth to water in the High Plains aquifer in Tripp and Gregory Counties ranged from about 5-132 feet below the land surface and 0–164 feet in Todd County (USGS 1998). The water of both the Ogallala and Arikaree aquifers generally has a low concentration of dissolved solids, is fresh, and is soft to moderately hard. The White River aquifer is higher in dissolved solids, more saline, and harder. Recharge to the shallow aquifers is by infiltration of precipitation and stream loss.

The bedrock aquifers lie deep beneath the shallower groundwater aquifers. The bedrock aquifers include the Pierre Shale, Dakota Sandstone, Inyan Kara, and the Minnelusa, and Madison aquifers. Depths to the top of these bedrock aquifers range from 1,270 – 2,348 feet below the land surface. Few wells have been completed in the deeper bedrock aquifers because of the cost and that water usually can be obtained from a less expensive source. The bedrock aquifers generally yield hard, saline water with high concentration of dissolved solids. Recharge to the deeper bedrock aquifers is primarily by infiltration of precipitation on outcrops of formations which occurs mainly in the Black Hills.

The National Water Quality Assessment Program (NAWQA) findings indicated that the quality of groundwater from deeper in the High Plains aquifer, where most private, public-supply, and irrigation wells are screened, is generally suitable for drinking and as irrigation water (USGS 2009). Comparison of private well water quality to US Environmental Protection Agency national primary and secondary drinking-water standards indicates that water from the Ogallala Formation in the northern and central High Plains had the best water quality; whereas water from the Ogallala Formation in the southern High Plains had the poorest quality. Most exceedances of primary and secondary drinking-water standards were those for dissolved solids, nitrate, arsenic, fluoride, iron, and manganese. The most frequently detected pesticide compounds were atrazine and deethylatrazine; while the most frequently detected volatile organic compound was chloroform. None of the pesticide compounds or volatile organic compounds exceeded a primary drinking-water standard.

Currently, the rural water system that provides water to the counties within the project area is the Tripp County Rural Water User District. It draws its water source from the Valentine formation of the Ogallala Aquifer and only requires gas chlorine and liquid fluoride treatment. Lewis and Clark Lake (the Missouri River) is also an extremely valuable potable water resource as it is suitable for domestic use, livestock use, and irrigation. The water has a low sodium hazard and a medium salinity hazard (USGS, Jorgensen 1971). The Missouri River and these rural water systems provide a high-quality, reliable domestic water supply to residents of Lewis & Clark Watershed Implementation Project area.

2.5 Water Bodies Studies and Current Status

Assessments in the watershed have identified sediment, phosphorous, and coliform bacteria as sources of water contaminants. Segment 1, of the LCWIP, was implemented from 2006 to 2009 to address these pollutants.

Additional background information was needed to develop a more comprehensive monitoring plan and identify critical regions in the watershed and to develop a PIP targeting these areas for development of restoration alternatives. Thus a steering committee was formed in 2007 with representative from eleven conservations districts and sponsoring federal and state agencies to help facilitate the efficient flow of cost effective Best Management Practices and make sure all needs were being met. Producer meetings and workshops were used to provide information on how producers might access Best Management Practice design and installation. Success of the implementation projects led producers to request that west river portion of the Lewis and Clark Lake watershed and Lake Andes be added to the project in 2008.

Segment 2 of the LCWIP was started in June of 2009 and completed in July 2011 and was done in cooperation with the SDDENR and the State of Nebraska. The project implementation was based on water quality data collected for this project and through water quality data collected throughout the Niobrara watershed in Nebraska (NDEQ 2005) as a part of their basin wide study conducted during the same time frame. The Lewis & Clark West Project Strategic Plan will not address the watersheds east of the Missouri River, as those watersheds were treated in a separate document.

Data from the Annualized Agricultural Nonpoint Source (AnnAGNPS) Model and Rapid Geomorphic Assessments (RGAs) identified approximately 100 animal feeding operations that contribute fecal coliform bacteria to tributaries in the watershed. Seventy of these were determined to be priority operations requiring the construction of Animal Waste Management Systems (AWMS) with accompanying nutrient management plans. High fecal levels were associated with land application of manure to include both excessive application rates and by not incorporating the applied manure after application.

The three primary sources of sediment loading were identified as (1) sheet and rill erosion of cropland, (2) degraded riparian areas, and (3) channel erosion. Degraded riparian areas and channel erosion were significant sources for sediment entering the reservoir. Eroded stream channels appeared to be related to several management practices:

- Season long grazing, overstocking, and grazing along stream banks
- Improper sizing and placement of road culverts
- Degraded rangeland

The *2012 South Dakota-DENR Integrated Report for Surface Water Quality Assessment* for the Lower Missouri River reported that mercury, high pH, *Escherichia coli*, and fecal coliform bacteria, Chlorophyll-*a*, and Total Suspended Solids were the identified impairments listed within the LCWIP West River area. The report of water bodies with designated beneficial uses, impairments, and causes of impairments is presented in Table 2-2. The 303(d) listed water bodies are summarized in Table 2-3. Figures 2-6 and 2-7 show the locations of the reaches for the identified water bodies in the Lower Missouri River Basin.

2.6.0 Description of the Impairments for 303(d) Water Body Listings in the Lewis & Clark Watershed Project

2.6.1 Chlorophyll-a

Chlorophyll-*a* is the primary photosynthetic pigment found in oxygen producing plants and blue-green algae. The measurement of Chlorophyll-*a* is an indirect indicator of the nutrient levels in a lake, the lake's productivity, and its state of eutrophication. Waters that have high chlorophyll conditions are typically high in nutrients, generally phosphorus and nitrogen. These two nutrients cause the algae to grow or bloom. High levels of nitrogen and phosphorus are indicators of pollution from man-made sources, such as animal wastes, septic system leakage, poorly functioning wastewater treatment plants, soil erosion, or fertilizer runoff. Chlorophyll measurement is utilized as an indirect indicator of these nutrient levels.

Nitrogen is difficult to limit in aquatic environments because of its highly soluble nature. Due to the many environmental sources of nitrogen (atmospheric, soil, fertilizer, and fecal matter), nitrogen is difficult to remove from a water system. Blue green algae can also convert nitrogen for their own growth making it even more difficult to control. For these reasons, the focus on nutrient reduction is usually on phosphorous instead of nitrogen.

Table 2-2. Lewis & Clark Watershed Water Bodies: Beneficial Uses, Listed as 303(d) Impaired, Source of Impairment, and Priority. (Data from "*The 2012 SD Integrated Report for Surface Water Quality Assessment*".)

WATERBODY AUID	LOCATION	MAP ID	BASIS	USE	SUPPORT	CAUSE	SOURCE	EPA CATEGORY	303(d) Priority
Roosevelt Lake	Tripp	L19	DENR	Fish/Wildlife Prop, Rec, Stock	FULL-TH	Mercury Fish Tissue		5	YES-1
SD-MI-L-Roosevelt_01	County			Immersion Recreation	FULL				
				Limited Contact Recreation	FULL				
				Warmwater Permanent Fish Life	FULL				
Ponca Creek	SD/NE Border	R16	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			4A*	NO
SD-MI-R-Ponca_01	to US Hwy 183		USACE	Irrigation Waters	FULL				
	Near Colome			Limited Contact Recreation	FULL-TH	Fecal Coliform	Livestock		
				Warmwater Semipermanent Fish Life	FULL-TH	Total Suspended Solids			
Rahn Lake	Tripp County	L1	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			5	Yes-2
SD-NI-RAHN_01				Immersion Recreation	NON	Chlorophyll-a	Unknown		
				Limited Contact Recreation	NON	Chlorophyll-a			
				Warmwater Permanent Fish Life	NON	Chlorophyll-a			
Antelope Creek	Near Mission,	R1	USGS	Fish/Wildlife Prop, Rec, Stock				2	NO
SD-NI-R-ANTELOPE_04	SD			Irrigation Waters					
USGS				Limited Contact Recreation	NA				
				Warmwater Semipermanent Fish Life					
Keya Paha River	SD/NE Border	R2	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			4A*	No
SD-NI-R-KEYA_PAHA_01	to confluence		USGS	Irrigation Waters	FULL				
	with Antelope			Limited Contact Recreation	FULL-TH	Escherichia coli	Livestock		
	Creek					Fecal Coliform			
				Warmwater Semipermanent Fish Life	FULL-TH	Total Suspended Solids	Natural		
Sand Creek	Near Olsonville,	R3	USGS	Fish/Wildlife Prop, Rec, Stock	INS			3	No
SD-NI-R-SAND_01_USGS	SD			Irrigation Waters	INS				

Category (1) All uses met, (2) Some uses met but insufficient data to determine support of other uses, (3) Insufficient data, (4a) Water impaired but has an approved TMDL, (5) Water impaired requires a TMDL. *Waterbody has an EPA approved TMDL. ^EPA added cause. D** TMDL development deferred to EPA.
FULL-TH means the water body meets water quality standards, however was previously listed as threatened. The threatened flag may be used when waterbody support is borderline, trends toward nonsupport, or a decision based on best professional judgment.

Table 2-3: Summary of Lewis & Clark Watershed Water bodies Listed as 303(d) Impaired, Beneficial Use Impaired, and Cause, SDDENR-IR 2012.

Water Body Impaired	Beneficial Use Impaired	Listed Cause of Impairment
Roosevelt Lake	Fish/Wildlife Prop, Rec, Stock	Mercury in Fish Tissue
Ponca Creek	Limited Contact Recreation	Fecal Coliform
Rahn Lake	Immersion Recreation	Chlorophyll-a
	Limited Contact Recreation	Chlorophyll-a
	Warmwater Permanent Fish Life	Chlorophyll-a
Keya Paha River	Limited Contact Recreation	Escherichia coli
		Fecal Coliform
	Warmwater Semipermanent Fish Life	Total Suspended Solids

Phosphorus is easier to control in the environment, making it the primary nutrient targeted for reduction when attempting to control lake eutrophication. The large algal blooms in studied lakes typically coincided with large phosphorus concentrations. Chlorophyll levels significantly increase due to algae blooms that occur during periods of higher water temperature. Levels may also increase due to the stratification of the water column (Rose Hill Lake/Sand Creek, SDDENR 2002), which may cause anoxic conditions in the hypolimnion. The anoxia is accompanied by low pH values and results in the release of nutrients, particularly phosphorus, from the bottom sediments. This release of total nitrogen, total phosphorous and total dissolved phosphorous concentration can result in the algal blooms that persist throughout the summer.

When algae populations bloom and then die in response to changing environmental conditions, they deplete the DO level which is a primary cause of most fish kills. Methods to eliminate the existing nutrients by artificial oxygenation of lake bottoms could result in fewer and less intense algal blooms. However, little data exists on circulators, oxygenators, and other types of equipment that eliminate stratification of the water column and the affect they will have on the frequency or intensity of nuisance algal blooms. The reduction of nutrient inputs, primarily phosphorous, into the waterbodies would be the preferred method to prevent algal blooms, reduce Chlorophyll-*a* concentrations, and meet 303(d) impairment standards.

Scientists from the U.S. Geological Survey (USGS 2010), studying the effects of harmful algal blooms on lake water quality, found that blooms of blue-green algae (cyanobacteria) in Midwestern lakes also produced mixtures of cyanotoxins and taste-and-odor causing compounds. Cyanotoxins can be toxic to mammals, including humans, causing allergic and/or respiratory issues, attacking the liver and kidneys, or affecting the nervous system. The findings of this study were significant because studies assessing toxicity and risk of cyanotoxin exposure have historically focused on only one class of toxins (microcystins). The World Health Organization has established the highest risk threshold for human exposure to cyanotoxins at >50 milligram per Liter (mg/L); with the range of 10-50 mg/L considered as a moderate exposure risk. After examining various thresholds, Region 8 of the U.S. EPA set a maximum threshold average of 30 mg/L during the growing season of May 1 to September 30 as the 303(d) listing criteria.

Figure 2-6. Nibobrara River Basin 303d

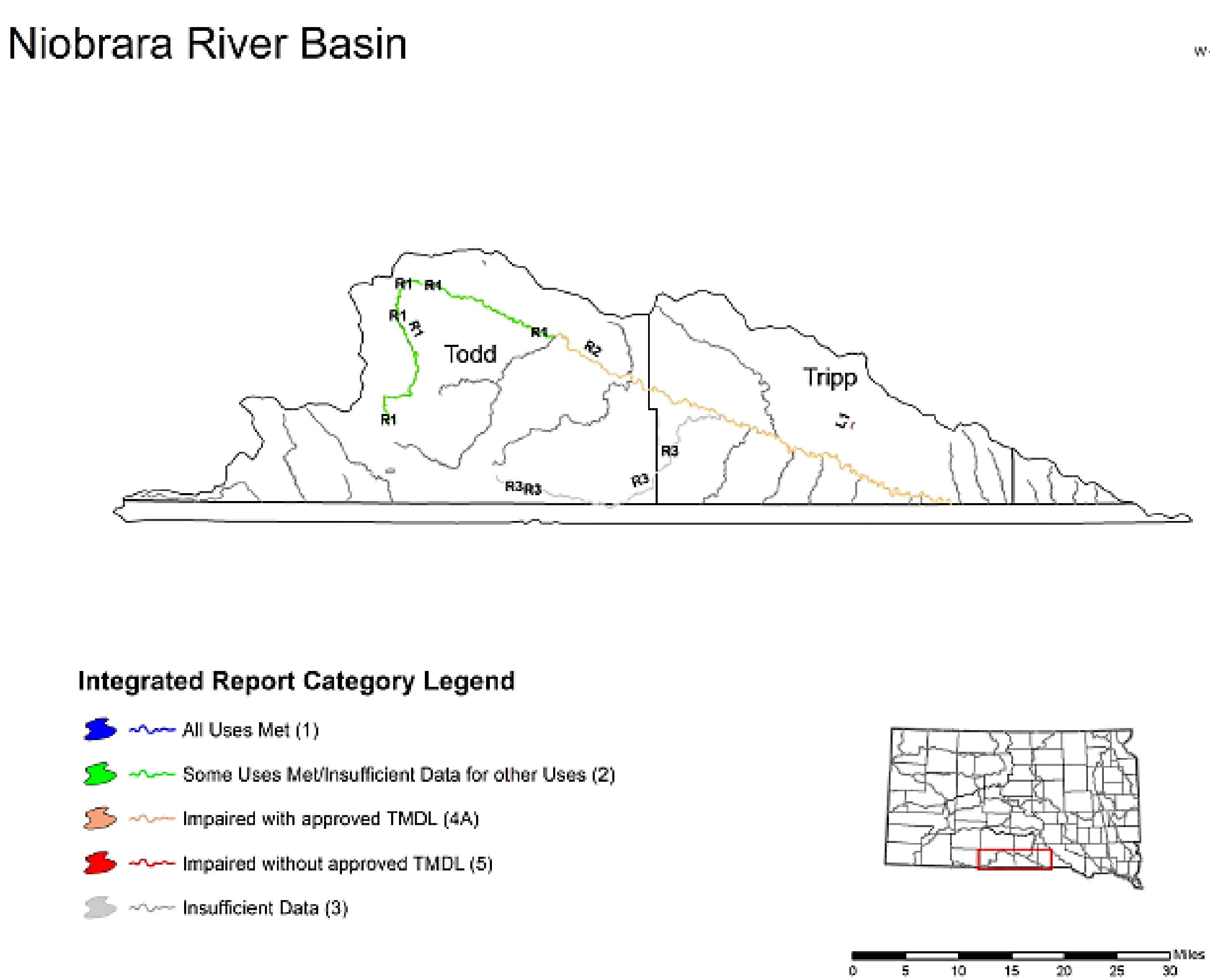
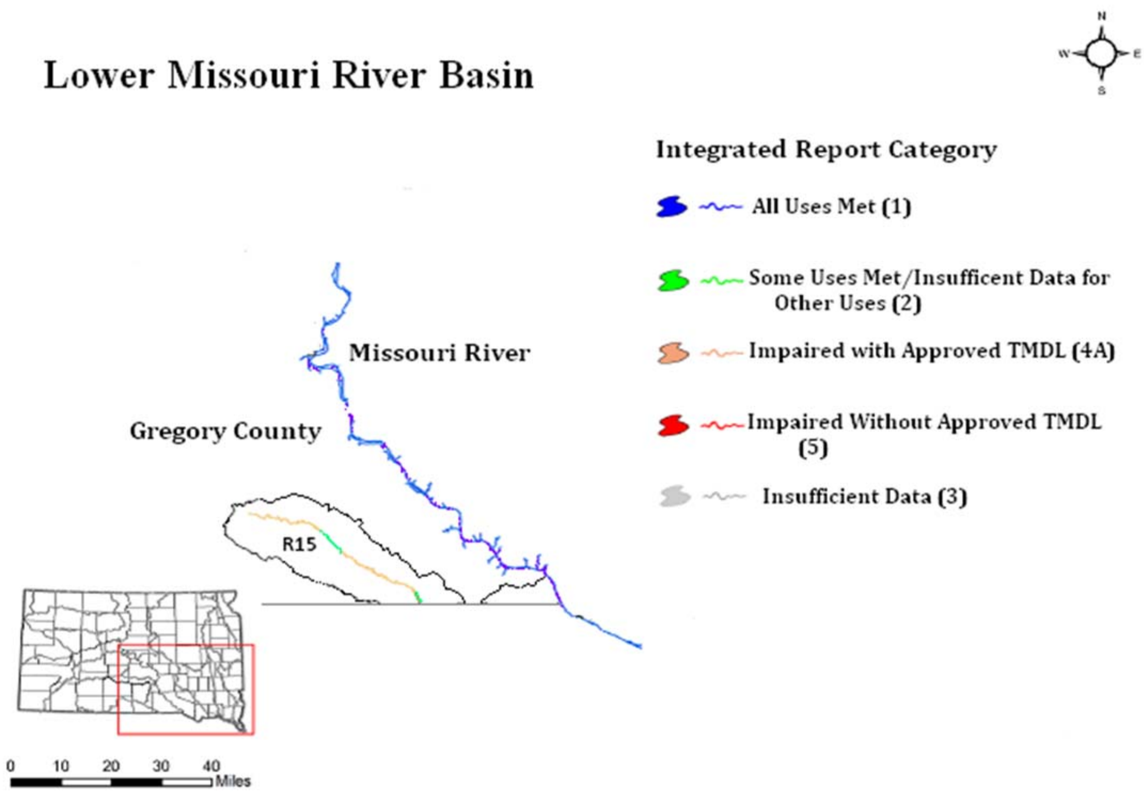


Figure 2-7. Ponca Creek, R15, Lower Missouri River Basin



2.6.2 *Escherichia coli* and Fecal Coliform

Fecal coliform are bacteria that are found in the waste of warm-blooded animals. Common types of bacteria associated with livestock, wildlife, and human feces are *Escherichia coli*, Salmonella, and Streptococcus. These fecal indicators are microbes whose presence indicates that the water is contaminated with human or animal wastes. Fecal coliform, enterococci, and *E. coli* bacteria are not usually disease-causing agents themselves; however, high concentrations may suggest the presence of disease-causing organisms.

Of the coliforms, *E. coli* is generally the most sensitive to environmental stresses and rarely grows outside the human or animal gut. *E. coli* bacteria are normally excreted by the billions in animal wastes and their survival time in the environment generally lasts only four to twelve weeks. The inability of *E. coli* to grow in water, combined with its short survival time in water environments, means that the detection of *E. coli* in a water body is a good indicator that fecal contamination from sewage or animal waste recently entered the system. Thus, *E. coli* is used to indicate the probability of finding other pathogenic organisms in a stream. The pathogenic microbes in these wastes can cause short-term health effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They also pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems. Sources of fecal contamination to surface waters include wastewater treatment plants, on-site septic systems, domestic and wild animal manure, and storm runoff. The presence of elevated levels of fecal bacteria can also cause cloudy water, unpleasant odors, and an increased oxygen demand.

2.6.3 Total Suspended Solids (TSS)

Solids present in water are addressed separately as total solids, dissolved solids, suspended solids, and volatile suspended solids. The TSS are the sum of all forms of material including suspended and dissolved solids that will not pass through a filter. The TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life by blocking light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis causes less DO to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and die. Bacteria uses up additional oxygen from the water as the plants decompose resulting in lower DO and can lead to fish kills. High TSS can also cause an increase in surface water temperature because the suspended particles absorb heat from sunlight. This can cause DO levels to fall even further as warmer waters hold less DO.

The decrease in water clarity caused by TSS can affect the ability of fish to see and catch food. Suspended sediment can also clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. When suspended solids settle to the bottom of a waterbody, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. Settling sediments can fill in spaces between rocks which could have been used by aquatic organisms. High TSS in a waterbody can mean high concentrations of bacteria, nutrients, pesticides, and metals in the water. These pollutants attach to sediment particles on the land, are carried into waterbodies with storm events, and are then released from the sediment or travel farther downstream.

2.6.4 Mercury

Mercury is a hazardous chemical that occurs naturally in the environment and is used in industrial applications. Exposure to mercury, even in small amounts, is a great danger to humans and wildlife acting as a neurotoxin interfering with the brain and nervous system. Mercury exposure is especially dangerous to pregnant women and young children. Frequent exposure during childhood can damage the central nervous system and affect neurological functions with possible effects on learning, muscle development, motor function, and attention. In adults, high levels of mercury. Mercury poisoning in adults can harm the kidneys and brain and increase the risk of cardiovascular disease. It can also adversely affect fertility, blood pressure regulation, cause memory and vision loss, cause tremors, and numbness of the fingers and toes.

In lakes and other bodies of freshwater, bacteria converts naturally occurring inorganic mercury into its organic form, methyl mercury. Methyl mercury binds with particles and sediments eaten by smaller fish. Larger game fish prey on these smaller, mercury contaminated fish. Because fish eliminate mercury at a very slow rate, it accumulates in their tissues and organs where it cannot be removed by filleting or cooking, unlike organic contaminants that concentrate in the skin and fat. From the bacterial level, each step-up of consumption in the food chain leads to higher concentrations of the methyl mercury, a process called "bio-magnification."
The mercury contamination is strongly linked to atmospheric pollution from coal-fired power plants. However, the natural cycle of wet and dry periods incorporated the mercury into South Dakota lakes (Stone et al. 2011). When the flooding from above average rainfall years occurred, it killed the grass and vegetation; the mercury that was bound to the plants was dissolved in the water and reincorporated into the aquatic food web (Selch 2008, Chipps 2009). Some South Dakota lakes with elevated mercury concentrations also did not have very good natural reproduction in walleyes and perch. There was a steep decline in fertilization success as mercury concentrations increased. Laboratory experiments (Hayer et al. 2011) have shown that high levels of mercury in water reduced the fertilization success of fish eggs, thus having a negative effect on fish reproduction.

2.7.0 Defining the Sources of Impairments for 303(d) Listed Water Bodies

The general sources of impairment have been listed in the 2012 South Dakota Integrated Report for Surface Water Quality Assessment , see Table 2-3, page 32; however, further identification of the physical sources is required for the land application of Best Management Practices (BMPs) to be successful. The implementation of BMPs that address the impairments of the listed water bodies would more specifically solve the water quality issues. Investigations of both point and nonpoint sources were completed within portions of the Lewis & Clark Watershed project watershed by SDDENR to identify the main sources of these impairments.

2.7.1 Point Sources of Impairment

Point sources of pollutants were investigated for Ponca Creek and the Keya Paha River as both water bodies were listed as 303(d) impaired for Fecal Coliform and/or *E. coli* in the 2012 SD DENR Integrated Report. The cities of Colome and Gregory were two permitted facilities in the Ponca Creek watershed (SDDENR 2010). Their wastewater treatment systems are comprised of retention pond systems that periodically may require a portion of the final pond to be discharged. The normal operation of these systems would typically result in only a portion of the calculated daily amounts actually being discharged and all discharges are required to meet the chronic water quality threshold for Ponca Creek. These two systems account for about 1,700 of the approximately 2,900 people in the watershed. Septic systems were assumed to be the primary human source for the rest of the population in the watershed. When included as a total loading, the remaining population produced fecals accounting for less than 0.1% of all fecal coliforms produced in the watershed. These bacteria should all be delivered to a septic system, which if functioning correctly would result in no fecal coliforms entering the creek.

There were no municipalities or other identified point sources that discharged to the Keya Paha River watershed (SDDENR 2011). Septic systems were determined to be an insignificant contributing source to the *E. coli* loads in the river based on the following information. The human population of Keya Paha watershed from the 2000 census was estimated at 3,500 people, or 2 people/square mile. When included as a total load, human produced *E. coli* accounted for less than 0.1% of all *E. coli* produced in the watershed. These bacteria should all be delivered to a septic system, which if functioning correctly would result in no *E. coli* entering the river.

The SDDENR Emanuel Creek TMDL (2009), watershed in the LCWIP area east of the Missouri river, document reported no point source discharges to Emanuel Creek and that human septic systems were determined to be an insignificant contributing source to the fecal loads. The conclusions repeated by these and other TMDL watershed studies in South Dakota on potential point sources of loadings did not identify human fecal bacteria as being significant. The municipalities had either (1) zero discharge NPDES permits, (2) discharges that were NPDES permitted and controlled or the discharges were so minor and/or infrequent as to be negligible, and (3) the remaining human produced fecals not delivered to a municipal treatment facility had a minimal impact on total loading**.**

2.7.2 Non Point Sources of Impairment

Non point sources of impairment have not been identified for all designated water bodies in the Lewis and Clark Project area watershed either because the water body met all of its 303(d) designated beneficial uses or because of insufficient water quality data to make a determination. The water body of Roosevelt Lake has met the 303(d) criteria of all its designated beneficial uses, per SD-DENR IR 2012; however, it is listed as on the threshold for mercury in fish tissue and is in a ‘watch-list’ status. The water bodies of Antelope Creek and Sand Creek were reported in the 2012 SD-DENR IR to have insufficient water quality data to ascertain whether they met the supporting criteria of their designated beneficial uses. These water bodies are not listed as having any priority under the 303(d) listing in this report. The future status of these water bodies’ evaluations is unknown.

Water quality studies in the LCWIP area on both the west and east sides of the Missouri River have concluded that agricultural activities were the major nonpoint source of excessive nutrients to the watershed and that all other potential sources were minimal. The following pollutants, as identified by the SDDENR 2012 Integrated Report, are discussed by each listed 303(d) impairment for the described water bodies.

2.7.2.1 Mercury – Roosevelt Lake, L19

Roosevelt Lake is a man-made impoundment located five miles east of Colome in Tripp County. The lake has a surface area of 85 acres and a watershed of 3,200 acres. The average depth is six feet and the maximum depth is eighteen feet. The South Dakota Department of Game, Fish and Parks (SDGF&P) owns approximately 75% of the lakeshore with the remaining 25% under private ownership. There is a boat ramp for water access on the northeast corner of the lake. Approximately 80% of the watershed is pasture and 20% is row crops. The lake maintains a good fishery of largemouth bass, Northern pike, golden shiner, yellow perch, black bullhead, bluegill, green sunfish, and black crappie.

Roosevelt Lake was listed in the SDDENR-IR 2012 as meeting its designated uses of Fish and Wildlife, Immersion and Limited Contact Recreation, and Warmwater Permanent Fish Life. However, the lake was given a Threshold (TH) rating on Fish and Wildlife Propagation, Recreation, and Stocking because of high mercury levels in fish. The SDGF&P issued a human health advisory for the consumption of Northern pike over 24 inches in length and largemouth bass over 18 inches in years 2011 and 2012.

The LWCIP is not able to address the 303(d) listing of mercury for this lake because the pollution is a combination of the above normal precipitation runoff into the lake, pollution from atmospheric deposition of mercury from sources outside the LCWIP area, and bio-magnification of the pollutant via the food web. Agricultural Best Management Practices (BMP) therefore will not be discussed for this pollutant.

2.7.2.2 Fecal Coliform. Ponca Creek, R16; Keya Paha River, R2.

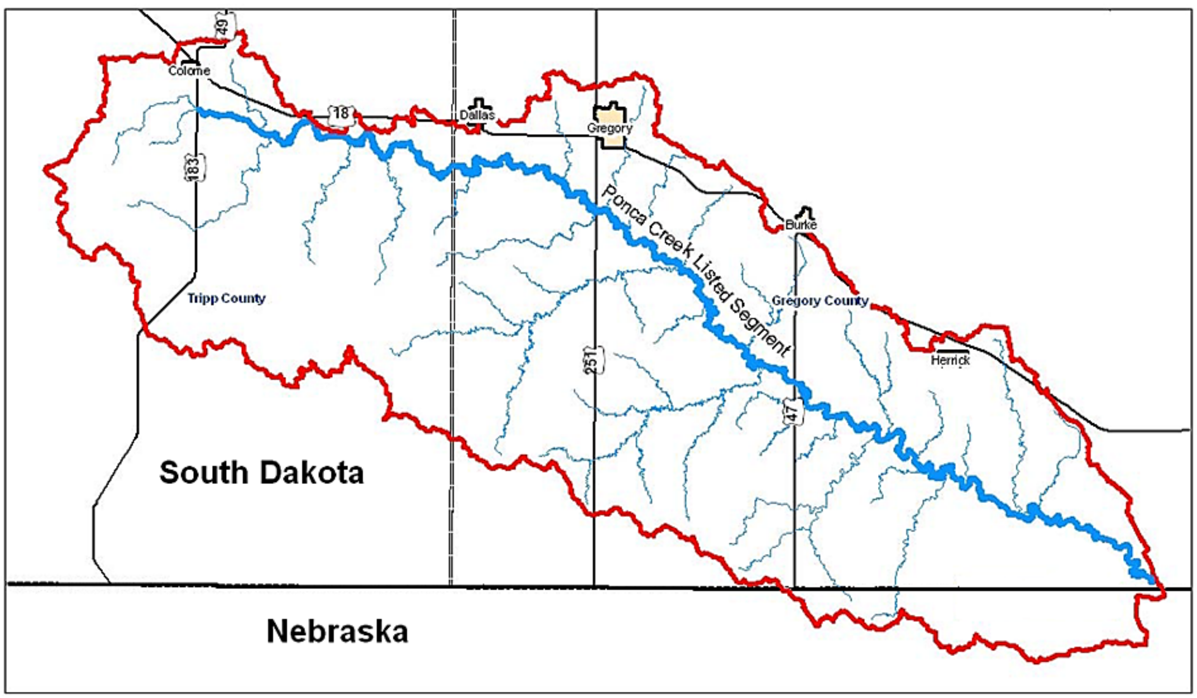
Ponca Creek and the Keya Paha River were listed as 303(d) impaired for Fecal Coliform for the support of Limited Contact Recreation in the 2012 SDDENR-IR. Fecal coliform bacteria are usually not harmful, but they can indicate the presence of other harmful bacteria, viruses and/or parasites that are often linked to food borne illnesses, as well as giardia and cryptosporidium. Recreational contact, especially swimming, is not recommended when high concentrations of fecal coliform bacteria are present.

R16, Ponca Creek:

The listed segment R16 of Ponca Creek drains about 240,000 acres in Tripp and Gregory Counties in south central South Dakota. During the Ponca Creek watershed assessment (SDDENR 2010), it was determined that the creek experiences periods of degraded water quality due to fecal coliform bacteria. The land use in the watershed is predominately agricultural consisting of 78% native rangelands, 8% row crops, 3% small grains, 2% hay ground; with the remaining portions of the watershed composed of 1% water and wetlands, 8% roads and housing, and 1% forested lands. Figure 2-8 shows the listed segment of Ponca Creek.

Water quality samples from Ponca Creek were collected during the years 1976 to 2009. The purpose of the study was to document sources of point and nonpoint source pollution in the watershed through water quality sampling and stream stage measurements. A total of 26 water samples were available for stream analysis. Ten of the 26 samples were above the chronic standard, while nine of those exceeded the acute standard. The data analysis was completed for Ponca Creek and resulted in Total Daily Maximum Load (TMDL) limits set for the identified impairment (SDDENR 2010).

Figure 2-8. 303(d) Listed Segment of Ponca Creek.



Nonpoint sources of fecal coliform bacteria in Ponca Creek were determined to come primarily from agricultural sources (SDDENR 2010). Livestock contributed fecal coliform bacteria directly to the stream by defecating while wading in the stream. They also can contribute by defecating while grazing on rangelands that get washed off during precipitation events. Table 2-4 allocates the sources for bacteria production in the watershed into three primary categories; feedlots, cattle on grass, and wildlife.

Evidence of the bacteria source was in the load duration curve data, which showed that elevated coliform counts occurred throughout different stream flow regimes. All five water samples in the low flow regime exceeded both the chronic and acute standards. Sources of bacteria in this low flow regime contained three of the highest fecal coliform concentrations recorded. This indicated that the main source of bacteria came from animals being in direct contact with the stream. Reducing direct access to the stream from livestock during this low flow zone should reduce the amount of fecal coliform bacteria in Ponca Creek.

It was determined a 15% reduction in fecal coliform bacteria from livestock sources would be required in the high flow zone of Ponca Creek to fully attain the current water quality standards; the same concentration as the chronic standard. An 11% reduction in fecal coliform bacteria was required in the midrange flow zone to fully attain current water quality standards and a 95% reduction would be required in the low flow zone to fully attain current water quality standards. The remaining flow regimes did not require reductions to maintain support of the standards.

Table 2-4 Fecal Source Allocation for Ponca Creek

Bacterial Source Allocations for Ponca Creek	
Sources	**Percent**
Feedlots	**9.1**
Livestock on Grass	**90.5**
Wildlife	**0.4**

R2, Keya Paha River:

The Keya Paha River drains approximately 1,092,300 acres in South Central South Dakota and discharges to the Niobrara River in Nebraska. The river receives runoff from agricultural operations and experiences periods of degraded water quality due to fecal coliform bacteria concentrations. Consequently, the river was listed in the SDDENR IR 2012 as 303(d) impaired for Fecal Coliform Bacteria. The land use in the watershed is predominately agricultural consisting of cropland (42%) and grazing (57%), with the remaining 1% of the watershed composed of water and wetlands, roads and housing, and forested lands. The contributing drainage area is composed of 50% Tripp County lands, and 33% Todd County lands.
Fecal coliform bacteria sampling exceeded the acute standard on nine of the 123 water samples collected (SDDENR 2009). The violations did not appear to be storm event driven as elevated and excessive concentrations were measured at a variety of flows. Similarly, when the data were examined for seasonal patterns, elevated concentrations were found throughout the growing season. Sixteen percent of the samples were above the chronic standard of 1000 colonies/ 100mL. Table 2-5 allocates 98.6% of the sources for bacteria production in the watershed into three primary categories. The similarity between the dry and low flow regimes, along with only

two instances of acute exceedance and no samples between the acute and chronic thresholds further supported the theory that the primary source is grazing livestock.

Table 2-5. Fecal Coliform and *E. coli* Source Allocations for Keya Paha River

Bacterial Source Allocations for Keya Paha River		
Sources	**Percent**	
Feedlots	**33.1**	
Livestock on Grass	**64.3**	
Wildlife	**1.2**	

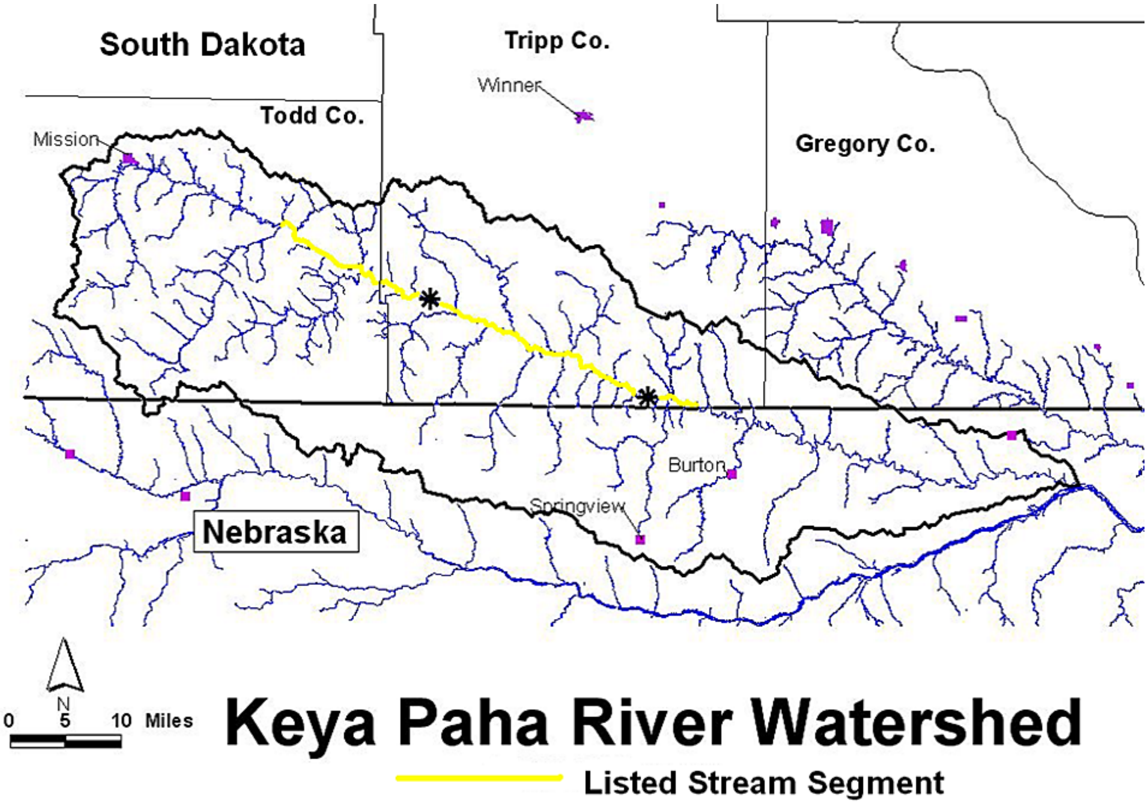
Animal feeding operations were present within the watershed. Tripp County has an estimated 140,000 (numbers from 2009 TMDL) head of cattle. Permitted animal feeding operations have the potential of holding 40,000 animals. The permitted zero discharge facilities account for the majority of the animals allocated to the feedlots in Table 2-5. It was possible that some smaller operations contributed to the bacteria counts measured in the river; however, it was more likely that livestock utilizing the stream were the primary source of bacteria.
The 2009 SDDENR TMDL study determined the percent of nonpoint source fecal coliform bacteria load reductions needed from livestock to reach the targeted goals. The Load Reductions needed were 41% in both the High Flow and the Moist Flow regime and 44% in the Mid-Range Flow regime. The remaining Dry Conditions and Low Flow regimes did not require reductions to maintain support of the standards. Attaining these load reduction percentages would provide assurance that the stream would meet both the chronic and acute standards at all times.

2.7.2.3 Keya Paha, R2. *Escherichia coli*

South Dakota has recently adopted *Escherichia coli* criteria for the protection of the limited contact and immersion recreation beneficial use. Because the indicators Fecal Coliform and E. coli are closely related; the fecal coliform bacteria TMDL and associated implementation strategy (described in the SDDENR TMDL 2009 document) were expected to address both the fecal coliform bacteria and possible future *E. coli* impairments. Later it was determined that a TMDL for *E. coli* was required.

The Keya Paha River receives agricultural runoff and also experiences periods of water quality degradation due to *Escherichia coli* bacteria (SDDENR 2011). The river had a TMDL allocation for fecal coliform bacteria in 2009, as previously discussed, with TMDL allocations for *E. coli* established by SDDENR in 2011. Refer to Figure 2-9 for the listed segment of the Keya Paha River. Nonpoint sources of *E. coli* bacteria came primarily from agricultural land use. Table 2-5 allocates the sources for bacteria production in the watershed into three primary categories.

Figure 2-9. Watershed and 303(d) Listed Segments of the Keya Paha River



The TMDL study determined the percent of nonpoint source fecal coliform bacteria load reductions needed from livestock to reach the targeted goals. The High Flow regime needed a load reduction of 64%; the Moist Flow needed a load reduction of 57%; and the Mid-Range Flow regime needed a load reduction of 38%. No load reductions were needed in the Dry Flow and No Flow zones. The Keya Paha River displayed distinct seasonality in terms of *E. coli* concentrations and flow as flow tended to rise in late winter and peak during the spring. *E. coli* concentrations were highest during May and June and declined later on in the summer. Spring and early summer is also a time of peak recreational use of the Keya Paha River. This fact coupled with elevated *E. coli* concentrations make spring and early summer a critical time in which to reduce loading.

2.7.2.4 Keya Paha River, R2. Total Suspended Solids (TSS)

The Keya Paha River watershed was discussed in previous sections reviewing the 303(d) listing for both *E. coli* and fecal coliform bacteria. The river also experiences periods of degraded water quality due to Total Suspended Solids (TSS). The river was listed in the SDDENR IR 2012 as 303(d) impaired for TSS. Analytical results from total suspended solids sampling (SDDENR 2009) suggested that the acute standard of 158 mg/L is exceeded approximately 15% of the time and the chronic standard of 90 mg/L approximately 30% of the time. The violations appeared to be storm event driven with the highest concentrations occurring during high flow periods. There were no municipalities or other point sources that discharged to the river; therefore all of the loads were nonpoint source in nature. The primary sources of sediments considered within the Keya Paha watershed were predicted sheet and rill erosion loads, the potential for bank failure based on the RGA assessment, and the natural soil conditions of both the listed segment as well as upstream contributions.

AnnAGNPs modeling was completed on 32 individual sub watersheds of the Keya Paha River. AnnAGNPs analysis of the subwatersheds in the Keya Paha basin indicated low rates of sediment production for a majority of the basin when compared to the greater Lewis and Clark drainage, see Table 2-6.

Table 2-6. Sediment Production Rate Comparison with other Lewis & Clark Drainages

Sediment Production Rate Comparison of Lewis & Clark Drainages			
Tributary	**Acres Drainage**	**Sediment - Tons**	**Tons/Acre**
Ponca Creek	**324,287**	**372,542**	**1.15**
Keya Paha River	**629,121**	**180,005**	**0.28**
Niobrara River	**2,386,284**	**144,809**	**0.06**
East River Area	**592,444**	**589,553**	**1.01**
Santee Area NE	**311,287**	**1,208,402**	**3.88**

Figure 2-10 depicts a relative ranking showing the Keya Paha River subwatersheds that the model suggested were producing higher erosion rates as compared against other drainages within the Keya Paha drainage. These areas are represented by darker shading. Sheet and rill erosion from the Keya Paha watershed was predicted by the AnnAGNPS model to be less than many of the other watersheds in the Lewis and Clark basin. There were several factors contributing to this, but the primary reason suspected was the high percentage of native range, in particular in locations that may be more erosion prone.

Rapid Geomorphic Assessments (RGAs) were also completed at 23 sites within the Keya Paha basin. Figure 2-11 depicts the areas where RGAs were completed with the AnnAGNPS results shaded. The results were broken into stable and unstable stream channels with approximately 12% of the sites ranked as unstable. The three unstable sites were located on tributaries. The RGA analysis indicated a relatively stable channel; however, aggravated banks on the outsides of the meanders in the floodplain indicated that the river has moved frequently over time. The primary soils through the stream corridor consist of the Invale Cass associations. These soils are characterized by loamy fine sands overlying fine to medium sands and are typically noncohesive and are more prone to failures; which was evident in the frequency of meander scars. Particle size data collected by the USGS was insufficient to conduct analysis, but it does suggest that the high sand content in the streams bed and banks mobilizes during higher velocity events.

The load reductions needed to reach the targeted total suspended solids concentration of less than 90 mg/L were calculated through the Aquarius program. They were attributed to the nonpoint sources and determined for each of the stream flow regimes. In the High Flow regime, an 86% reduction in suspended solids from all sources was necessary; this regime was characterized by the most frequent rate of standard exceedance. BMPs would have limited impact on events that occur in the High Flow regime. The Moist Flow regime required a 50% reduction and the Mid-Range regime required a 30% reduction in total suspended solids loads. The remaining flow regimes did not require reductions to maintain support of the standards.

Examination of the upstream and downstream concentrations and loads indicated that erosion rates are consistent throughout the entire basin, suggesting no particular source is generating excessive loads. BMPs may be able to improve the condition of several of the tributaries, particularly those that scored poorly in the RGAs. The modeling strongly suggested that the majority of the suspended solids were originating from the bed and banks and was not attributed to upland practices and erosion processes. This information taken in aggregate suggests that the concentrations measured in the Keya Paha River were natural occurrences and that the current state standard may not be an appropriate measure for this stream. Site specific BMPs may yield some reductions; however, the concentrations appear to be a natural condition for this river. This suggested a reevaluation of the water quality standards for the Keya Paha River may be needed.

Figure 2-10. Erosion Rates in the Keya Paha River Watershed

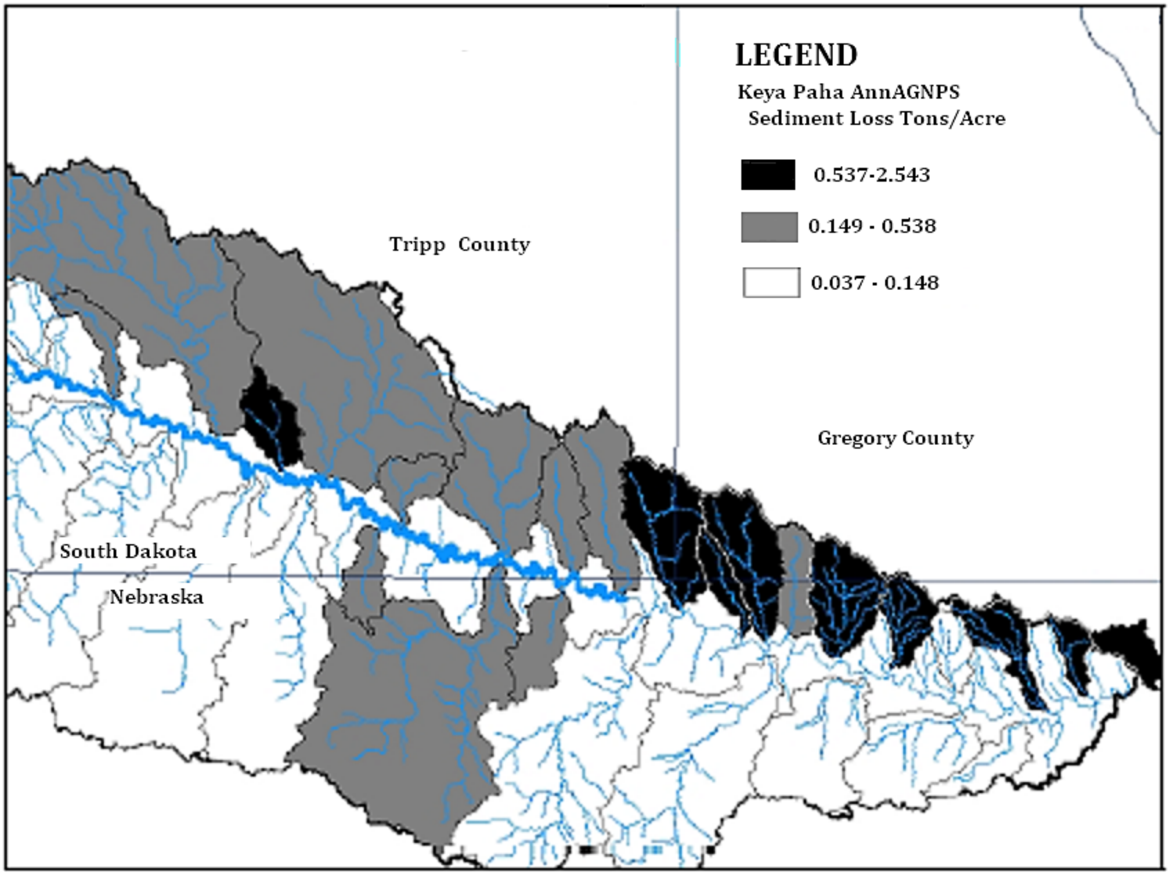
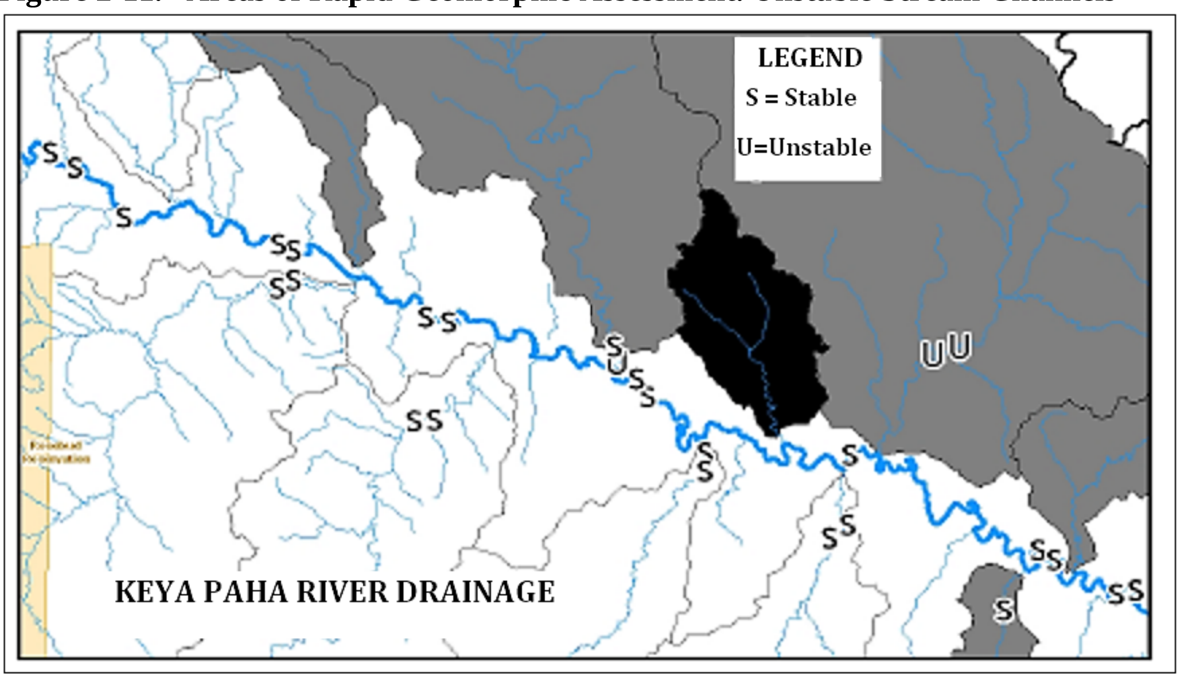


Figure 2-11. Areas of Rapid Geomorphic Assessment. Unstable Stream Channels



2.7.2.5 Rahn Lake, L1. Chlorophyll-*a*

Rahn Lake is a man-made reservoir located in Tripp County located 19 miles south and west of Winner. The lake has a surface area of 13.6 acres with a 19,840 acre watershed. The mean depth is 6.3 feet with a maximum depth of 16 feet. The SDGF&P owns approximately 50% of the adjacent lands with the remaining land as privately owned. Land use in the watershed is approximately 50% haying and grazing, 30% cultivated, and 20% in shelterbelts, roads, and farmsteads. There is a boat ramp on the southwest corner of the lake for lake access. Shoreline fishing access to the lake is provided by a public road that exists all along the west side of the lake. Fishing from the shoreline was severely hindered due to vegetation during the summer months. The 2002 South Dakota Statewide Fisheries Survey found the shallow areas, especially the upper portion of the lake, were nearly choked with submergent vegetation and excessive amounts of filamentous algae was found throughout the lake.

Rahn Lake was sampled in 2000 and found to be hyper eutrophic due to nutrient enrichment and siltation. The SDDENR Integrated Reports for the years 1998 through 2008 listed the causes of this hyper eutrophic state as agricultural activities in the watershed. SDDENR maintains one water quality monitoring site downstream of Rahn Lake on the Keya Paha River. The USGS also had water quality monitoring sites within this basin located on Antelope Creek and Sand Creek. During the SDDENR-IR 2010 reporting cycle, EPA added Rahn Dam to the 303(d) list for not supporting the designated warm water fish life and recreation beneficial uses due to chlorophyll-*a*. This listing was based strictly on criteria developed by EPA to address narrative standards associated with eutrophication. EPA's methodology and justification for this listing was defined in the 2010 Integrated Report as follows.

The EPA had selected a water quality threshold value of 30 mg/L (milligrams/liter) chlorophyll-*a* based on thresholds associated with recreational use impacts, expected nuisance algal blooms, and user perception survey results (SDDENR-IR 2010). Literature based values for chlorophyll-*a* concentrations were associated with reference lakes in the Northern Great Plains and Northern Glaciated Plains. The Minnesota Pollution Control Agency conducted extensive studies in the Northern Glaciated Plains comparing reference values observed in water bodies to user perception information, trophic status information, and fishery considerations. Based on their data, Minnesota adopted an assessment threshold for chlorophyll-*a* of 32 mg/L in this ecoregion; this same ecoregion that extends into South Dakota. EPA's National Lake Survey used a chlorophyll-*a* value of 30 mg/L in defining hyper eutrophic conditions; the threshold which indicates a change in aesthetics, recreational use support, and changes to the fish community composition. After examination of the various thresholds and approaches, the Region 8 US-EPA selected the threshold of 30 mg/L of chlorophyll-*a* as a growing season average from May 1 to September 30 or an exceedance frequency that exceeds this concentration 25% of the time during this period.

Although intensive watershed analysis was not conducted on Rahn Lake, the high levels of chlorophyll-*a* are indicators of pollution from man-made sources and are used as an indirect indicator of nitrogen and phosphorous levels.

3.0 NONPOINT SOURCE MANAGEMENT MEASURES

The management measures needed to address the causes and sources of pollution impairments are strongly interrelated. The nonpoint impairments have been identified as agricultural activities linked to livestock feeding operations, nutrients from livestock manure, direct use of water bodies by livestock, and soil erosion from both adjacent cropland and pasture. Practice effectiveness will overlap in many instances and these nonpoint measures will result in load reductions that affect several sources. Load reduction predictions from other studies are presented in Table 3-1. The Nonpoint Source Measures will be described and referenced to Best Management Practices (BMPs) as defined by the Natural Resources Conservation Service (NRCS), USDA; however, any related NRCS practices may be added to supplement these identified BMPs.

Table 3-1. Estimated BMP Reduction Efficiencies by Pollutant Type Evan et al. 2003/2008.

BMP SYSTEM/TYPE	NRCS PRACTICE	NITROGEN	PHOSPHOROUS	SEDIMENT	FECAL
Crop Residue Manage	329 & 345	50%	38%	64%	-
Vegetated Buffer	390	54%	52%	58%	70%
Grazing Land Manage	528	43%	34%	13%	-
Streambank Protect	580	65%	78%	76%	-
Nutrient Manage Plan	590	70%	28%	-	-
Grassed Waterways	428	54%	52%	58%	-
Constructed Ponds/Wetlands	378 & 657	88%	53%	51%	71%
Waste Storage Facility	313	75%	75%	-	75%

A thorough evaluation of the effects of conservation practices on cultivated cropland from 2003 to 2006 in the Missouri River Basin was completed by USDA-NRCS in 2012 via the Conservation Effects Assessment Project (CEAP). See Figure 3-1 for the watersheds covered in the study. The original goals of CEAP were to estimate conservation benefits for reporting at the national and regional levels and to establish the scientific understanding of the effects and benefits of conservation practices at the watershed scale. The scope was expanded as CEAP evolved to provide research and assessment on how to best use conservation practices in managing agricultural landscapes to protect and enhance environmental quality. The studied subregions included in the LCWIP west of the Missouri River are the Niobrara River Basin (code 1015) and the Missouri-Big Sioux-Lewis-Clark Lake (code 1017). The Subregion code 1017 does include a small fraction of lands on the west side of the Missouri River. Lands west of the river generally contain mostly rangeland, while project lands east of the river contain mostly cultivated cropland. The Niobrara Basin west of the Missouri River has 77.9% grazing lands and 14.5% cropland; while the Lewis and Clark drainage, east of the Missouri River, has approximately 68.6% of the watershed in cultivated cropland and 13.4% in grazing lands. This is almost a reversal in the percentages contributed to the two respective land uses.

The CEAP study used the computer model HUMUS/SWAT to evaluate the transport of water, sediment, pesticides, and nutrients from the land to receiving streams and route the flow downstream to the next watershed and ultimately to estuaries and oceans. Conservation practices in use on cultivated cropland in 2003-06, including land in long-term conserving cover, have reduced sediment, nutrient, and atrazine loads delivered to rivers and streams from cultivated cropland sources per year, on average, by; 76 percent for sediment, 54 percent for nitrogen, 60 percent for phosphorus, and 36 percent for atrazine.

Figure 3-1. Subregions Studied in the Missouri River Basin, CEAP, NRCS 2012

A Field-Level Cropland Model called APEX was used to simulate the effects of conservation practices at the field level. Computer model simulations show that adoption of additional erosion control and nutrient management practices on the 15.3 million under-treated acres would further reduce field losses in the region by;

- 37 percent for sediment loss due to water erosion,
- 24 percent for nitrogen lost with surface runoff,
- 12 percent for nitrogen loss in subsurface flows,
- 20 percent for phosphorus lost to surface water (sediment-attached and soluble), and
- 22 percent for wind erosion.

The implementation of conservation practices implemented on cropland would benefit cropland acres. However, the impact would be less in the LCWIP west of the Missouri River as compared to east of the river because of the almost reversal of cropland percentages.

3.1 Animal Waste Management System. NRCS Practice Code 313, Waste Storage Facility

A Waste Storage Facility (313) is part of an Animal Waste Management Systems (AWMS) and is designed for the full containment of animal wastes by the proper handling, storage, and utilization of wastes generated from animal confinement operations. The waste storage facility should reduce any discharge of animal wastes into the waters of the State. Therefore, the potential nutrient reduction in loading should be significant. Wastes would only be applied, through a Nutrient Management Plan (NMP), when growing crops can use the accompanying nutrients and soil and weather conditions are appropriate.

There are approximately 250 animal feeding operations (AFOs) in the West River portion of the LCWIP. Field staff estimated 60 AFO's may require the constructions of animal waste management systems with an accompanying nutrient management plan to reduce the fecal load. Knippling reported (2009 Segment 1) that with the construction of 19 AWMS nitrogen was reduced by 126,148 pounds per year and phosphorous by 27,337 pounds per year. An additional 12 AWMS were completed under LCWIP Segment 2 that further reduced nitrogen by 138,160 pounds per year and phosphorous by 30,687 pounds per year.

The Emanuel Creek TMDL (SDDENR 2009), a subwatershed in the LCWIP, reported that 41.9% of the fecal source allocation was from cattle in feedlots. Other South Dakota studies identified below have found that AWMS's were very effective in eliminating nutrient loading as the source of the nutrients are contained in a closed system:

- The adjacent Lower James River watershed indicated that the most likely sources of the nutrient loading and fecal coliform bacteria were AFOs/CAFOs and intense season long grazing (SDDENR James River, Yankton 2011). The analysis of Firesteel Creek found that if all 116 animal feeding areas with an AGNPS non-corrected rating over 30 were treated, the soluble phosphorus concentrations delivered to Lake Mitchell would be reduced by approximately 51% which would reduce in-lake phosphorus by 17 percent (SDDENR, Firesteel Creek 1997; Kringen 2010).

- Study results in the Upper Minnesota River watershed indicated that the most likely sources of the nutrient loading and bacterial contamination were animal feeding operations and cattle grazing adjacent to water bodies. The analysis in Blue Dog Lake (SDDENR 1999) found that if the animal feeding areas, with an AGNPS rating over 55 were treated, the phosphorus load would be reduced by 17 percent and the nitrogen by 7.5 percent.

- The AGNPS computer modeling in the Clear Lake study (SDDENR 1999) indicated that major nutrient sources were streamside animal feeding operations and runoff from fertilized cropland. Twenty-five animal feeding areas were evaluated as part of the study. Sixteen were found to have an AGNPS rank of 50 or more and 10 had an AGNPS rank of 60 or more on a scale of zero (no impact) to 100 (severe). When the model was run with the ten feeding areas with an AGNPS rating > 60 taken out of the watershed, the dissolved phosphorous load into Clear Lake was reduced by 9.6% reduction and the dissolved nitrogen load was reduced by 10.7%.

3.2 Nutrient Management System. NRCS Practice Code 590

A Nutrient Management Plan (NMP) is a required component of the AWMS. The purpose of an NMP is to utilize manure or organic byproducts and commercial fertilizer as plant nutrient sources and minimize agricultural nonpoint source pollution of surface and ground water resources. A nutrient budget is developed for nitrogen, phosphorus, and potassium that considers all potential sources of nutrients including, but not limited to, animal manure and organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water. This should result in reduced nutrient loading from manure and fertilizers spread on fields as estimated in Table 3-1 of 70% for nitrogen and 28% for phosphorous.

The assessment of conservation practices for the entire Missouri River Basin (NRCS 2012) found the Niobrara River Basin subregion (code 1015) had only one percent of its cropland acres treated with manure. The Missouri-Big Sioux-Lewis-Clark Lake (code 1017) had one of the highest percentages of cropped acres that had manure fertilizer applied for all subregions with 16 percent of the total cropland acres. This area, subregion 1017, however, only represents a small portion of the LCWIP area in the southeast corner of Gregory County. Although the number of cropland acres fertilized with manure in the West River portion of the LCWIP may not be high the treatment of these acres may be significant. As Knippling reported in 2012, the data indicated that high fecal levels were associated with the land application of manure to include both excess application rates and not incorporating manure applied in areas subject to high runoff rates.

3.3 Prescribed Grazing – Riparian Areas. NRCS Practice Code 528

Prescribed Grazing may be applied on all lands where grazing and/or browsing animals are managed. Removal of herbage by the grazing animals will be in accordance with production limitations, plant sensitivities and management goals. Frequency of defoliations and season of grazing is based on the rate of growth and physiological condition of the plants. The duration and intensity of grazing is based on desired plant health and expected productivity of the forage species to meet management objectives. In all cases enough vegetation is left to prevent accelerated soil erosion. Proper grazing management would include practices such as (1) utilizing stocking rates to better manage grass height, (2) grazing riparian pastures timely when ground conditions are not conducive (wet) to excessive bank and shoreline damage, and (2) rotational use of pastures to allow periods of grass rest and recovery.

SDDENR watershed TMDL studies within the West River portion of the LCWIP area that have identified livestock grazing as an additional source of nutrients and fecal bacteria are Ponca Creek (SDDENR 2010) and Keya Paha (SDDENR 2009). The Rahn Lake study data (SDDENR 2011) calculated that for every 50 acres of severely impaired rangeland, the lake would receive an extra pound of phosphorous and 10 pounds of nitrogen. TMDL studies on the East River portion of the LCWIP that also identified livestock as sources were Lake Andes 2010, Geddes Lake 2007, Dante Lake 2006, and Corsica Lake 2005. Other projects in South Dakota that have shown similar results with livestock grazing and access to water bodies, in addition to the animal feeding operations, were the Yellow Bank TMDL (SDDENR 2012), Blue Dog Lake (SDDENR 1999), and the Minnesota Water Pollution Control Agency (2010). Evans etal. (2008), estimated a 34% reduction in phosphorous and a 43% reduction in nitrogen through proper grazing management.

Knippling (2012) reported 34,961 pounds per year reduction in nitrogen, 8,304 pounds per year of phosphorous, and 5,766 tons of sediment on 15,678 acres of grazing land management under the LCWIP Segments 1 and 2. This equates to 2.23 pounds of nitrogen/acre/year, 0.53 pounds of phosphorous/acre/year, and 0.37 tons of soil/acre/year. The Corsica Lake TMDL (SDDENR 2005) calculated phosphorus reductions from rangeland to be 16% for the watershed as a whole and that targeting the 3,840 critical rangeland acres in the watershed would result in a phosphorus reduction of approximately 4%. Kringen reported (Kringen 2010) rotational grazing systems on 14,421 acres to have reduced nitrogen by 2,575 pounds/year, phosphorous by 342.9

pounds/year, and sediment by 151 tons/year; this equates to 0.18 pounds of nitrogen/acre/year, 0.24 pounds of phosphorous/acre/year, and 0.01 tons/acre/year.
Rotational grazing and exclusion of livestock from critical riparian areas (steep slopes adjacent to the lake and stream) also provides benefits that are difficult to simulate in modeling. Phosphorus was reported to be reduced by 0.4 tons/year in the Firesteel Creek 319 Phase I Summary (Kringen 2006) by improved grazing management on 13,000 acres of grassland. The estimated P load reduction used for grazing management systems was 0.06 pounds of phosphorus reduction per acre per year. The application of this practice basin wide would manipulate the intensity, frequency, duration, and season of grazing to: (1) improve water infiltration, (2) maintain or improve riparian and upland area vegetation, (3) protect stream banks from erosion, and (4) manage for deposition of fecal material away from water bodies.

The Lake Andes TMDL (SDDENR 2010) reported that restricting cattle and other livestock access to Lake Andes and its tributaries and establishing buffer zones in the areas immediately adjacent to the lake and tributary streams should result in an appreciable reduction of sediment and nutrient loadings. Management of livestock should include prescribed grazing, constructing fences or other barriers to control concentrated livestock access to riparian areas, livestock crossing structures, and alternative water supply. Other alternatives include seasonal access or rotational grazing to reduce the intensity and duration of access to riparian zones and uplands. Grazing along shoreline could be restricted by fencing the stream corridors off and keeping cattle out of the stream channel area or by limiting grazing to drier periods of the season, like late summer or early fall during low flow periods. Conservation Reserve Program (CRP) vegetative buffer strips could also be enrolled to protect streams and stream banks. Current CRP buffer practices allow up to 120 feet of perennial herbaceous vegetation to be protected from grazing adjacent to intermittent streams to benefit water quality. Other practices along riparian areas would be Stream Bank Restoration and Riparian Forest Buffers.

3.4 Residue & Tillage Management on Cropland. NRCS Practice Code 329

Residue and Tillage Management BMPs applies to all cropland and includes both no-till and tillage methods commonly referred to as mulch tillage; where the soil surface is disturbed by tillage operations. Mulch tillage includes vertical tillage, chiseling, disking, and also includes tillage/planting systems with relatively minimal soil disturbance. No Till or Strip Till applies to limiting the soil disturbing activities to only those necessary to place nutrients, condition residue, and plant crops. Surface residue is left evenly distributed and no full width tillage is implemented.

The NRCS CEAP study (2012) found some acres required additional conservation treatment on only one of the five resource concerns, while other acres required additional treatment for two or more resource concerns. The five resource concerns evaluated for the Missouri River Basin were; (1) sediment loss due to water erosion, (2) nitrogen loss with surface runoff (nitrogen attached to sediment and in solution), (3) nitrogen loss in subsurface flows, (4) phosphorus lost to surface water (phosphorus attached to sediment and in solution, including soluble phosphorus in subsurface lateral flow pathways), and (5) wind erosion.

After accounting for the acres that need treatment for multiple resource concerns, the evaluation of treatment needs for the Missouri River Basin determined the following:

- 1 percent of cropped acres (1.1 million acres) have a 'High Level' of need for additional conservation treatment,
- 17 percent of cropped acres (14.2 million acres) have a 'Moderate Level' of need for additional conservation treatment, and
- 82 percent of cropped acres (68.3 million acres) have a 'Low Level' of need for additional treatment and were considered to be adequately treated.

Land acres that required treatment for two or more resource concerns were considered 'Under-Treated'; these acres were the High and Moderate Levels that needed additional conservation treatments. The Niobrara River Basin subregion (code 1015) was noted as having a disproportionately high percentage of under-treated cropland acres, with 34.0 percent of its subregion acres listed as under-treated. In contrast the Missouri-Big Sioux-Lewis/Clark Lake subregion (code 1017) had a disproportionately low percentage of under-treated cropland acres with only 5.2 percent of its subregion acres listed as under-treated.

Twenty-six subregions were studied in the Missouri River study (NRCS 2012) and analyzed for the amount of nitrogen, phosphorous, and sediment delivered to the rivers and streams. The Lewis & Clark (code 1017) watershed was in the top ten subregions that delivered a combined total of 65% of the nitrogen load; a total of 70% of the phosphorous load, and 62% of the sediment load from cultivated cropland. The Niobrara River Basin total sediment delivery rates were low due to the larger percentage of rangeland and lesser amount of cropland in the subregion. However, the Niobrara River Basin subregion still has need for conservation treatments on cropland as approximately one-third of its cropland acres were listed as under-treated. See Table 3-2 for the percentages and amounts per acre of delivery for the Niobrara, Lewis & Clark, and Fort Randall subregions.

The remaining 82 percent of the cropped acres in the Missouri River Basin that had a 'Low Level' of conservation treatment need were considered to be 'adequately treated'. This is in part due to the relatively lower vulnerability potential for most cropped acres in this region as compared to other regions of the United States. Additional conservation treatment for these acres with a 'low' need for treatment is expected to provide small per-acre reductions in erosion and nutrient losses; requiring a large number of acres to be treated in order to have a significant impact at the subregional and regional levels. The emphasis in the NRCS-CEAP study was to identify and target the lands that needed Moderate and High Levels of conservation treatment needs and concentrate work efforts on these priority areas.

Table 3-2 Nitrogen, Phosphorous, & Sediment Delivery from Cropland Acres of Three Adjacent Subwatersheds. NRCS CEAP Study 2012.

Nitrogen, Phosphorus, and Sediment Delivery by Missouri River Subregion						
	Nitrogen		Phosphorous		Sediment	
Subregion	%	#/Ac/Yr	%	#/Ac/Yr	%	Ton/Ac/Yr
Niobrara River Basin	2	6.24	1	0.15	1	0.09
Code 1015						
Missouri-Big Sioux-Lewis-Clark Lake	8	6.51	7	0.38	5	0.11
Code 1017						
Missouri-White River -Fort Randall Reservoir	2	3.76	2	0.24	3	0.14
Code 1014						
NRCS 2012 Study Average	3.9	5.82	3.9	0.38	3.9	0.17

The Corsica Lake Phase 1 and TMDL study (SDDENR 2005) also targeted priority areas through their analysis with the computer model AnnAGNPS. Targeting identified approximately 12,800 acres or 22.8% of the watershed for BMP implementation. A breakdown of this acreage shows that approximately 70% or 8,960 acres were cropland and 30% or 3,840 acres were rangeland. It was estimated that with a 3% participation by operators in critical cropland areas would result in a 6 % reduction of phosphorous from each 1,200 acres treated.

The Corsica Lake study simulated changing the cropping practices from minimum tillage in the current state to no-till for the corn and soybean acres, which comprised the majority of the cropland within this watershed. Sediment was reduced at the outlet by 46%, emphasizing the importance of conservation tillage to reducing sediment concentration in runoff. Nitrogen and phosphorus concentrations also dropped by 8% and 4% respectively by modeling the no-till practices.

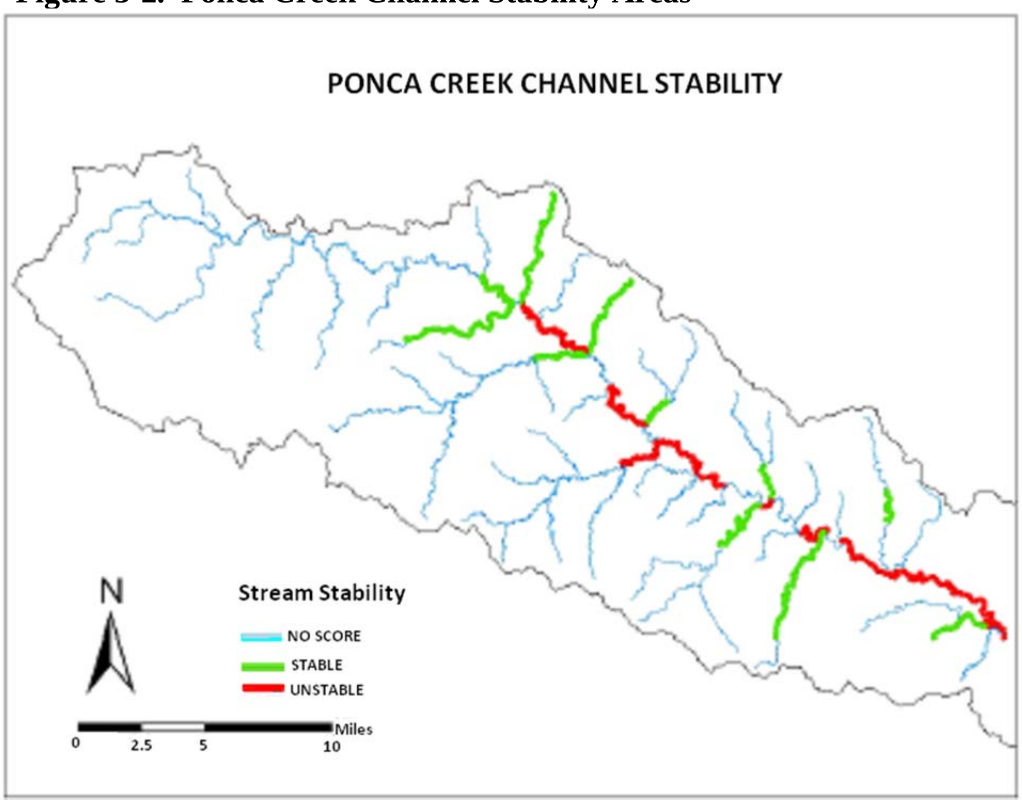
Studies in other areas of South Dakota have utilized the Agricultural Nonpoint Source Model (AGNPS) to evaluate their watersheds and identify "target" areas. The Blue Dog Lake study (SDDENR 1999) found 2.9 % of its acres needed reduced tillage. By implementing no-till cropping practices on these cells, the AGNPS showed an 18% reduction in phosphorus, a 35% reduction in sediment, and an 8% reduction in nitrogen delivered to Blue Dog Lake. The emphasis for the implementation of BMPs should be targeted to cropland identified in the critical AGNPS cells as treatment of these critical acres will yield the most effective load reductions.

3.5 Streambank & Channel Stabilization. NRCS Practice Code 580

Stream bank stabilization is a treatment used to stabilize and protect banks of streams and shoreline of lakes or reservoirs. The purpose is to prevent the loss of land or damage to land use or facilities adjacent to the banks of streams or lakes. Stabilization efforts also reduce the offsite or downstream effects of sediment deposition resulting from bank erosion. The treatment of severely eroded banks usually involves back-sloping with heavy earth moving equipment to a stable grade. The area is then protected with a geotextile fabric and covered with stone rip-rap according to USDA-NRCS standards. This practice is quite costly and is typically used as a last resort to stabilize a bank and protect valuable facilities adjacent to the bank.

Channel stability in Ponca Creek (SDDENR 2010) was identified as a critical component contributing to the suspended solids loadings in the stream. To characterize channel stability in Ponca Creek, 56 Rapid Geomorphic Assessments (RGA's) were conducted. RGA's are a qualitative technique used to quickly identify and compare the evolutionary stage of stream channels. The values obtained were unit-less and were not designed to generate a sediment or nutrient load from the channel. However, they did allow for a comparison between channels of different sizes to identify portions of the stream that may benefit from additional analysis or BMPs. The main stem of Ponca Creek consistently received scores indicating an unstable channel while the smaller tributaries to the main channel consistently received scores indicating that they were stable. Refer to Figure 3-2 for Ponca Creek Channel Stability areas. This data indicated that the primary sources for the sediment loads in Ponca Creek were its bed and stream banks. Depending on the reduction target selected, maximum or median stable channels, a reduction in sediment transport of 73% to 93% would be needed for Ponca Creek to reach reference conditions.

Figure 3-2. Ponca Creek Channel Stability Areas `



The Keya Paha River had suspended solids load calculated from the water quality data at approximately 7,952 tons/ year for the downstream site (SDDENR 2009). The watershed erosion rate for this site was calculated as 2.73 tons/square kilometer (t/km^2). This load was higher than the median sediment production rate for the rest of the Lewis and Clark basin. The upstream sampling site generated a load of 3,382 tons/ year with a watershed erosion rate of 2.46 tons/ km^2. Average suspended solids concentrations, volatile solids concentrations, and the percent volatile all indicated that the water quality changes very little between the two sites. AnnAGNPs analysis of the subwatersheds in the Keya Paha basin indicated low rates of sediment production for a majority of the basin when compared to the greater Lewis and Clark drainage.

Rapid Geomorphic Assessments (RGAs) were completed and the data indicated a relatively stable channel. The results were broken into stable and unstable stream channels with approximately 12% of the sites ranking as unstable. Refer to Figure 2-11 on page 43. The primary soils through the stream corridor consist of the Invale Cass associations. These soils are characterized by loamy fine sands overlying fine to medium sands. These types of soils are typically noncohesive and are more prone to failures, which was evident in the frequency of meander scars. Particle size data collected by the USGS was insufficient to conduct analysis, but it suggested that the high sand content in the streams bed and banks mobilizes during higher velocity events and adds to instability. The High Flow regime would require an 86% reduction in suspended solids from all sources to reach the target of a suspended solids concentration of less than 90 mg/L; the Moist Flow regime would require a 50% reduction; and the Mid-Range flows would require a 30% reduction. The remaining lower flow regimes would not require reductions to maintain support of the standards.

Examination of the upstream and downstream site concentrations and loads indicated that erosion rates were consistent throughout the entire basin suggesting no particular source was generating excessive loads. BMPs may be able to improve the condition of several of the tributaries, particularly those that scored poorly in the RGAs. The aggregate information suggested that the concentrations measured in the Keya Paha River were natural occurrences and that the current State standard may not be an appropriate measure for this stream.

The Emanuel Creek study (SDDENR 2009) and the Choteau Creek study (SDDENR 2010), both located in the LCWIP east of the Missouri River, found the sources of sediment were the result of bank failure and channel instability through the use of ANNAGNPS and RGAs. The suspected primary cause of bank failure on Emanuel Creek was linked to livestock use of the riparian areas and the loss of riparian vegetation from cattle grazing. Channel instability on Choteau Creek was linked to the placement of culverts and bridges. Proposed BMPs to address riparian area degradation included livestock use exclusion, stream bank stabilization and protection, and reseeding or manual planting of native plant species.

3.6 Grassed Waterways. NRCS Practice Code 412

Grassed waterways are shaped or graded channels that are established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet. They are used to control gully erosion formed in fields where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff. AnnAGNPS (Yuan et al. 2006) estimated that ephemeral gully erosion accounted for approximately 85% of the total landscape erosion in that watershed, while sheet and rill erosion amounted to the remaining 15%. The simulation of ephemeral gullies for delivery of sediments and associated nutrients is an important process captured in AnnAGNPS; which is not an element of many other watershed models and highlights the importance of grassed waterways and buffer strips in load reductions. The PRediCT model, Evans et al. (2008), estimates a 54% reduction in nitrogen, a 52 % reduction in phosphorous, and a 58% reduction in sediment by installing grassed waterways.

Knippling reported 99.3 acres of grassed waterways being constructed during LCWIP Segments 1 and 2. Sediment was reduced by 1,472 tons at a rate of 4.82 tons/acre/year; nitrogen was reduced by 6,636 pounds at a rate of 66.83 lbs/acre/year; and phosphorous was reduced by 1,666 pounds at a rate of 16.78 lbs/acre/year.

Kringen, in the James River watershed (2010), reported load reductions on 2.9 acres of constructed waterways (2,253 LF) that reduced sediment by 16.7 tons/acre/year; nitrogen by 124.3 pounds/acre/year; and phosphorous by 32.6 pounds/acres/year. His calculations were based on 110 acres of cropland watersheds contributing runoff to the waterways. Jensen (2007) calculated load reductions in the Little Minnesota River study on 111.9 acres (76,031 LF) of constructed waterways that represented 9,978 acres of watershed contributing sediment at 27.46 tons/acre/year and phosphorous at 52.3 lbs./acre/year. The differences in the load reduction between the two studies may have been that Jensen's contributing watershed acres per acre of constructed waterway was approximately 2.4 times larger than Kringens'. Gullies are some of the more serious forms of erosion on slight to moderate slopes where contour farming and terraces are not practical. Grassed waterways need to be implemented basin wide in the identified critical cells in conjunction with conservation tillage and no-till.

3.7 Wetland Restoration, Pond Construction, Water & Sediment Control Basins, and Structures for Water Control. NRCS Practice Codes 657, 378, 638, 587, Respectively

Concave slopes, often occupied by wetlands, serve as sediment traps on the landscape and act as a filter for adjacent aquatic systems (NDSU 2006). Excessive deposition in wetland landscapes, where erosion has been accelerated substantially, has reduced the wetlands capabilities to store sediments. The problem of sedimentation is then passed downstream, eventually impacting aquatic systems such as lakes and streams. Wetlands have evolved to transform the soluble and adsorbed chemical load delivered in surface runoff into nontoxic forms that allow diverse biotic conditions to flourish. When wetlands are removed from the landscape, soluble and adsorbed chemicals are delivered directly to aquatic systems. Streams, rivers and lakes have not evolved the capacity to withstand increased chemical inputs, particularly at the rates delivered due to accelerated erosion. The result is hyper-eutrophic conditions and chemical toxicity that reduces the biotic diversity and value of aquatic water resources.

Nitrogen levels in Northern Prairie Pothole Region (NPPR) wetlands, lakes and tributaries have been observed to vary seasonally. Generally the highest concentrations of nitrites and nitrates are found during spring runoff from agricultural activities. These concentrations subside substantially by biological activity as temperatures increase later in the spring and summer. Total nitrogen concentrations in NPPR lakes are lowest in the fall, increase in the winter, remain the same or decrease in the spring, and increase in the summer. The periods of highest total nitrogen concentrations are the summer and winter. In the summer, the predominant form of nitrogen is organic due to flourishing populations of aquatic organisms. In the winter, the predominant form of nitrogen is ammonia. This is because decomposition of organic material occurs through the ammonification steps of mineralization due to the reduced environment. By the end of winter, toxic levels of ammonia may become a water quality problem, particularly in smaller lakes.

Phosphorus is distinctly less mobile in the environment, compared with nitrogen. An important aspect of phosphorus control is related to the release of PO4 -3 from lake sediments, known as internal nutrient loading. Anoxic or low redox potentials in lake or wetland sediments will contribute to environmental conditions that maintain soluble PO4 -3 in the water at relatively high levels. The oxidation state of iron in iron oxides is reduced when the redox potential is lowered. Under these conditions PO4-3 is not readily adsorbed to iron oxide surfaces and is released to solution. Mineralization also continues to release PO4 -3 from organic matter. Therefore, aquatic systems that have accumulated a significant layer of eroded sediment likely will not see much reduction in PO4 -3 concentrations for extended periods after the implementation of management practices.

The Corsica Lake TMDL (2005) used AnnAGNPS management scenarios to simulate the removal of the 880 acres of impoundments 10 acres or larger in size (including small dams and wetland areas) throughout the watershed. There were approximately 880 acres of impoundments of 10 acres or larger in size throughout the watershed. Removal of these impoundments increased sediment loading by 8%, nitrogen by 1%, and phosphorus loading by 4%. While these reductions are fairly small, it is important to note that the majority of these wetlands and impoundments were located upstream of the most critical areas in the watershed and that wetland restoration or small dam repair and maintenance downstream of critical areas may result in greater reductions than were represented in this simulation.

Load reductions for sediment and phosphorus were also documented in both restored wetlands with vegetated buffers and constructed ponds during the Little Minnesota River (Jensen 2007) project. Sediment and phosphorous reductions were reported as 91,579 tons/pond lifespan and 174,000 lbs./pond lifespan, respectively. For this reason, wetland restoration, pond construction, water and sediment control structures, and structures for water control will be part of the Lewis & Clark project's strategic plan. The purpose for these practices is to create multi-purpose ponds in the watershed to trap sediment, phosphorous, nitrogen, benefit wildlife, and serve as an alternative water source for grazing management systems.

3.8 Conversion of Cropland to Forage and Biomass Plantings. NRCS Practice Code 512

The ANNAGPS model (Yuan et al. 2006) estimated a suspended sediment loading reduction of 54% with a conversion of 10% of the highest eroding cropland to grassland. A 60% reduction was achieved for a combined management scenario involving conservation tillage, conversion of crop to grassland, and improved nutrient management. One scenario, which converted 25% of the highest eroding cropland in the watershed to grassland, reduced the sediment loads at the watershed outlet by 80 percent. Converting the highest eroding cropland cells to grassland was more efficient in sediment reductions than converting the highest eroding cropland cells from reduced tillage to no tillage practice (Yuan et al. 2006). The data clearly implies the importance of utilizing AGNPS programs that identifying critical cells throughout the LCWIP area and evaluating them before BMP's are installed.

Using AnnAGNPS management scenarios in the Corsica Lake TMDL (SDDENR 2005) the phosphorus reductions practices for the conversion of critical cropland acres to grass would result in measurable reductions. Reductions were calculated basin wide, but if targeted areas were converted, a margin of safety is generated. Converting cropland to grassland through critical area seeding, CRP, and riparian buffers would result in 1% reductions in phosphorus, nitrogen, and sediment for every 200 acres; for example, a 3% participation by operators in critical areas would result in a 6% reduction from 1,200 acres.

Knippling reported 378.8 acres of grass seedings completed for Segments 1 and 2 of the Lewis & Clark Watershed Implementation Project (2012). Sediment load reductions were 1,652 tons at a rate of 4.36 tons/acre; nitrogen load reductions were 7,167 pounds at a rate of 18.92 pounds/acre; and phosphorous reductions were 2,189 pounds at a rate of 5.78 pounds/acres.

Kringen (2010) reported the savings of 4.01 pounds/acre/year of nitrogen, 1.23 pounds/acre/year of phosphorous, and 0.72 tons/acre/year of sediment converting cropland to grass through Conservation Reserve Programs (CRP). The conversion to grassland was also reported to reduce total soil erosion by approximately 1.6 tons/acre/year in the Little Minnesota River study (Jensen 2007).

An alternative to conservation residue management within critical watershed cells would be the conversion of cropland to vegetative species suited to pasture, hayland, or biomass production. This would be a conversion without retiring the land from production completely, as with the Conservation Reserve Program. The benefits would be to reduce erosion and improve soil and water quality, while increasing forage production or energy production and improving livestock nutrition.

3.9.0 Conservation Crop Rotation And Conservation Cover Crops. NRCS Practice Codes 328 & 340

3.9.1 Conservation Crop Rotation (328)

A Conservation Crop Rotation that meets NRCS practice standards is the growing of crops in a planned sequence on the same field with at least one-third of the planned crop rotation, on a time basis, planted to annual crops. A planned crop rotation must consist of a minimum of two "crop types." Crop types in South Dakota are defined as follows:

- Warm-season grasses (WSGs), examples; corn, sorghum, millet, warm season perennial grasses.
- Cool-season grasses (CSGs), examples; winter and spring wheat, barley, oats, cool-season perennial grasses.
- Warm-season broadleaf (WSB), examples; soybean, sunflower, dry beans, potatoes, alfalfa, and other warm season perennial broadleaf crops.
- Cool-season broadleaf (CSB), examples; field pea, flax, canola, mustard.

This practice consists of growing different crops in a planned rotation to manage nutrient and pesticide inputs, enhance soil quality, or reduce soil erosion. Including hay or a close grown crop in rotations with row crops can have a pronounced effect on long-term average field losses of sediment and nutrients, as well as enhancement of soil quality.

In the Missouri River Basin study (USDA 2012) crop rotations that meet NRCS criteria occurred on about 88 percent of the cropped acres. The LCWIP would require an additional resource-conserving crop in the producer's rotation that reduces soil erosion, improves soil fertility and tilth, interrupts pest cycles, and reduces depletion of soil moisture or otherwise reduces the need for irrigation. A resource-conserving crop is defined as one of the following; (a) perennial grass; (2) legume grown for use as forage, seed for planting, or green manure; (3) legume-grass mixture; or (4) a small grain grown in combination with a grass or legume green manure crop whether inter-seeded or planted in rotation. Nutrient and sediment loading from cropland runoff has been identified in the Lewis & Clark Watershed Project area as contributing to water quality degradation in the following SDDENR water quality reports; Lake Andes 2010, Corsica Lake 2005, Dante Lake 2006, Choteau Creek 2010, and Geddes Lake 2007.

3.9.2 Conservation Cover Crop (340)

A conservation cover crop includes grasses, legumes, and forbs for seasonal cover that are planted on lands requiring vegetative cover for natural resource protection. A cover crop is also considered a crop in the rotation and does meet the standard for a Conservation Crop Rotation (328). Generally, the cover crop may be planted late in another crops growing season or soon after harvest for over wintering protection. A cover crop can provide multiple conservation benefits several being (1) to reduce erosion from wind and water, (2) to capture and recycle or redistribute nutrients in the soil profile thus preventing leaching, and (3) encourage the deposition of sediment to reduce sediment delivery to water bodies.

Studies (Hargrove 1991) have shown that cover crops are very effective at reducing soil erosion and the runoff from precipitation events. Convention tillage on soybean field had a soil loss of 3.34 tons/acre/year; the incorporation of a cover crop into the rotation reduced the soil loss to 0.75 tons/acre/year. Utilizing both a no-till system and a cover crop further reduced the soil erosion loss to 0.04 tons per acre. Soil loss reductions were more pronounced when a cover crop was used with conventional tillage systems. The winter cover crop treatment produced results similar to a meadow rotation treatment. Use of the cover crop reduced average annual runoff from 31% - 65% and accompanying soil losses from 42% - 92%. Conservation cover crop treatment use will provide both soil erosion benefits and the reduction of water runoff that carries the fertilizers and pesticides.

The two most important functions of cover crops (NRCS 2012) from a water quality perspective are (1) to provide soil surface cover and reduce soil erosion and (2) to utilize and convert excess nutrients remaining in the soil from the preceding crop into plant biomass, thereby reducing nutrient leaching and minimizing the amount of soluble nutrients in runoff during the non-crop growing season. In the Missouri River Basin, cover crops were not commonly used as a conservation practice, as less than one percent of the acres met the criteria for cover crop use in the basin.

3.10 Windbreak/Shelterbelt Establishment. NRCS Practice Code 380

The objectives of Windbreak/Shelterbelt Establishment (Practice Code 380) are to; reduce soil erosion from wind; provide shelter for structures, animals, and people; enhance wildlife habitat; improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors; improve irrigation efficiency; increase carbon storage in biomass and soils; and reduce energy use.

The windbreak/shelterbelt practice also protects the land that is planted to trees and/or shrub species in that it requires the establishment of permanent woody vegetation with minimal use or only periodic management. Jensen reported (2007) a riparian forest buffer was installed on a tributary of the Little Minnesota River consisting of a four acre buffer of 885 rod rows of trees and shrubs. A 5.4 acre filter strip of native grasses was also planted adjacent to the trees to reduce sediment delivery from an adjoining crop field. Sediment delivery from the field was reduced by approximately 1.623 tons/acre/year and phosphorous was reduced by 3.08 pounds/acre/year.

3.11 Nutrient Management Plan - Cropland. NRCS Practice Code 590

This nutrient management practice (590) is intended for cropland acres where animal manures are not used on cropland fields. The use of animal manures may be impractical because of the distances involved in hauling manure to all crop fields, the lack of the quantities of manure needed to meet the needs of all fields, or the lack of livestock production, and thus the lack of available manure. Nutrient management utilizes farm practices that permit efficient crop production while controlling non-point source water pollutants. A nutrient management plan is a written, site-specific plan that addresses these issues. The plan must be tailored to specific soils and crop production systems. The goal of the plan is to minimize detrimental environmental effects, primarily on water quality, while optimizing farm profits. Nutrient losses will occur with the plan but will be controlled to an environmentally acceptable level. Nutrient management programs emphasize how proper planning and implementation will improve water quality and enhance farm profitability through reduced input costs. These plans incorporate soil test results, manure test results, yield goals and estimates of residual nitrogen (N) to generate field-by-field recommendations.

The efficient use of nutrients in agricultural production systems has important environmental implications. Crops are not efficient at removing fertilizer and manure nitrogen from the soil during the growing cycle. Unused or residual nitrogen is vulnerable to leaching prior to the start of the next cropping year especially during the fall and winter months if precipitation occurs when fields lay dormant. The potential exists for accelerated nutrient loss when essential nutrient amounts exceed crop uptake needs. Nutrient reactions and pathways in the soil-water system are complex. Nutrient flow to surface water and groundwater vary from nutrient to nutrient as do the threats to water quality. Potential surface water impacts include sedimentation, eutrophication, and overall water quality degradation. Evans et al. (2003/2008) estimated that nutrient management plans had reduction efficiencies of 70% reduction for nitrogen and a 28% reduction for phosphorous.

Although nutrient management practices were widely used on cropped acres in the Missouri river basin (NRCS 2012); few producers met the management criteria for application rate, timing of application, and method of application. Only 24 percent of the cropped acres met all three criteria for both nitrogen and phosphorous applications. The importance for the promotion of nutrient management plans on cropland is obvious and will be used as a BMP in the Lewis & Clark Watershed Implementation Project.

3.12 Terraces - NRCS Practice Code 600.

A terrace is an earth embankment, or a combination of a ridge and channel, constructed across the field slope usually on the contour. The terrace is generally applied as part of a resource management system to reduce erosion by reducing slope length, thus soil erosion, and retaining runoff for moisture conservation. The length of a hill's slope is reduced by constructing the terraces perpendicular to the slope. Both soil erosion and channel erosion are reduced further because the terraces force the field to be farmed on the contour between the terraces (Foster 1983). Although terraces are generally constructed on the contour, channel grades are sometimes increased to facilitate water storage for terraces with tile outlets in an effort to keep terraces parallel to each other to facilitate farming. Contour farming alone is very effective in reducing soil erosion by approximately 50% (Czapar 2005), but it does have limits of application. Generally, as slope increases, the maximum slope length decreases, and when erosion is most severe, such as slopes exceeding 9%, much of the effectiveness of contouring is lost. Thus, terraces are needed for controlling slope length, managing water flow, and reducing soil erosion on the more erodible steeper and longer field slopes.

Terraces have a negligible effect on crop yields, but a major effect on sediment delivery (Czapar, etal. 2005). Estimated annual soil and nutrient losses under various erosion control practices in a Central Iowa climate, showed conventional tilled non-terraced soils with soil losses at 7.8 tons/acre/year compared to terracing with 2.3 tons/acre/year (averaged over ten soils, a 73 foot long slope of 9%, and a 300 foot long slope of 5%). Terraces in an Iowa corn/small grain rotation reduced soil loss from 7.6 kilogram/square-meter to 2.7 kilograms/square-meter (Foster 1983). Soil losses in these two examples were reduced 70.5% and 65.5%, respectively, by the installation of a terrace system.

Terraces may discharge their water through surface channels or by infiltration in a pond area through underground drain lines. Terraces that drain by surface channels are designed to have no erosion in the terrace channels. Terraces that drain through underground outlets are very effective at reducing sediment delivery of eroded material. It is estimated that about 95% of material eroded between terraces was deposited in pond areas around the underground intakes (Czapar, etal. 2005). However, terraces drained by tile outlets may deliver more nitrogen than fields that are not tiled. Total nitrogen yields in the Corn Belt region varied greatly, but were typically less than 10 lb./acre/year in non-tiled drained watersheds and greater than 20 lb./acre/year in tile-drained watersheds. Terraces may be used in the LCWIP on steeper and longer field slopes when other BMP's do not bring soil losses down to acceptable levels or as needed to control rill and gully erosion.

3.13 Filter Strips - Non CRP

Areas adjacent to streams were evaluated in section 3.3 as riparian areas. Grassed filter strips can also be installed adjacent to other water bodies (wetland, ponds) or serve as filters for smaller animal waste facilities or tile outlets. A non CRP option would allow the haying or grazing of the filter strips without severe use restrictions and still provide resource protection. Haying would not impose much reduction in the conservation effects of grass cover, but grazing might and would need to be managed. Management of livestock may be needed allowing only seasonal access, rotational grazing, and/or time limitations, to reduce intensity and duration of grazing. Knippling (2012) reported on 4,233.1 acres of installed filter strips under LCWIP Segments 1 and 2. Load reductions for sediment were 14,096 tons at a rate of 3.33 tons/acre; nitrogen load reductions were 62,153 pounds at a rate of 14.68 pounds/acre; and phosphorous reductions were 19,650 pounds at a rate of 4.64 pounds/acre. However, load reductions on grazed or hayed buffer strips were reported by Knippling at the lower rates of 0.69 tons/acre for sediment, 4.83 lbs/acre of nitrogen, and 1.35 lbs/acre of phosphorous. These lower rates will be used for the non-CRP filter strips that may be hayed or grazed.

3.14 Brush Management – NRCS Practice Code 314

One of the most striking land cover changes on rangelands worldwide over the past 150 years has been the proliferation of trees and shrubs at the expense of perennial grasses (Archer et al. 2011). Brush encroachment has long been considered one of the major management problems confronting managers of rangeland as a dense stand of brush usually minimizes grass cover (Welch 2000). The reduced grass cover results in increased soil erosion, inefficient use of rainfall with increased runoff, and loss of livestock production. Brush Management, NRCS conservation practice code 314, is the management or removal of invasive and noxious woody (nonherbaceous or succulent) plants to create the desired plant community consistent with the ecological site. The practice is designed to restore or release desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality, or enhance stream flow, and improve forage accessibility, quality, and quantity for livestock and wildlife. Brush includes woody half-shrubs, shrubs, and trees that invade areas on which they are not part of the natural plant community or that occur in amounts significantly in excess of that natural to the site.

A study by Zhang et al. (2012) found that dramatic increases in runoff and soil loss were attributed to the increase in the frequency and intensity of extreme events for plant communities in three scenarios, since there was no significant increase in mean annual precipitation. The projected mean annual runoff and soil loss approximately doubled and predicted erosion from shrub communities increased more than for other plant communities under the three scenarios. Greater increases of soil loss indicated that soil erosion was more sensitive to changes in storm patterns than runoff. A predicted future of increasing runoff and soil erosion appeared to accelerate the transitions of grassland to shrub lands or to more eroded states than what already had been occurring on the study area over the past century. The prediction of more soil erosion on shrub lands in the future (Westoby et al. 1989) could mean significant shifts from shrubs to the eroded state. This may imply that it may be difficult to restore historical plant communities over time frames relevant to ecosystem management. The option of woody plant control and removal through brush management is a technique that could be considered to reduce soil erosion on rangelands.

Brush management in the project area generally applies to the following species: Eastern Red cedar (Juniperus virginiana) and Rocky Mountain juniper (Juniperus scopulorum). It is designed to achieve the desired plant community based on species composition, structure, density, and canopy (or foliar) cover or height. Brush management is applied in a manner to achieve the desired control of the target woody species and protection of desired species. This can be accomplished by mechanical, chemical, or biological methods either alone or in combination. However, this practice should be completed in conjunction with a planned prescribed grazing management system, NRCS practice code 528.

4.0 LOAD REDUCTIONS

4.1 Animal Waste Storage Facilities

There are an estimated 250 animal feeding operations within the LCWIP west of the Missouri River, with more than 70 of the feedlots determined to be priority operations requiring the construction of an animal waste management systems. Since that time, approximately 10 feedlots have had Animal Waste Storage Facilities (AWSF) constructed under the LCWIP Segments 1 and 2. The CD/NRCS field offices in the Lewis & Clark Project area were contacted for the number of AWSF's that are needed in each county to address their nonpoint source pollution concerns. Their combined estimated need was for 60 AWSFs to be constructed within the LCWIP area. Based on the field office's response they calculated an average construction rate of 4 AWSF's per year. At this construction rate it will take additional years beyond the 5 years addressed in this plan to complete the needed AWSF's. Load reductions used were those calculated from AWMS's installed in the LCWIP Segments 1 and 2. The averaged reductions were 12,612 pounds of nitrogen and 2,753 pounds of phosphorous per system. Refer to Table 4-1 for projected load reductions and yearly applications.

Table 4-1. Estimated N and P Load Reductions Per AWSF System

Estimated Nitrogen (N) and Phosphorous (P) Load Reductions (LR) Associated with Animal Waste Storage Facilities (AWSF)						
Year	# Goal	% Goal	N #/System	Total N #/Syst	P #/System	Total P #/Syst
1	4	6.6	12,612.0	50,448	2,753.0	11,012
2	4	6.6	12,612.0	50,448	2,753.0	11,012
3	4	6.6	12,612.0	50,448	2,753.0	11,012
4	4	6.6	12,612.0	50,448	2,753.0	11,012
5	4	6.6	12,612.0	50,448	2,753.0	11,012
Subtotal	20	33.3		252,240		55,060
6-10	20	33.3	12,612.0	252,240	2,753.0	55,060
11-15	20	33.3	12,612.0	252,240	2,753.0	55,060
Total	60	100.0		756,720		165,180

Nutrient reduction estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load. Knippling 2012

4.2 Nutrient Management System Load Reductions for Animal Wastes

The NMPs for animal wastes are designed to manage the manure from the Animal Waste Storage Facilities. The NMPs need approximately one acre of land per animal unit to safely spread the manure over time. The manure is spread on approximately 10 percent of these acres annually to meet crop nutrient needs. Four facilities with 999 animal units constructed on average each year would require approximately 4,000 acres in the NMPs; however, only about 400 acres would receive the manure each year. Load reductions used were calculated from NMPs installed in the LCWIP Segments 1 and 2, with averaged reductions of 11,143 pounds of nitrogen and 2,445 pounds of phosphorous per system. See Table 4-2 for the estimated nitrogen and phosphorous load reductions associated with NMPs.

Table 4-2. Estimated N and P Load Reductions by NMP System

Estimated Nitrogen (N) and Phosphorous (P) Load Reductions (LR) for Nutrient Management Plans Associated with Animal Waste Storage Facilities (AWSF)						
Year	# Goal	% Goal	N #/YR	Total N #/YR	P #/YR	Total P #/YR
1	4	6.6	11,143	44,572	2,445	9,780
2	4	6.6	11,143	44,572	2,445	9,780
3	4	6.6	11,143	44,572	2,445	9,780
4	4	6.6	11,143	44,572	2,445	9,780
5	4	6.6	11,143	44,572	2,445	9,780
Subtotal	20	33.0		222,860		48,900
6-10	20	33.0	11,143	222,860	2,445	48,900
11-15	20	33.0	11,143	222,860	2,445	48,900
Total	60	100.0		668,580		146,700

Nutrient reduction estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load. Knippling 2012

4.3 Prescribed Grazing Systems

4.3.1 Upland Prescribed Grazing Systems

The CD/NRCS field offices in the LCWIP watershed were contacted for the number of acres of grazing lands that need a grazing management system for each county. The estimated need was for 70,000 acres of prescribed grazing systems to be planned and implemented. The estimated yearly average implementation rate was 14,000 acres per year. At the end of this five year Strategic Plan all acres would be treated and 100% of the needed BMP would be implemented. Load reductions are presented in Table 4-3-1 using nitrogen load reduction estimates by Knippling (2012) of 2.23 pounds of nitrogen/acre/year, 0.53 pounds of phosphorous/acre/year, and 0.37 tons of sediment/acre/year. Prescribed grazing systems are figured on 1,500 acres per system, with a drilled well/solar pump station, three tanks, water pipeline footage of 2,500 feet, and 2,500 feet of fencing per system.

Table 4-3-1. Estimated N, P, and Sediment Load Reductions for Prescribed Grazing on Pasture and Rangeland

Estimated Nitrogen (N), Phosphorous (P), and Sediment (S) Load Reductions (LR) for Prescribed Grazing								
Year	Acres	% Goal	N #/Ac/Yr	Total #N/YR	P #/Ac/YR	Total #P/YR	Sed T/Ac/YR	Total T/YR
1	14,000	20.0	2.23	31,220.00	0.5296	7,414.40	0.3678	5,149.20
2	14,000	20.0	2.23	31,220.00	0.5296	7,414.40	0.3678	5,149.20
3	14,000	20.0	2.23	31,220.00	0.5296	7,414.40	0.3678	5,149.20
4	14,000	20.0	2.23	31,220.00	0.5296	7,414.40	0.3678	5,149.20
5	14,000	20.0	2.23	31,220.00	0.5296	7,414.40	0.3678	5,149.20
TOTAL	70,000	100.0		156,100.00		37,072.00		25,746.00

Load Reduction Estimates from Knippling 2012

4.3.2 Riparian Area Grazing

Grazing management systems will be implemented on 20,500 linear feet (LF) of stream to reduce nutrient and sediment transport to water bodies. These footages were estimated by CD/NRCS field office staff in the watershed counties. Load reductions were calculated from Knippling (2012) analysis using STEPL from systems installed in Segments 1 and 2 of the LCWIP. His figures were converted to linear feet using 124 acres of installed riparian grazing area and dividing by an average riparian grazing area width of 1,325 feet. A grazing management plan can be as simple as fencing off the riparian zones to schedule grazing periods during cooler and less erosive periods. The Continuous CRP can also be used to provide landowners an incentive to establish buffer strips along streams to improve the water quality. This program will assist landowners with exclusion of livestock from the riparian areas through planning and installation of grazing systems that utilize 10-15 year land use agreements. Table 4-3-2 presents the load reductions for nitrogen, phosphorous, and sediment for 20,500 linear feet of riparian management for the LCWIP watershed during the first five years of the Strategic Plan.

Table 4-3-2. Riparian Area Management Program and Conservation Reserve Program Load Reductions.

Riparian Area Management Load Reductions of Nitrogen, Phosphorous, and Sediment								
Year	Linear Feet (LF) Planned	% Goal	N Reduction Lbs/LF	Total N Reduction Lbs/Year	P Reduction Lbs/LF	Total P Reduction Lbs/Year	Sediment Reduction Tons/LF	Total Sediment Tons/Year
1	4,100	20.0	0.1469	602.3	0.4100	1,681.0	0.0209	85.7
2	4,100	20.0	0.1469	602.3	0.4100	1,681.0	0.0209	85.7
3	4,100	20.0	0.1469	602.3	0.4100	1,681.0	0.0209	85.7
4	4,100	20.0	0.1469	602.3	0.4100	1,681.0	0.0209	85.7
5	4,100	20.0	0.1469	602.3	0.4100	1,681.0	0.0209	85.7
TOTAL	20,500	100.0		3,011.5		8,405.0		428.5

N, P, and Sediment Load Reduction estimates from STEPL: Knippling 2012

4.4 Residue & Tillage Management on Cropland

Field Offices estimated 70,000 acres of conservation tillage would be needed to solve resource concerns. At the implementation rate of 14,000 acres per year this goal should be achieved in the five year plan. The sediment, nitrogen, and phosphorous load delivery rates vary per watershed depending on soil erodibility, tillage practices, rotations, steepness of the slope, and slope length. The use of AGNPS cells in the Lake Mitchell/Firesteel Creek Diagnostic Study (1997) identified that critical cropland cells (those with soil erosion rates over 4.0 tons/acre/year) averaged 8.6 tons/acre/year of soil erosion. Applying Evans estimate of soil reductions by conservation tillage practices, soil loss could be reduced by 64 percent to 3.1 ton/acre/year; saving 5.5 tons/acre/year. With an estimated 40 percent delivery rate to a water course, this would result in a sediment load reductions of 2.2 tons/acre/year. The Firesteel Creek 319 Application (Kringen 2006) reported P load reduction for cropland was 0.5 pounds of phosphorus reduction per ton of soil saved; saving 2.75 pounds of P per acre. Nitrogen load reductions along the Big Sioux River were calculated at 9.81 pounds/acre/year (Berg, 2010) on cropland management practices.

Nitrogen, phosphorus, and sediment load reductions were not calculated in the LCWIP reports. Therefore, phosphorous and sediment load reductions reported in the adjacent Lake Mitchell/Firesteel Creek study will be used to estimate sediment and phosphorous load reductions. The values for nitrogen loss are those calculated by Berg (2010) along the Big Sioux River. These load reduction values are presented in Table 4-4.

Table 4-4. Estimated Nitrogen, Phosphorous, and Sediment Load Reductions for Cropland Conservation Tillage on Cropland Acres

Estimated Nitrogen (N), Phosphorous (P), and Sediment (S) Load Reductions (LR) for Cropland Conservation Tillage on Critical Cells								
Year	Acres	% Goal	N #/Ac/Yr	Total #/YR	P #/Ac/YR	Total #YR	Sed T/Ac/YR	Total T/YR
1	14,000	20.0	9.81	137,340.0	2.75	38,500.0	2.20	30,800.0
2	14,000	20.0	9.81	137,340.0	2.75	38,500.0	2.20	30,800.0
3	14,000	20.0	9.81	137,340.0	2.75	38,500.0	2.20	30,800.0
4	14,000	20.0	9.81	137,340.0	2.75	38,500.0	2.20	30,800.0
5	14,000	20.0	9.81	137,340.0	2.75	38,500.0	2.20	30,800.0
TOTAL	70,000	100.0		686,700.0		192,500.0		154,000.0

Phosphorous and Sediment Load Reduction Estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load v. 4.0. Evans/Kringen . Nitrogen from Berg .

4.5 Streambank Stabilization

The planned bank stabilization footages were estimated by field office staff as 12,500 linear feet (LF) of stream bank stabilization. It is estimated that an average of 500 LF could be completed each year, which would require additional years to complete the total goal. Table 4-5 presents load reductions for nitrogen as calculated using STEPL from stream bank restoration installed along the Big Sioux River (Strom 2010). Load reductions may vary from these estimates depending on the height of bank, annual regression of the bank, and frequency of precipitation events.

Table 4-5. Stream Bank Stabilization Load Reductions

Stream Bank Stabilization and Load Reductions								
Year	Linear Feet Planned	% Total Goal	N Reduction Lbs/LF	Total N Reduction Lbs	P Reduction Lbs/LF	Total P Reduction Lbs	Sediment Reduction Tons/LF	Total Sediment Tons
1	500	4.0	2.60	1,300.0	1.0	500.0	1.83	915.0
2	500	4.0	2.60	1,300.0	1.0	500.0	1.83	915.0
3	500	4.0	2.60	1,300.0	1.0	500.0	1.83	915.0
4	500	4.0	2.60	1,300.0	1.0	500.0	1.83	915.0
5	500	4.0	2.60	1,300.0	1.0	500.0	1.83	915.0
Subtotal	2,500	20.0		6,500.0		2,500.0		4,575.0
6-10	2,500	20.0	2.60	6,500.0	1.0	2,500.0	1.83	4,575.0
11-15	2,500	20.0	2.60	6,500.0	1.0	2,500.0	1.83	4,575.0
16-20	2,500	20.0	2.60	6,500.0	1.0	2,500.0	1.83	4,575.0
21-25	2,500	20.0	2.60	6,500.0	1.0	2,500.0	1.83	4,575.0
Totals	12,500	100.0		32,500.0		12,500.0		22,875.0

Nitrogen, Phosphorous, and Sediment Load Reduction reduction estimates from STEPL: Strom 2010

4.6 Grassed Waterways

The constructed linear feet (LF) of grassed waterways estimated by field offices for full treatment of gullies is 84,500 feet. At 3,850 LF per year; 19,250 LF will be completed in the five years of the Strategic Plan, which is only 22.5% of the needed estimate. More years will be needed to complete the necessary linear feet of grassed waterways to control gully erosion. Nitrogen, phosphorous, and sediment load reduction estimates used were the calculations use in LCWIP reports for segments 1 and 2. The load reductions are converted to linear feet of waterway based on an average waterway width of 35 feet. This data is presented in Table 4-6.

Table 4-6. Grassed Waterway Load Reductions for N, P, and Sediment

Grassed Waterway Load Reductions for Nitrogen, Phosphorous, Sediment								
Year	Linear Feet (LF) Planned	% Goal	N Reduction Lbs/LF	Total N Reduction Lbs/Year	P Reduction Lbs/LF	Total P Reduction Lbs/Year	Sediment Reduction Tons/LF	Total Sediment Tons/Year
1	3,850	4.5	0.054	207.9	0.0135	52.0	0.0112	43.1
2	3,850	4.5	0.054	207.9	0.0135	52.0	0.0112	43.1
3	3,850	4.5	0.054	207.9	0.0135	52.0	0.0112	43.1
4	3,850	4.5	0.054	207.9	0.0135	52.0	0.0112	43.1
5	3,850	4.5	0.054	207.9	0.0135	52.0	0.0112	43.1
Subtotal	19,250	22.5		1,039.5		259.9		215.6
6-10	19,250	22.5	0.054	1,039.5	0.0135	259.9	0.0112	215.6
11-15	19,250	22.5	0.054	1,039.5	0.0135	259.9	0.0112	215.6
16-20	19,250	22.5	0.054	1,039.5	0.0135	259.9	0.0112	215.6
20-25	7,250	10.0	0.054	391.5	0.0135	97.9	0.0112	81.2
Total	84,250	100.0		4,549.5		1,137.4		943.6

N, P, and Sediment reduction estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load . Knippling 2012

4.7 Wetland Restoration, Pond, and Basin Construction

Planned restoration of wetlands, pond construction, and water and sediment control basin numbers were estimated by field office personnel to be 50 to meet estimated load reductions. Five basins are restored or constructed each year on average. At the end of the Strategic Plan, approximately 50% of the basin construction estimates will be completed. More years will be needed to meet the estimates of the FO personnel. See Table 4-7.

Calculated total sediment and phosphorous load reductions data expected from the constructed ponds/basins and restored wetlands are from multi-purposed ponds constructed in the Little Minnesota River/Big Stone Lake implementation project (Jensen 2007). Water and sediment control basins are typically an ‘open basin’ and are drained with a tile outlet to control the water flow. This is unlike the closed systems of a wetland restoration or pond in Jensen’s load reduction calculation. However, the water and sediment basins should result in similar control of the sediment delivery and sediment attached phosphorous. Jensen based the phosphorous and sediment load reductions on five acres of watershed protection (WSAc) around the restored wetlands/ponds over an estimated 20 year lifespan. LCWIP field offices estimated 140 acres of watershed per acre of wetland/pond.

Table 4-7. Wetland Restoration, Pond, Basin Construction Load Reductions

Wetland Restoration and Pond Construction Load Reductions							
Year	No. Ponds Wetlands Planned	% Goal	Watershed Acres Restored	P Reduction Lbs/WS Ac Lifespan	Total Lbs P Reduction Lifespan	Sed Reduct Lifespan Tons/ WS Ac	Total Tons Sediment Reduction
1	5	10.0	700	29.76	20,832.0	15.67	10,969
2	5	10.0	700	29.76	20,832.0	15.67	10,969
3	5	10.0	700	29.76	20,832.0	15.67	10,969
4	5	10.0	700	29.76	20,832.0	15.67	10,969
5	5	10.0	700	29.76	20,832.0	15.67	10,969
Subtotals	25	50.0	3,500		104,160.0		54,845
6-10	25	50.0	3,500	29.76	104,160.0	15.67	54,845
Total	50	100.0	7,000		208,320.0		109,690

Phosphorous and Sediment Load Reduction Estimates from Jensen 2007

4.8 Conversion of Cropland to Forage and Biomass Plantings

The conversion of the highest eroding cropland to vegetative species suited to pasture, hayland, or biomass production was estimated by field office staff to be 8,750 acres for the LCWIP watershed. The calculated load reductions of nitrogen, phosphorous and sediment were those reported by Knippling (2012) in Segments 1 and 2 of the LCWIP. His sediment load reductions were 4.36 tons/acre, nitrogen load reductions were 18.92 pounds/acre, and phosphorous reductions were 5.78 pounds/acres. This data is presented in Table 4-8.

Table 4-8. Estimated N, P, and Sediment Load Reductions for Cropland Conversion to Perennial Vegetation

Estimated Nitrogen (N), Phosphorous (P), and Sediment (Sed) Load Reductions (LR) for Cropland Conversion to Perennial Vegetation								
Year	Acres	% Goal	N #/Ac/Yr	Total #N/YR	P #/Ac/YR	Total #P/YR	Sed T/Ac/YR	Total T/YR
1	665	7.6	18.92	12,581.8	5.78	3,843.7	4.36	2,899.4
2	665	7.6	18.92	12,581.8	5.78	3,843.7	4.36	2,899.4
3	665	7.6	18.92	12,581.8	5.78	3,843.7	4.36	2,899.4
4	665	7.6	18.92	12,581.8	5.78	3,843.7	4.36	2,899.4
5	665	7.6	18.92	12,581.8	5.78	3,843.7	4.36	2,899.4
Subtotal	3,325	38.0		62,909.0		19,218.5		14,497.0
6-10	3,325	38.0	18.92	62,909.0	5.78	19,218.5	4.36	14,497.0
11-15	2,100	24.0	18.92	39,732.0	5.78	12,138.0	4.36	9,156.0
Total	8,750	100.0		165,550.0		50,575.0		38,150.0

Nitrogen, Phosphorous and Sediment reduction estimates from STEPL: Knippling 2012.

4.9 Conservation Crop Rotation and Conservation Cover Crop on Cropland Acres

The need of Conservation Crop Rotations and/or Cover Crops on cropland acres was estimated by Field Office staff to be 70,000 acres and 31,250 acres, respectively, for the LCWIP. These acres were combined for Load Reduction estimates as Cover Crops do meet the NRCS standards criteria for a Conservation Crop Rotation. The combined goal is 101,250 acres. The effectiveness in using cover crops to reduce soil erosion and rainfall runoff was demonstrated by Hargrove (1991). However, the sediment and nutrient delivery on cropland acres has not been analyzed in the LCWIP area. The watershed study of Clear Lake (SDDENR 1999) reported the sediment transport and deliverability throughout the watershed indicated, that for an average year, approximately 3,084 tons (0.121 tons/acre) of sediment enter the lake. The AGNPs data indicated that the Clear Lake sub watersheds had a total nitrogen (soluble+sediment bound) deliverability rate of 22.1 lbs./acre/yr., and a total phosphorus (soluble+sediment bound) deliverability rate of 5.2 lbs./acre/yr. to the lake. The results also indicated that runoff from fertilized cropland was a significant source of water soluble nutrients to Clear Lake.

Hargrove (1991) found the use of cover crops reduced average annual runoff from 31% - 65%. Applying his data to the Clear Lake study, nitrogen and phosphorous could be reduced conservatively by 31%; 22.1 lbs. nitrogen/acre/year could be reduced to 6.85 lbs./ac/year and 5.2 lbs. of phosphorous/acre/year could be reduced to 1.6 lb./ac/year.

Hargrove's report found soil losses to be reduced from 42% - 92%. A conservative application to the Clear Lake study would be to estimate a 42% reduction in sediment load delivery. The load reduction is estimated at 0.121 tons/acre/year multiplied by 42% reduction equals a load reduction of 0.051 ton/acre/year. These cover crop load reductions are used in Table 4-9. The winter cover crop treatment produced results similar to a meadow rotation treatment (Hargrove 1991); therefore the load reductions reported in Table 4-9 may be higher if a crop rotation that incorporates meadow or hayland is included.

Table 4-9. Estimated Nitrogen (N), Phosphorous (P), and Sediment (S) Load Reductions (LR) for Crop Rotations and Cover Crops on Cropland

Estimated Nitrogen (N), Phosphorous (P), and Sediment (S) Load Reductions (LR) for Conservation Crop Rotation and Cover Crops on Cropland								
Year	Acres	% Goal	N #/Ac/Yr	Total #/YR	P #/Ac/YR	Total #YR	Sed T/Ac/YR	Total T/YR
1	20,250	20.0	6.85	138,712.5	1.61	32,602.5	0.051	1,032.8
2	20,250	20.0	6.85	138,712.5	1.61	32,602.5	0.051	1,032.8
3	20,250	20.0	6.85	138,712.5	1.61	32,602.5	0.051	1,032.8
4	20,250	20.0	6.85	138,712.5	1.61	32,602.5	0.051	1,032.8
5	20,250	20.0	6.85	138,712.5	1.61	32,602.5	0.051	1,032.8
Totals	101,250	100.0		693,562.5		163,012.5		5,163.8

Projected Estimates from Hargrove 1991 and TMDL Clear Lake SDDENR 1999. LR Estimates are for Cover Crop Use Only. The Addition of Crop Rotation with a Cover Crop May Give Higher LR (Hargrove 1991)

4.10 Windbreak/Shelterbelt Establishment. NRCS Practice Code 380

Windbreak or Shelterbelt Establishment (NRCS Practice Code 380**)** typically consists of trees and/or shrub plantings designed to solve a conservation resource concern. Field Offices estimated the need for 425 acres of trees to address resource concerns in the LCWIP. An annual planting rate of 85 acres per year would achieve this goal in the five year period. Kringen (2010) reported riparian projects of 349 acres within the Firesteel Creek Riparian Area Management Program averaged a nitrogen load reduction at 3.65 pounds/acre/year, phosphorus at 2.52 pounds/acre/year, and sediment at 0.09 tons/acre/year. Estimated load reductions for the LCWIP are presented in Table 4-10.

Table 4-10. Nitrogen, Phosphorous, and Sediment Load Reductions on Tree Plantings

Estimated Nitrogen (N), Phosphorous (P), and Sediment (Sed) Load Reductions (LR) for Cropland Conversion to Tree Plantings								
Year	Acres	% Goal	N #/Ac/Yr	Total #N/YR	P #/Ac/YR	Total #P/YR	Sed T/Ac/YR	Total T/YR
1	85	20.0	3.65	310.25	2.52	214.20	0.873	74.2
2	85	20.0	3.65	310.25	2.52	214.20	0.873	74.2
3	85	20.0	3.65	310.25	2.52	214.20	0.873	74.2
4	85	20.0	3.65	310.25	2.52	214.20	0.873	74.2
5	85	20.0	3.65	310.25	2.52	214.20	0.873	74.2
TOTAL	425	100.0		1,551.25		1,071.00		371.0

Load reduction estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load v. 4.0. Kringen 2010

4.11 Nutrient Management Plan - Cropland

The Field Offices estimated a total need of 43,750 acres of nutrient management plans on cropland where manure is not applied in the LCWIP. At approximately 8,000 NMP acres targeted annually, it will require an additional year of project implementation to meet their goal. The NMP can be developed to manage the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments necessary to sustain plant growth and production goals. The NMP should minimize agricultural nonpoint source pollution of surface waters and result in reduced nutrient loading. Estimated load reductions for NMP are presented in Table 4-11.

Table 4-11. Nitrogen and Phosphorous Load Reductions on Nutrient Management Plans on Non-Manure Applied Cropland

Estimated Nitrogen (N) and Phosphorous (P) Load Reductions (LR) for Nutrient Management Plans Associated Non-Manured Cropland						
Year	Acre	% Goal	N #/AC/YR	Total N #/YR	P #/YR/AC	Total P #/YR
1	8,000	18.3	9.81	78,480.0	0.60	4,800.0
2	8,000	18.3	9.81	78,480.0	0.60	4,800.0
3	8,000	18.3	9.81	78,480.0	0.60	4,800.0
4	8,000	18.3	9.81	78,480.0	0.60	4,800.0
5	8,000	18.3	9.81	78,480.0	0.60	4,800.0
Subtotal	40,000	91.5		392,400.0		24,000.0
6-10	3,750	8.5	9.81	36,787.5	0.60	2,250.0
Total	43,750	100.0		429,187.5		26,250.0

Nutrient reduction estimates from STEPL: Spreadsheet Tool for the Estimation of Pollutant Load v. 4.0. Kringen 2010

4.12 Terraces

Erosion concerns on cropland can be addressed with tillage and crop rotations, however, terraces may be needed on steeper slopes. Field Offices estimated a need of 6,250 LF of terrace construction to address these steeper slopes in the LCWIP; completing 625 LF per year would require approximately ten years to complete their goal. Soil loss calculations projected before and after terrace construction were based on average soil losses computed by several field offices in the LCWIP. The average soil loss of steeper field slopes in the LCWIP that would need terracing was estimated at 7.0 tons/acre/year without terraces as compared to 2.0 tons/acre/year after terraces application. The soil load reductions were more easily calculated using soil erosion estimators. However, calculating load reductions of nitrogen and phosphorous is more complicated. The dominant path for nitrate loss is leaching and nitrate concentrations in runoff are usually low compared to subsurface (tile) drainage waters. The impacts of increased losses of dissolved phosphorus and decreased losses of particulate phosphorus due to the widespread adoption of conservation tillage systems make estimates less certain. In some settings, dissolved inorganic phosphorus is likely to be more biologically available than sediment bound phosphorus. In other settings, dissolved phosphorus may become sediment bound and relatively unavailable. Sediment bound phosphorus can also become dispersed in anaerobic environments, and thus become more biologically available for phytoplankton.

Load reductions for nitrogen and phosphorous were based on load reductions losses with associated soil. Czapar reported loss reductions of nitrogen from 32.8 lbs/acre/year to 7.4 lbs/acre/year, a savings of 25.4 lbs/acre/year (77.4%) and phosphorous from 12.7 lbs/acre/year to 2.9 lbs/acre/year, a savings of 9.8 lbs/acre/year (77.2%). These load reductions for both nitrogen and phosphorous are presented in Table 4-12. Acres of cropland protected are based on terrace length times 180 feet cropping interval between terraces.

Table 4-12. Terrace Load Reductions for N, P, and Sediment

Terrace Load Reductions for N, P, and Sediment									
Year	Linear Feet Planned	Acres Protected	% Goal	N Reduction Lbs/Acre	Total N Reduction Lbs/Year	P Reduction Lbs/Acre	Total P Reduction Lbs/Year	Sediment Reduction Tons/Acre	Total Sediment Tons/Year
1	625	2.6	10.0	25.4	66.0	9.8	25.5	5.0	13.0
2	625	2.6	10.0	25.4	66.0	9.8	25.5	5.0	13.0
3	625	2.6	10.0	25.4	66.0	9.8	25.5	5.0	13.0
4	625	2.6	10.0	25.4	66.0	9.8	25.5	5.0	13.0
5	625	2.6	10.0	25.4	66.0	9.8	25.5	5.0	13.0
Subtotal	3,125	13.0	50.0		330.2		127.4		65.0
6-10	3,125	13.0	50.0	25.4	330.2	9.8	127.4	5.0	65.0
Total	6,250	26.0	100.0		660.4		254.8		130.0

4.13   Filter Strips - Non-CRP

The need for Non-CRP filter strips was estimated by Field Offices to be 1,175 acres within the LCWIP watershed. Installing 63 acres annually would require another fifteen years to meet the estimated goal. The load reduction for nitrogen, phosphorous, and sediment for grassed filter strips were calculated from 124 acres of grazed buffers installed in the LCWIP Segment 2 report. It is unknown whether the non-CRP filter strips will be harvested for hay or grazed, so the load reduction calculations will be based on the more severe land use of grazing. The load reduction estimates are presented in Table 4-13.

Table 4-13. N, P, and Sediment Load Reduction of Non-CRP Filter Strips

Estimated Nitrogen (N), Phosphorous (P), and Sediment (S) Load Reductions (LR) for Non CRP Filter Strips								
Year	Acres	% Goal	N #/Ac/Yr	Total #N/YR	P #/Ac/YR	Total #P/YR	Sed T/Ac/YR	Total T/YR
1	63	5.4	4.83	304.3	1.35	85.05	0.69	43.47
2	63	5.4	4.83	304.3	1.35	85.05	0.69	43.47
3	63	5.4	4.83	304.3	1.35	85.05	0.69	43.47
4	63	5.4	4.83	304.3	1.35	85.05	0.69	43.47
5	63	5.4	4.83	304.3	1.35	85.05	0.69	43.47
SubTotal	315	27.0		1,521.5		425.25		217.35
6-10	315	27.0	4.83	1,521.5	1.35	425.25	0.69	217.35
11-15	315	27.0	4.83	1,521.5	1.35	425.25	0.69	217.35
16-20	230	19.0	4.83	1,110.9	1.35	310.50	0.69	158.70
TOTAL	1,175	100.0		5,675.3		1,586.25		810.75

Load Reductions data from LCWIP Final Report Knippling 2012.

4.14 Brush Management

Zhang et al. (2012) evaluated the climate change impacts on soil erosion and surface runoff in southeastern Arizona with the Rangeland Hydrology and Erosion Model (RHEM). Data from the 1970 -1999 conditions was compared to future conditions in 2050s and 2090s. The results suggested no changes in annual precipitation across the region under the three scenarios, but projected annual runoff and soil loss increased significantly, ranging from 78.7% - 91.7% and from 127.3% - 157.1%, respectively, relative to the baseline years 1970-1999**.** The baseline annual mean runoff was 0.09 inches/year with the projected future scenarios annual mean runoff of 0.21 inches. Estimated reduction in annual runoff is the difference of these two figures; 0.12 inches/year. Zhang's average annual soil loss rates were 0.09 ton/acre/year during 1970 to 1999 and 0.23 ton/acre/year for all the combinations in future scenarios. Soil loss estimates use in Table 4-14 were 0.23 ton/acre/year minus 0.09 ton/acre/year, which equaled 0.14 ton/acre/year.

Table 4-14. Mean Annual Runoff/ Sediment Load Reductions for Brush Management

Mean Annual Runoff Depth and Mean Annual Sediment Loading Reductions for Brush Management						
Year	Acres Planned	% Goal	Reduction Runoff Depth Inches	Total Runoff Reduction Inches/Year	Sediment Reduction Tons/Acre	Total Sediment Tons/Year
1	250	6.6	0.12	30.0	0.14	35.0
2	250	6.6	0.12	30.0	0.14	35.0
3	250	6.6	0.12	30.0	0.14	35.0
4	250	6.6	0.12	30.0	0.14	35.0
5	250	6.6	0.12	30.0	0.14	35.0
Subtotal	1,250	33.3		150.0		175.0
6-10	1,250	33.3	0.12	150.0	0.14	175.0
11-15	1,250	33.3	0.12	150.0	0.14	175.0
Total	3,750	100.0		450.0		525.0

5.0 TECHNICAL AND FINANCIAL ASSISTANCE NEEDED

The Randall Resource Conservation & Development (RRCD) will be administratively responsible for the project implementation and will be the lead sponsor. A project coordinator will manage all water quality project activities among the watershed counties which will include all the local, state and federal conservation personnel. The counties supporting the project will appoint members to serve on a steering committee. The Conservation District Managers and NRCS District Conservationists will assist the project coordinator with cost-share reimbursement, file maintenance, and other financial transactions. Technical expertise from these offices will be necessary to implement the BMPs in each local county. This expertise has been and will be provided through existing partnerships with Gregory, Clearfield-Keya Paha (Tripp), and Todd County Conservation Districts; the Randall Resource Conservation & Development, the South Central Resource Conservation & Development; South Central Water Development District; SD Grassland Coalition; the SD Association of Conservation Districts; Pheasants Forever; SD Game, Fish and Parks (SD GF&P); SDDENR; SD Department of Agriculture (SDDOA); SD Extensions Service; US Environmental Protection Agency; USDI Fish and Wildlife Service; USDA Farm Service Agency; and USDA Natural Resources Conservation Service.

The sources of funds accessed for financial assistance during LCWIP Segments 1 and 2 included:

- SD Department of Agriculture - SD Soil and Water Conservation Grant awarded through the SD Conservation Commission,
- SD Game, Fish, & Parks - State Acres for Wildlife Enhancement (SAFE),
- SD Department Environment & Natural Resources – Consolidated Water Facilities Construction Fund Program,
- USDA NRCS – Environmental Quality Incentive (EQIP) and Wildlife Habitat Incentive(WHIP) and Farm Bill Implementation Technical Assistance Programs,
- USDA Farm Service Agency – Conservation Reserve and Continuous Conservation Reserve Programs (CRP and CCRP),
- US Fish & Wildlife Service – Annual appropriation for SD habitat projects, and
- US Environmental Protection Agency - Clean Water Act Section 319 Implementation Project Grant and 303(d) Watershed Projects.

Additional funding for the implementation of the BMPs will be solicited from these partners through their programs such as; the NRCS Environmental Quality Incentive Program and Wetland Reserve Program; FSA Conservation Reserve Program and Conservation Reserve Enhancement Program; SD GF&P Wildlife Partnership Program and Wetland and Grassland Habitat Program; and US-FWS Grassland and Wetland Easement Programs and Private Land Programs.

The Lewis and Clark watershed basin land use is fairly homogenous west of the Missouri River and the impairment problems have been consistently identified as agricultural in nature for both cropland and animal uses. The extrapolations have been conservative and the expected outcome to be consistent. This Five Year Strategic Plan is intended to describe and detail the funding needed for the proposed BMP's and the administrative costs needed to implement them. The estimated costs are based on the 2012 NRCS cost share docket and actual costs from similar local projects. Tables 5-1 through 5-5 summarize the costs of the BMP and associated practice components per each year. Table 5-6 presents an annual summary of both BMPs and administrative costs which includes personnel, office equipment and supplies for the project years.

Table 5-1. Technical and Financial Resources Needed					Year 1			
Year	BMP - Animal Waste management System				BMP - Prescribed Grazing			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Engineer Design	$ 20,000	4	$ 80,000	Grazing System, EA	$ -	6	$ -
	AWSF	$200,000	4	$ 800,000	Drilled Wells, EA	$ 4,400	6	$ 26,400
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	15,000	$ 75,000
	NMP	$ 2,500	4	$ 10,000	Tanks, EA	$ 1,500	18	$ 27,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	75,000	$ 75,000
				$ 967,000				$ 203,400
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	1,000	$ -	Rock, Fabric/LF	$ 110	500	$ 55,000
	Fencing LF	$ 1	26,400	$ 26,400				$ -
				$ 26,400				$ 55,000
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	6,000	$ 60,000	Dirt Work, Seed/ LF	$ 2.20	3,850	$ 8,470
				$ 60,000				$ 8,470
Year	BMP - Wetlands, Ponds, Sed Basins				BMP - Cropland Conversion to Forage Plantings			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Dirt Work/Seed EA	$ 2,800	5	$ 14,000	Tillage/Seeding AC	$ 46	665	$ 30,590
				$ 14,000				$ 30,590
Year	BMP - Rotation/Cover Crop on Cropland				BMP - Nutrient Manage Plan, Non AWMS			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 38	20,250	$ 769,500	Cost Incentive/AC	$ 3.58	8,000	$ 28,640
				$ 769,500				$ 28,640
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	85	$ 34,000	Dirt Work/LF	$ 3.50	625	$ 2,188
				$ 34,000				$ 2,188
Year	BMP - Filter Strips, Non-CRP				Brush Management			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 46	63	$ 2,898	Cost Incentive/AC	$ 300	250	$ 75,000
				$ 2,898				$ 75,000
					TOTAL BMP COSTS			$ 2,277,086

Table 5-2. Technical and Financial Resources Needed					Year 2			
Year	BMP - Animal Waste management System				BMP - Prescribed Grazing			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Engineer Design	$ 20,000	4	$ 80,000	Grazing System, EA	$ -	6	$ -
	AWSF	$200,000	4	$ 800,000	Drilled Wells, EA	$ 4,400	6	$ 26,400
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	15,000	$ 75,000
	NMP	$ 2,500	4	$ 10,000	Tanks, EA	$ 1,500	18	$ 27,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	75,000	$ 75,000
				$ 967,000				$ 203,400
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	1,000	$ -	Rock, Fabric/LF	$ 110	500	$ 55,000
	Fencing LF	$ 1	26,400	$ 26,400				$ -
				$ 26,400				$ 55,000
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	16,000	$ 160,000	Dirt Work, Seed/ LF	$ 2.20	3,850	$ 8,470
				$ 160,000				$ 8,470
Year	BMP - Wetlands, Ponds, Sed Basins				BMP - Cropland Conversion to Forage Plantings			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Dirt Work/Seed EA	$ 2,800	5	$ 14,000	Tillage/Seeding AC	$ 46	665	$ 30,590
				$ 14,000				$ 30,590
Year	BMP - Rotation/Cover Crop on Cropland				BMP - Nutrient Manage Plan, Non AWMS			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 38	20,250	$ 769,500	Cost Incentive/AC	$ 3.58	8,000	$ 28,640
				$ 769,500				$ 28,640
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	85	$ 34,000	Dirt Work/LF	$ 3.50	625	$ 2,188
				$ 34,000				$ 2,188
Year	BMP - Filter Strips, Non-CRP				Brush Management			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 46	63	$ 2,898	Cost Incentive/AC	$ 300	250	$ 75,000
				$ 2,898				$ 75,000
					TOTAL BMP COSTS			$ 2,377,086

Table 5-3. Technical and Financial Resources Needed					Year 3			
Year	BMP - Animal Waste management System				BMP - Prescribed Grazing			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Engineer Design	$ 20,000	4	$ 80,000	Grazing System, EA	$ -	6	$ -
	AWSF	$200,000	4	$ 800,000	Drilled Wells, EA	$ 4,400	6	$ 26,400
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	15,000	$ 75,000
	NMP	$ 2,500	4	$ 10,000	Tanks, EA	$ 1,500	18	$ 27,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	75,000	$ 75,000
				$ 967,000				$ 203,400
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	1,000	$ -	Rock, Fabric/LF	$ 110	500	$ 55,000
	Fencing LF	$ 1	26,400	$ 26,400				$ -
				$ 26,400				$ 55,000
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	16,000	$ 160,000	Dirt Work, Seed/ LF	$ 2.20	3,850	$ 8,470
				$ 160,000				$ 8,470
Year	BMP - Wetlands, Ponds, Sed Basins				BMP - Cropland Conversion to Forage Plantings			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Dirt Work/Seed EA	$ 2,800	5	$ 14,000	Tillage/Seeding AC	$ 46	665	$ 30,590
				$ 14,000				$ 30,590
Year	BMP - Rotation/Cover Crop on Cropland				BMP - Nutrient Manage Plan, Non AWMS			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 38	20,250	$ 769,500	Cost Incentive/AC	$ 3.58	8,000	$ 28,640
				$ 769,500				$ 28,640
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	85	$ 34,000	Dirt Work/LF	$ 3.50	625	$ 2,188
				$ 34,000				$ 2,188
Year	BMP - Filter Strips, Non-CRP				Brush Management			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 46	63	$ 2,898	Cost Incentive/AC	$ 300	250	$ 75,000
				$ 2,898				$ 75,000
					TOTAL BMP COSTS			$ 2,377,086

Table 5-4. Technical and Financial Resources Needed					Year 4			
Year	BMP - Animal Waste management System				BMP - Prescribed Grazing			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Engineer Design	$ 20,000	4	$ 80,000	Grazing System, EA	$ -	6	$ -
	AWSF	$200,000	4	$ 800,000	Drilled Wells, EA	$ 4,400	6	$ 26,400
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	15,000	$ 75,000
	NMP	$ 2,500	4	$ 10,000	Tanks, EA	$ 1,500	18	$ 27,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	75,000	$ 75,000
				$ 967,000				$ 203,400
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	1,000	$ -	Rock, Fabric/LF	$ 110	500	$ 55,000
	Fencing LF	$ 1	26,400	$ 26,400				$ -
				$ 26,400				$ 55,000
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	16,000	$ 160,000	Dirt Work, Seed/ LF	$ 2.20	3,850	$ 8,470
				$ 160,000				$ 8,470
Year	BMP - Wetlands, Ponds, Sed Basins				BMP - Cropland Conversion to Forage Plantings			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Dirt Work/Seed EA	$ 2,800	5	$ 14,000	Tillage/Seeding AC	$ 46	665	$ 30,590
				$ 14,000				$ 30,590
Year	BMP - Rotation/Cover Crop on Cropland				BMP - Nutrient Manage Plan, Non AWMS			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 38	20,250	$ 769,500	Cost Incentive/AC	$ 3.58	8,000	$ 28,640
				$ 769,500				$ 28,640
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	85	$ 34,000	Dirt Work/LF	$ 3.50	625	$ 2,188
				$ 34,000				$ 2,188
Year	BMP - Filter Strips, Non-CRP				Brush Management			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 46	63	$ 2,898	Cost Incentive/AC	$ 300	250	$ 75,000
				$ 2,898				$ 75,000
					TOTAL BMP COSTS			$ 2,377,086

Table 5-5. Technical and Financial Resources Needed					Year 5			
Year	BMP - Animal Waste management System				BMP - Prescribed Grazing			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Engineer Design	$ 20,000	4	$ 80,000	Grazing System, EA	$ -	6	$ -
	AWSF	$200,000	4	$ 800,000	Drilled Wells, EA	$ 4,400	6	$ 26,400
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	15,000	$ 75,000
	NMP	$ 2,500	4	$ 10,000	Tanks, EA	$ 1,500	18	$ 27,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	75,000	$ 75,000
				$ 967,000				$ 203,400
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	1,000	$ -	Rock, Fabric/LF	$ 110	500	$ 55,000
	Fencing LF	$ 1	26,400	$ 26,400				$ -
				$ 26,400				$ 55,000
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	16,000	$ 160,000	Dirt Work, Seed/ LF	$ 2.20	3,850	$ 8,470
				$ 160,000				$ 8,470
Year	BMP - Wetlands, Ponds, Sed Basins				BMP - Cropland Conversion to Forage Plantings			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Dirt Work/Seed EA	$ 2,800	5	$ 14,000	Tillage/Seeding AC	$ 46	665	$ 30,590
				$ 14,000				$ 30,590
Year	BMP - Rotation/Cover Crop on Cropland				BMP - Nutrient Manage Plan, Non AWMS			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 38	20,250	$ 769,500	Cost Incentive/AC	$ 3.58	8,000	$ 28,640
				$ 769,500				$ 28,640
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	85	$ 34,000	Dirt Work/LF	$ 3.50	625	$ 2,188
				$ 34,000				$ 2,188
Year	BMP - Filter Strips, Non-CRP				Brush Management			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 46	63	$ 2,898	Cost Incentive/AC	$ 300	250	$ 75,000
				$ 2,898				$ 75,000
					TOTAL BMP COSTS			$ 2,377,086

TABLE 5-6. SUMMARY OF 5 YEAR COSTS LWCIP						
BMP IMPLEMENTATION COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TASK TOTAL
Animal Waste Manage System	$967,000	$967,000	$967,000	$967,000	$967,000	$4,835,000
Prescribed Grazing	$203,400	$203,400	$203,400	$203,400	$203,400	$1,017,000
Riparian Area	$26,400	$26,400	$26,400	$26,400	$26,400	$132,000
Bank Stabilization	$55,000	$55,000	$55,000	$55,000	$55,000	$275,000
Residue & Tillage Manage	$60,000	$160,000	$160,000	$160,000	$160,000	$700,000
Grassed Waterways	$8,470	$8,470	$8,470	$8,470	$8,470	$42,350
Wetland/Pond/Basin Restoration	$14,000	$14,000	$14,000	$14,000	$14,000	$70,000
Cropland Conversion to Grass	$30,590	$30,590	$30,590	$30,590	$30,590	$152,950
Conservation Cover Crop & Rotation	$769,500	$769,500	$769,500	$769,500	$769,500	$3,847,500
Nutrient Manage Plan, Non AWMS	$28,640	$28,640	$28,640	$28,640	$28,640	$143,200
Windbreak/Shelterbelt	$34,000	$34,000	$34,000	$34,000	$34,000	$170,000
Terraces	$2,188	$2,188	$2,188	$2,188	$2,188	$10,940
Filter Strips Non-CRP	$2,898	$2,898	$2,898	$2,898	$2,898	$14,490
Brush Management	$75,000	$75,000	$75,000	$75,000	$75,000	$375,000
BMP SUB TOTAL COSTS	$2,277,086	$2,377,086	$2,377,086	$2,377,086	$2,377,086	$11,785,430
PERSONNEL SUPPORT						
Project Coordinator - 40% West River	$24,000	$24,700	$26,000	$28,000	$30,000	$132,700
Assist. Coordinator - 40% West River	$16,000	$16,700	$18,000	$19,300	$21,400	$91,400
Admin. Assistant - 40% West River	$10,000	$10,700	$11,400	$12,000	$12,700	$56,800
OPERATIONS						
Vehicle, Fuel, Travel, Insurance	$12,000	$13,300	$14,700	$16,000	$17,300	$73,300
ADMINISTRATION						
Information & Outreach	$2,000	$2,000	$2,000	$2,000	$2,000	$10,000
Computer, Supplies, Telephone,	$8,700	$9,300	$10,000	$10,700	$11,300	$50,000
RC&D Office, Postage						
PERS/ADMIN SUB TOTAL COSTS	$72,700	$76,700	$82,100	$88,000	$94,700	$414,200
YEARLY TOTALS	$2,349,786	$2,453,786	$2,459,186	$2,465,086	$2,471,786	$12,199,630

6.0 PUBLIC OUTREACH

The Lewis and Clark Watershed Assessment was initiated during January of 2003 at the request of several local organizations that expressed concerns relative to sediment loading of Lewis and Clark Lake. The project goal was based on water quality data collected during watershed and lake assessments initiated in 2003. The original scope of the project was intended to identify areas and causes of sediment entering the impoundment. The goal of the Lewis and Clark Implementation Plan is to restore the beneficial uses of Lewis and Clark watersheds through the installation of Best Management Practices (BMPs) that target sources of sediment, nutrients, and fecal coliform bacteria.

Producer meetings, workshops and the print and electronic media have been used and will continue to be used to promote project awareness and provide information regarding how producers might access BMP design and installation assistance from the project and its partners. Notable among the outreach activities included the holistic grazing school sponsored by the project. As a result of the school, interest in the installation of managed grazing systems increased significantly.

Public involvement continued through the use of Local Work Groups (LWG). These LWGs are sponsored by each of the three counties' Soil and Water Conservation Districts' encompassed by the implementation projects. Segments I and II implementation projects have utilized funds from South Dakota 319 Grants, State Conservation Commission Grants, Consolidated Waters Facilities Construction Program, Clean Water State Revolving Fund, USDA Environmental Quality Improvement Program, local participant matching private funds, In-Kind work match, and the USDA Conservation Reserve Program. Funding sources for the LCWIP are listed by county in Table 6-1.

TABLE 6-1: FUNDING SOURCES FOR THE LCWIP

	FUNDING TYPE								
COUNTY	319	Cons Com	Consolid	CWSRF	EQIP	Local	In-Kind	USDA	County Subtotals
Gregory	$618,597	$0	$0	$29,069	$303,680	$388,870	$2,975	$237,627	$1,580,818
Todd	$96,253	$59,854	$0	$1,019	$0	$51,901	$475	$0	$209,502
Tripp	$416,963	$0	$77,208	$13,803	$191,453	$396,138	$4,693	$0	$1,100,258
Program Subt	$1,131,813	$59,854	$77,208	$43,891	$495,133	$836,909	$8,143	$237,627	$2,890,578

The LWGs meet annually gathering input on critical resource concerns and BMP solutions within each county. The LWGs then come together on a watershed basis to share their priorities and recommendations. This outreach momentum has continued as its success resulted in the watershed project area increasing in size by the addition of more subwatersheds. The NRCS Field Offices are usually co-located with the Project, CD, and NRCS staff. These offices will be utilized to disseminate the information to producers. Updates and achievements will be emailed to these field offices on a quarterly basis by the project coordinator. Annual meetings with be held by the LCWIP Project Coordinator and the District Managers of each CD to provide them with information on the BMPs available to each county.

A project steering committee will meet twice each year to provide input for project management and coordination of resources. The Steering Committee will consist of representatives of Gregory County, Clearfield/Keyapaha, and Todd County Conservation Districts; both the Randall and the South Central Resource Conservation & Development Associations, Inc.; and the South Central Water Development District. Watershed assessment needs are determined by Local Work Groups (LWG). Technical and financial assistance are provided by the SD Game, Fish, & Parks, SD Department Environmental Natural Resources, SD Department of Agriculture, SD Association of Conservation Districts, South Dakota State University Extension Service, USDA Natural Resources Conservation Service, USDA Farm Service Agency, and the US Fish & Wildlife Service.

Public outreach will come through; informational public meetings, nineteen meetings have been held to date: (a) presentations will be held for public and private organizations, thirty have been presented to date; (b) field tours are scheduled to show the completed and functioning BMPs, five have been completed, including the holistic grazing workshop; (c) newsletters from the CDs; (d) articles in the local newspapers of Bonesteel, Burke, Colome, Gregory, Mission, Mitchell, and Winner; (e) postcards sent to landowners along tributaries for CRP; (f) WEB page articles by several Conservation Districts; (g) personal contact of landowners by Project staff; (h) and development of display for the local county fairs.

7.0 IMPLEMENTATION SCHEDULE

The implementation of this project will be through voluntary programs with producers and landowners over a three county-wide watershed area and will be coordinated by the project coordinator. The implementation of the practices is targeted at the agricultural sector. The unique delivery systems of the South Dakota Conservation Districts to this sector will be utilized to provide information to the landowners and agricultural producers and implement the voluntary tasks scheduled. The BMPs will be installed with funding as available from local funding sources, South Dakota Conservation Commission funds, South Dakota Consolidated Funds, the USDA programs, and EPA 319 funds. The implementation schedule for BMPs, project outreach, task assignments, and project reports is detailed semi-annually in Table 7-1.

Table 7-1: Implementation & Task Assignment Schedule for LCWIP

Implementation & Task Assignment			Year 1		Year 2		Year 3		Year 4		Year 5	
Objectives, Tasks, Products	Group	Quantity	Jan - Jun	Jul-Dec	Jan - Jun	Jul - Dec	Jan - Jun	Jul - Dec	Jan - Jun	Jul - Dec	Jan - Jun	Jul - Dec
OBJECTIVE 1: BMP IMPLEMENTATION												
Task 1: Animal Waste Manage Systems (#)												
Product 1: Animal Waste Manage Systems	1,2,3											
Engineering Studies		20		4		4		4		4		4
Animal Waste Storage Facilities		20		4		4		4		4		4
Construction Management		20		4		4		4		4		4
Nutrient Management Plan		20		4		4		4		4		4
Cultural Resource Study		20		4	4	2	2	2	2	2	2	0
Task 2: Grassland Management	1,2,4											
Product 2: Prescribed Grazing Systems (Ac)		70,000		14,000		14,000		14,000		14,000		14,000
Product 3: Riparian Areas (LF)		20,500		4,100		4,100		4,100		4,100		4,100
Product 4: Brush Management (Ac)		1,250		250	100	150	100	150	100	150	100	150
Task 3: Streambank Stabilization	2,4											
Product 5: Streambank Stabilization (LF)		2,500		500	0	500	0	500	0	500	0	500
Task 4: Cropland Management	1,2,4											
Product 6: Residue & Tillage Manage (Ac)		70,000		6,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Product 7: Grassed Waterways (LF)		19,250		3,850		3,850		3,850		3,850		3,850
Product 8: Wetland & Pond Construct (No)		25		5	2	3	2	3	2	3	2	3
Product 9: Conversion of Crop to Grass (Ac)		3,325		665		665		665		665		665
Product 10: Conservation Rotation/Cover Crop (Ac)		101,250		20,250		20,250		20,250		20,250		20,250
Product 11: Cropland NMP (Ac)		40,000	2,000	6,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Product 12: Windbreak/Shelterbelt (Ac)		425		85		85		85		85		85
Product 13: Terraces (LF)		3,125		625	300	325	300	325	300	325	300	325
Product 14: Filter Strips, Non-CRP (Ac)		315		63		63		63		63		63
OBJECTIVE 2: INFORMATION OUTREACH												
Task 5: Information Distribution												
Product 15: Articles, Newsletter, Radio, WEB	1,2,3,4											
CD Newsletters		10	1	1	1	1	1	1	1	1	1	1
Newspaper Articles		5	1		1		1		1		1	
Radio Spots		5		1		1		1		1		1
OBJECTIVE 3: PROJECT REPORTS												
Task 6: Semi-annual, Annual, Final												
Product 16: Reports	1,2											
Semi-Annual		5	1		1		1		1		1	
Annual		5		1		1		1		1		1
Final		1										1

8.0 SHORT-TERM CRITERIA AND MILESTONES FOR BMP IMPLEMENTATION PROGRESS

The implementation schedule will be used as a comparative measurement to determine progress of the Strategic Plan. The BMP's in this Strategic Plan have been selected based on the identified 303(d) pollutants and their success at achieving load reductions. These BMPs have been documented by previous studies that for reducing fecal coliform bacteria, *Escherichia coli*, nutrients, Chlorophyll-*a*, and Total Dissolved Solids. Although this method of measuring progress is not the same as testing water quality, it is assumed that the successful implementation of the practices will have a positive impact on water quality of the Lewis & Clark Watershed basin. Success was achieved through the implementation of BMP's in the Choteau Creek watershed located in the East River portion of the LCWIP. These efforts by the LCWIP, administered by the Randall RC&D, led SDDENR to remove a 42-mile-long segment of Choteau creek from the 303(d) impaired waters list for DO and TSS in 2012 (EPA 2013). The creek now meets the DO and TSS criterion necessary to support its designated use of warm-water, semi-permanent fish life propagation designated use.

The short-term progress of the project will be measured annually in the last quarter of each project year. The project coordinator will be responsible for tabulating the number of BMPs installed, the number of acres treated, and the public outreach campaign efforts made in each county as identified in Table 8-1. This information will be published in an annual report sent to all cooperating agencies and made available to residents of the watershed. The project steering team will examine the achievements to determine if adequate progress has been made by the current BMP implementations. If they determine that adequate progress has not been made, they can adjust the implementation projects in order to achieve the five year BMP goals.

Table 8-1. Short-term Criteria & Milestones				Year 2		Year 3		Year 4	
BMP or Activity	Quantity	Year 1	Year 2	Subtotal	Year 3	Subtotal	Year 4	Subtotal	Year 5
Engineering Studies - AWMS	20 No.	4	4	8	4	12	4	16	4
Animal Waste Storage Facilities	20 No.	4	4	8	4	12	4	16	4
Construction Management - AWMS	20 No.	4	4	8	4	12	4	16	4
Nutrient Management Plan	20 No.	4	4	8	4	12	4	16	4
Cultural Resource Study - AWMS	20 No.	4	6	10	4	14	4	18	2
Prescribed Grazing Systems	70,000 Ac	14,000	14,000	28,000	14,000	42,000	14,000	56,000	14,000
Riparian Areas	20,500 LF	4,100	4,100	8,200	4,100	12,300	4,100	16,400	4,100
Brush Management	1,250 Ac.	250	250	500	250	750	250	1,000	250
Streambank Stabilization	2,500 LF	500	500	1,000	500	1,500	500	2,000	500
Residue & Tillage Manage	70,000 Ac	6,000	16,000	22,000	16,000	38,000	16,000	54,000	16,000
Grassed Waterways	19,250	3,850	3,850	7,700	3,850	11,550	3,850	15,400	3,850
Wetland/Pond/Basin Construction	25 No.	5	5	10	5	15	5	20	5
Conversion of Crop to Grass	3,325 Ac	665	665	1,330	665	1,995	665	2,660	665
Conservation Cover & Crop Rotation	101,250	20,250	20,250	40,500	20,250	60,750	20,250	81,000	20,250
Nutrient Management Plan	40,000 Ac	8,000	8,000	16,000	8,000	24,000	8,000	32,000	8,000
Windbreak/Shelterbelt	425 Ac	85	85	170	85	255	85	340	85
Terraces	3,125 LF	625	625	1,250	625	1,875	625	2,500	625
Filter Strips Non-CRP	1,175 Ac	63	63	126	63	189	63	252	63
CD Newsletters	10	2	2	4	2	6	2	8	2
Newspaper Articles	5	1	1	2	1	3	1	4	1
Radio Spots	5	1	1	2	1	3	1	4	1
Semi-Annual Reports	5	1	1	2	1	3	1	4	1
Annual Reports	5	1	1	2	1	3	1	4	1
Final	1	0	0	0	0	0	0	0	1

9.0 MONITORING AND EVALUATION PLAN

Monitoring and evaluation efforts will include analyzing water quality changes from BMP installation compared to water quality changes since the most recent watershed assessments on selected sites. The completion of the TMDL studies cited in Section 1.2 of this document has also provided a solid baseline of water quality data to use as BMPs are installed. The AGNPS can be used to identify specific feeding operations or cropland practices and where the BMPs should be implemented. The models can also be used to quantify the changes in load reductions. The SDDENR maintains five ambient water quality monitoring (WQM) sites evaluating this watershed area; WQM 460815 on the Keya Paha River near Wewela in Tripp County; WQM 460670 on Ponca Creek near St. Charles in Gregory County; two stations are located on the Missouri River, WQM 460673 in Charles Mix County and WQM 460674 in Yankton County; the fifth site is WQM 460134 at the mouth of Choteau Creek in Bon Homme County. The data from these water quality monitoring stations can also be used by the project director to make comparisons of installed practices.

The effectiveness of BMPs installed relative to the improvement in water quality will be evaluated using the appropriate tools and models available such as AnnAGNPS, RUSLE2, and STEPL models. The AnnAGNPS model will be used for changes in loadings due to BMP installation, while STEPL will be used to estimate annual load reductions in the watershed. Any water sampling, testing, and test result evaluations for water quality changes will be completed with technical assistance from DENR. They will also assist to develop a sampling and analysis plan, train project staff, and help in data storage and evaluation. Sampling will be completed according to the “Standard Operating Procedures for Field Samplers, Volumes I & II, Tributary and In-Lake Sampling Techniques”, SD DENR, 2005.

10.0 BIBLIOGRAPHY

1. Archer, S.R., Kirk W. Davies, Timothy E. Fulbright, Kirk C. McDaniel, Bradford P.Wilcox, and Katharine I. Predick. *Brush Management as a Rangeland Conservation Strategy: A Critical Evaluation*. Chapter 3 Pages 105-170 in *Conservation Benefits of Rangeland Practices* Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps. Briske, D.D., editor. 2011. United States Department of Agriculture, Natural Resources Conservation Service.

2. Berg, Barry. 2010. *Final Report Lower Big Sioux River Watershed Implementation Project – Segment 1*. South Dakota Association of Conservation Districts. Pierre, South Dakota.

3. Chipps, Steven R. August 2009. *SDSU Fisheries Research Explores Mercury Issues*. In South Dakota State University News and Events Articles, SDSU, Brookings, South Dakota. http://sdstate.edu/news/articles/mercury.cfm

4. Czapar, G.F., J.M. Laflen, G.F. McIsaac, and D.P. McKenna. 2005. Effects of erosion control practices on nutrient loss. *In* Final Report: Gulf Hypoxia and Local Water Quality Concerns Workshop, Ames, Iowa, September 26-28, 2005, 117-127. Ames, IA: Upper Mississippi River Sub-basin Hypoxia Nutrient Committee.

5. Evans, Barry M., David W. Lehning, and Kenneth J. Corradini. June 2003, Revised February 2008. PRedICT Version 7.1, Users Guide for the Pollutant Reduction Impact Comparison Tool. Penn State Institutes of Energy and the Environment, The Pennsylvania State University, University Park, PA 16802.

6. Foster, G. R. and R. E. Highfill. 1983. *Effect of terraces on soil loss: USLE P factor values for terraces*. Journal of Soil and Water Conservation 38(1):48-51. Soil and Water Conservation Society. Ankeny, Iowa.

7. Hargrove, W.L., ed. 1991. *Cover Crops for Clean Water*. Ankeny, IA: Soil and Water Conservation Society.

8. Hayer, C.A., S. R. Chipps, and J.J. Stone. 2011. Influence of Physiochemical and Watershed Characteristics on Mercury Concentration in Walleye, *Sander vitreus.* M. Bulletin of Environmental Contamination and Toxicology 86:163-167.

9. Jensen, Mike. February 2007. *Little Minnesota River Watershed/Big Stone Lake Restoration/Continuation Project.* Roberts Conservation District. Sisseton, South Dakota.

10. Knippling, Rocky. November 2009. *Watershed Project Final Report, Corsica Lake / Lewis & Clark Lake Watershed Improvement Project Segment 1.* Randall Resource Conservation & Development Association. Lake Andes, South Dakota.

11. Knippling, Rocky. March 2012. *Final Report Lewis & Clark Watershed Implementation Project, Segment 2.* Randall Resource Conservation & Development Association. Lake Andes, South Dakota.

12. Kringen, David. October 2006. Firesteel Creek/Lake Mitchell Watershed Project – Segment II Section 319 Application. Davison Conservation District, Mitchell, South Dakota.

13. Kringen, David. September 2010. Section 319 Nonpoint Source Pollution Control Program Watershed Project Final Report, Firesteel Creek/Lake Mitchell Watershed Project – Segment 2. Davison County, South Dakota.

14. Minnesota Pollution Control Agency. 2010. *Big Stone Lake.* RMB Environmental Laboratories. Minnesota River Basin, Upper Minnesota River Watershed. Saint Paul, Minnesota.

15. Nebraska Department of Environmental Quality. 2005. *Total Maximum Daily Loads for the Niobrara River Basin (Segments NI2-10000, NI3-10000, NI3-12300, NI3-13000, NI3-13100, NI3-21900, NI3-22500 and NI4-10000) Parameter of Concern: E. coli Bacteria.* December 2005. Nebraska Department of Environmental Quality, Planning Unit, Water Quality Division. Lincoln, Nebraska.

16. North Dakota State University Extension Service. August 2006. Water Quality and Wetland Function in the Northern Prairie Pothole Region. Bruce Seelig and Shawn DeKeyser. North Dakota State University, Fargo, North Dakota 58105.

17. SDDENR (South Dakota Department of Environment and Natural Resources). 1992. *Lake Assessment Project Report, Lake Andes, Charles Mix County, South Dakota.* South Dakota Clean Lakes Program, Division of Water Resources Management. SDDENR, Pierre, SD.

18. SDDENR. March 1997. *Phase I, Diagnostic Feasibility Study, Final Report Lake Mitchell / Firesteel Creek, Davison County, South Dakota.* SDDENR. Pierre, South Dakota.

19. SDDENR. June 1999. *Phase I Watershed Assessment Final Report. Clear Lake, Deuel County, South Dakota*. South Dakota Water Resources Assistance Program, Division of Financial and Technical Assistance SDDENR. Pierre, South Dakota.

20. SDDENR . September 1999. *Phase I Watershed Assessment Final Report. Blue Dog Lake, Day County, South Dakota*. South Dakota Water Resources Assistance Program, Division of Financial and Technical Assistance SDDENR. Pierre, South Dakota.

21. SDDENR. January 2002. *Phase I Watershed Assessment and TMDL Final Report, Rose Hill Lake/Sand Creek, Hand County, SD.* Sean Kruger and Andrew Repsys. South Dakota Watershed Protection Program Division of Financial and Technical Assistance. SDDENR, Pierre, South Dakota.

22. SDDENR. 2004. *Total Maximum Daily Load for Ammonia in Dry Choteau Creek near Avon, South Dakota.* South Dakota Watershed Protection Program, SDDENR, Pierre, South Dakota.

23. SDDENR. February 2005. *Phase I Watershed Assessment and TMDL Final Report, Corsica Lake, Douglas County, South Dakota.* South Dakota Watershed Protection Program South Dakota Department of Environment and Natural Resources, Pierre, South Dakota.

24. SDDENR. January 2006. *Phase I Watershed Assessment and TMDL Final Report, Dante Lake, Charles Mix County, SD.* Sean Kruger and Andrew Repsys. South Dakota Watershed Protection Program Division of Financial and Technical Assistance. Pierre, South Dakota.

25. SDDENR. April 2006. *Phase I Watershed Assessment Final Report Burke Lake, Gregory County, South Dakota.* Richard A. Hansen. South Dakota Watershed Protection Program, SDDENR. Pierre, South Dakota.

26. SDDENR. March 2007. *Phase I Watershed Assessment and TMDL Final Report, Geddes Lake, Charles Mix County, South Dakota.* Richard A. Hansen. South Dakota Watershed Protection Program Division of Financial and Technical Assistance, SDDENR. Pierre, South Dakota.

27. SDDENR. April 2009. *Fecal Coliform Total Maximum Daily Load Evaluation for Emanuel Creek, Bon Homme County, South Dakota.* SDDENR, Pierre, South Dakota.

28. SDDENR. May 2009. *Total Suspended Solids Total Maximum Daily Load Evaluations for the Keya Paha River, Tripp County, South Dakota.* SDDENR, Pierre, South Dakota.

29. SDDENR. May 2009. *Total Suspended Solids Total Maximum Daily Load Evaluation for Emanuel Creek, Bon Homme County, South Dakota.* SDDENR, Pierre, South Dakota.

30. SDDENR. October 2009. *Fecal Coliform total Maximum Daily Load Evaluation for Keya Paha River, Tripp County, South Dakota.* SDDENR, Pierre, South Dakota.

31. SDDENR. February 2010. *Dissolved Oxygen Total Maximum Daily Load (TMDL) Lake Andes, Charles Mix County, South Dakota.* Aaron M. Larson. Water Resources Assistance Program. Pierre, South Dakota.

32. SDDENR. February 2010. *Total Suspended Solids Total Maximum Daily Load Evaluation for Choteau Creek, Bon Homme and Charles Mix Counties, South Dakota.* SDDENR. Pierre, South Dakota.

33. SDDENR. April 2010. *Fecal Coliform Bacteria Total Maximum Daily Load Evaluation for Ponca Creek, Gregory, and Tripp Counties, South Dakota.* SDDENR, Pierre, South Dakota.

34. SDDENR. 2010. *The 2010 South Dakota Integrated Report Surface Water Quality Assessment*. SDDENR, Pierre, South Dakota.

35. SDDENR. January 2011. *Fecal Coliform Total Maximum Daily Load Evaluation of James River, Yankton County, South Dakota.* SDDENR. Pierre, South Dakota.

36. SDDENR. April 2011. *Phase I Watershed Assessment and TMDL Final Report Lewis and Clark Basin, Nebraska and South Dakota.* SDDENR. Pierre, South Dakota.

37. SDDENR. June 2011. *Escherichia coli Total maximum Daily Load Evaluation for the Keya Paha River, Tripp County, South Dakota.* SDDENR. Pierre, South Dakota.

38. SDDENR. June 2012. *The 2012 South Dakota Integrated Report Surface Water Quality Assessment*. SDDENR, Pierre, South Dakota.

39. SDDENR. June 2012. *Escherichia coli Bacteria Total Maximum Daily Load Evaluations for the North and South Forks of the Yellow Bank River – Grant, Codington, and Duel Counties, South Dakota*. SDDENR, Pierre, South Dakota.

40. South Dakota Geological Survey. Dragan Filipovic. 2004. *Hydrogeologic Assessment of the High Plains Aquifer in Tripp and Gregory Counties, South Dakota.* South Dakota Geological Survey. Vermillion, South Dakota.

41. USDA-NRCS) United States Department of Agriculture. Natural Resources Conservation Service). June 2012. *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Missouri River Basin.* Conservation Effects Assessment Project.

42. USDA-NRCS. (*Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.* United States Department of Agriculture Handbook 296, Issued 2006.

43. USDA-NRCS. June 2009. *Phase II Sedimentation Assessment for the Upper Missouri River Basin Assessment Report*. USDA Natural Resources Conservation Service, Nebraska, South Dakota, North Dakota, Montana, and Wyoming. Prepared for the Missouri Sedimentation Action Coalition.

44. US-EPA (United States Environmental Protection Agency). South Dakota: Choteau Creek Implementing Best Management Practices Reduces Sediment Loading in Creek. January 18, 2013. http://water.epa.gov/polwaste/nps/success319/sd_choteau.cfm

45. USGS (United States Geological Survey, Department of Interior). 1971. *Geology and Water Sources of Bon Homme County, South Dakota. Part II.* Donald G. Jorgensen. Bulletin 21. Prepared in cooperation with the South Dakota Geological Survey, County of Bon Homme, and Fort Randall Water Conservancy Sub-District.

46. USGS. 1998. Water Resources of Mellette and Todd Counties, South Dakota. Janet M. Carter. Water-Resources Investigations Report 98-4146. U.S. Department of the Interior, U.S. Geological Survey. Prepared in cooperation with the Rosebud Sioux Tribe, Mellette County, West River Water Development District, and the South Dakota Geological Survey.

47. USGS. 2009. *Water Quality in the High Plains Aquifer, Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming, 1999–2004*. Jason J. Gurdak, Peter B. McMahon, Kevin Dennehy, and Sharon L. Qi. U.S. Geological Survey Circular 1337. U.S. Geological Survey, Denver, Colorado.

48. USGS. 2010. Graham, J.L, Loftin, K.A., Meyer, M.T., Ziegler, A.C. *Cyanotoxin Mixtures and Taste-and-Odor Compounds in Cyanobacterial Blooms from the Midwestern United States.* Environmental Science and Technology, doi: 10.1021/es1008938.

49. Selch, Trevor M. 2008. *Factors Affecting Mercury Accumulation in South Dakota Fishes*. Doctor of Philosophy Dissertation. Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, South Dakota.

50. Stone, J.J., C.M. McCutcheon, L.D. Stetler, and S.R. Chipps. 2011. *Interrelationships between fish tissue mercury concentrations and water quality for South Dakota natural lakes and impoundments*. Water, Air and Soil Pollution 222:337-349.

51. Strom, Roger. 2010. *Final Report Central Big Sioux River Watershed Project – Segment 1*. East Dakota Water Development District, Brookings, South Dakota.

52. Welch, T.J. July 2000. *Brush Management Methods.* Bulletin E-44. Agri-Life Extension, Texan A&M University System. https://agrilifebookstore.org/publications.

53. Westoby, M., B. Walker, and I. Noy-Meir. 1989. *Opportunistic Management for Rangelands Not at Equilibrium.* Journal of Range Management 42:266-274.

54. Yuan, Y., R.L. Bingner, and J. Boydstun. Development of TMDL Watershed Implementation Plan Using Annualized AGNPS. Land Use and Water Resources Research 6 (2006) 2.1-2.8

55. Zhang, Y., Hernandez, M., Anson, E.L., Nearing, M.A., Wei, H., Stone, J.J., Heilman, P. 2012. Modeling Climate Change Effects on Runoff and Soil Erosion in Southeastern Arizona Rangelands and Implications for Mitigation with Rangeland Conservation Practices. Journal of Soil and Water Conservation. 67(5): 390-405.