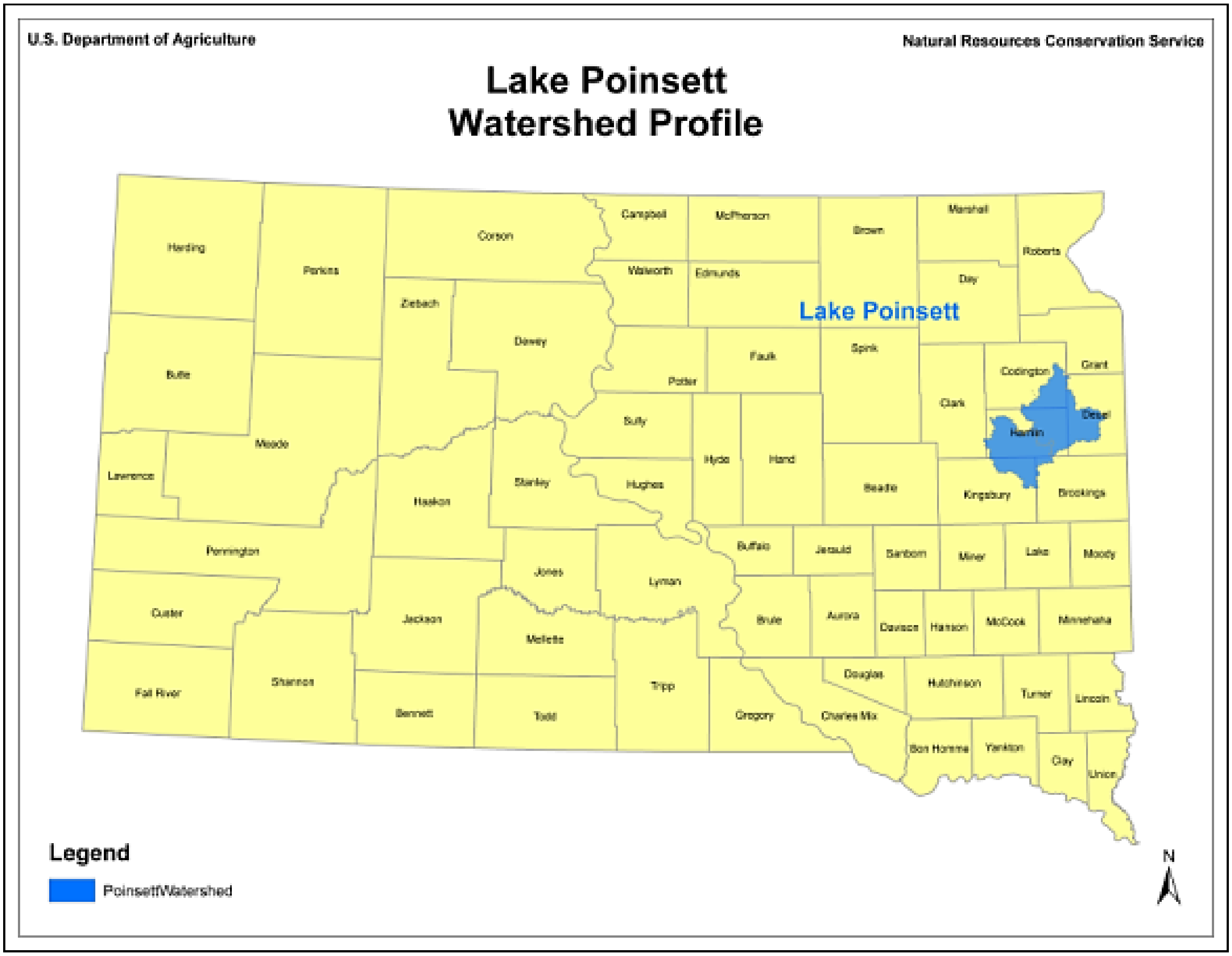

LAKE POINSETT WATERSHED STRATEGIC PLAN

In Cooperation With:
South Dakota Conservation Districts
South Dakota Association of Conservation Districts
South Dakota Department of Environment and Natural Resources
USDA Natural Resources Conservation Service
Date: August 2013

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Executive Summary

Lake Poinsett is one of the largest natural lakes located in eastern South Dakota with a surface area of 7,868 acres and a contributing watershed of 287,628 acres. Its watershed increases during flood flow conditions of the Big Sioux River Basin by approximately 470,000 acres due to its connection to Lake Poinsett through the Boswell diversion ditch. Lake Poinsett is a lake highly developed for both recreational and commercial purposes. Excessive algal blooms have historically plagued the lake and hampered recreational uses during the summer months of the year. The algal blooms were caused by excessive nutrients delivered from several sources within the watershed. Early studies in the 1970's had determined that Lake Poinsett had reached a state of super phosphorus saturation known as a hypereutrophic state.

The Lake Poinsett Water Project District requested the South Dakota Department of Environment and Natural Resources (SDDENR) to conduct a Phase I Diagnostic/Feasibility Study in 1993. The objective was to determine the extent and location of nutrient and sediment inputs to the lake and delineate their effect on the trophic status of Lake Poinsett. The watershed analysis revealed high concentrations of nitrogen, phosphorus, sediment, and fecal coliform bacteria from the Big Sioux River and the Lake Albert drainage area. The purpose of the Boswell diversion ditch was to route floodwaters from the Big Sioux River to Lake Poinsett for off-stream storage of floodwaters and act as a surface recharge to the lake. The ditch capacity was increased threefold in 1955, and the natural outlet to the lake was modified in 1989 to include a control structure. The Boswell diversion ditch gates are currently inoperable and remain closed. A sediment survey, conducted on Lake Poinsett, concluded that a sediment removal project would not be required, although the lake was accumulating both nutrients and sediments. The 1996 SDDENR study found a strong relationship between in-lake total phosphorus and the severe algal blooms. It was determined that the inflow of total phosphorus must be reduced to obtain a reduction in the blue-green algae.

Recommendations to reduce phosphorus and sediment inflow to Lake Poinsett were the installation of a Centralized Sanitary Sewer System, proper operation of the Boswell ditch and the outlet structure, reduction of the use of lawn fertilizers around the lake, construction of animal waste management systems for the identified animal feeding operations, installation of grass buffer strips and critical area grass seedings, and implementation of crop residue management in critically identified agricultural fields. The diagnostic/feasibility study led to Segment 1 of the Lake Poinsett Watershed Project (LPWP) that implemented the recommended Best Management Practices (BMP) from 1998 through 2007. The watershed area for the LPWP included Lake Poinsett, Lake Albert, Lake Norden, Lake St. John, Marsh Lake, Lake Mary, Dry Lake, Thisted Lake, and Badger Lake. The goal of a 40% reduction in both nutrient and sediment loading was established, and the phosphorus reduction goal was reached by the LPWP. Segment 2 of the Lake Poinsett Watershed Implementation Project (LPWIP) was initiated in June 2007 and is planned to be in operation until July 2014. Both the LPWP and LPWIP were sponsored by the Hamlin County Conservation District. The LPWIP was amended in 2010 to include the adjoining North Central Big Sioux River watershed from Watertown to Estelline and the watersheds of Willow Creek, Stray Horse Creek, and Hidewood Creek.

The *2012 South Dakota-DENR Integrated Report for Surface Water Quality Assessment* for water bodies in the LPWIP area stated that Chlorophyll-*a*, *Escherichia coli,* and fecal coliform bacteria were the identified impairments listed within the watershed area. Point sources of pollutants were investigated for the five water bodies listed as 303(d) impaired in the 2012 SDDENR Integrated Report; Segment R7 of the Big Sioux River, Bullhead Lake, Willow Creek, Stray Horse Creek, and Hidewood Creek. The investigations did not identify any significant point discharges in the water bodies. The TMDL studies found that municipalities had either zero discharge NPDES permits, discharges that were NPDES permitted and controlled or the discharges were so minor and/or infrequent as to be negligible, and the remaining human produced fecals not delivered to a municipal treatment facility had a minimal impact on total loading**.**

The nonpoint sources of pollutants for these five water bodies listed as 303(d) impaired were also investigated. Water quality studies in the LPWIP area concluded that nonpoint pollution sources were the major contributors of excessive nutrients and sediments to the watershed. These sources were the Big Sioux River floodwaters through the Boswell diversion ditch, sheet and rill erosion from the agricultural lands, manure from livestock feedlots, livestock defecating while wading in water bodies and defecating while grazing on rangeland, and lake shore line erosion.

Water bodies that have met the 303(d) criteria of all their designated beneficial uses, per SDDENR IR 2012, were Lake Albert, Clear Lake, Lake Norden, Lake Poinsett, School Lake, Lake St. John, and segment R8 of the Big Sioux River. The water body of Lake Marsh was reported in the 2012 SDDENR IR to have insufficient water quality data to ascertain whether it met the supporting criteria of all the designated beneficial uses.

The Hamlin Conservation District is the current project sponsor and the lead agency responsible for the completion of the goals, objectives, and tasks of the LPWIP. The Conservation District has entered into a cooperative agreement with the Codington, Deuel, and Kingsbury Conservation Districts to help advise the project sponsor, develop priorities, practice manuals, work plans, and strategies for the LPWIP. The goal of this strategic plan is to identify the pollutant sources for the 303(d) listed water bodies; to find suitable Best Management Practices (BMP) that, when implemented, will result in the delisting of the 303(d) water bodies; and to identify practice and administrative costs and goals over a five year period. The Best Management Practices in this Strategic Plan have been selected based on the identified 303(d) pollutants and their success at achieving load reductions. The implementation of these BMPs should achieve delisting of the identified water bodies by eliminating or reducing the nutrient, sediment, and fecal coliform bacteria loadings in the LPWIP area.

1. INTRODUCTION

1.1 Project Background and Scope

Lake Poinsett is a 7,868 acre glacial lake with 287,628 acres of watershed, excluding the Big Sioux River watershed, located in Hamlin County, approximately eight miles southeast of Hayti, South Dakota. The lake is the last in a chain-of-lakes that outlets into the Big Sioux River that includes Marsh Lake, Dry Lake, Badger Lake, Thisted Lake, Mary Lake, Lake Norden, Lake Albert, and St. John Lake. See Figure 1-1. Dry Lake is located on the north branch of Lake Poinsett and is hydraulically connected to Lake Poinsett. Historically, excessive algal blooms on Lake Poinsett had consistently hampered recreational use during the summer months of the year (SDDENR 1996). The algal blooms were caused by excessive nutrients delivered annually from several sources within the watershed. Skille (1971) reported that the nutrient levels in Lake Poinsett had reached a hypereutrophic system, a state of super saturation. Lake Poinsett is a lake highly developed for both recreation and business with 622 cabins and businesses located around the lake (SDDENR 1996).

The Lake Poinsett Watershed Improvement Project (LPWIP) is located within a portion of the Big Sioux River watershed. The Big Sioux River watershed drains approximately 5,282 square miles in eastern South Dakota and an additional 3,000 square miles in southwestern Minnesota and northwestern Iowa. The river's headwaters start near Summit, South Dakota, and flow southward for approximately 420 miles to its confluence with the Missouri River near Sioux City, Iowa. Its elevation above mean sea level is 1,826 feet near Summit and 1,085 feet at its mouth near Sioux City. The LPWIP area includes the watersheds of the Lake Poinsett chain-of-lakes and the immediate watershed of the Big Sioux River from Willow Creek to Stray Horse Creek.

Lake Poinsett is connected to the Big Sioux River through Dry Lake by the Boswell diversion ditch. The Boswell diversion ditch is a two mile constructed channel built in 1929 to route floodwaters from the Big Sioux River to Dry Lake and then to Lake Poinsett. Its purpose was to use Lake Poinsett and Dry Lake for off-stream storage of the Big Sioux River flood waters as a surface water recharge for the lakes. The ditch was modified in 1955 to increase its maximum capacity flow from 500 cubic feet per second (cfs) to 1500 cfs. The ditch currently is permanently blocked to inflow water from the Big Sioux River (Smith, personal communication). However, the Boswell diversion ditch control gates are overtopped when flood conditions occur on the adjacent reach of the Big Sioux River (SDDENR 1996). Dry Lake and Lake Poinsett are hydraulically connected by a thick sand and gravel deposit and an extensive aquifer northeast of Lake Poinsett that hydraulically connects both Lakes to the Big Sioux River (SDGS 1971).

During the flood of 1969, it was calculated that 25% of the water in Lake Poinsett was floodwater. It was found that the phosphorous concentration of the Big Sioux River has consistently been three to ten times the concentration of the water measured at the inlet of water from Lake Albert to Lake Poinsett. Phosphorous levels of the Big Sioux River during the flood of 1969 were 1.3 parts per million (ppm), and it was estimated these floodwaters could raise the Lake Poinsett phosphorous levels to 0.32 ppm (SDGS 1971). The Boswell diversion ditch, which connected Lake Poinsett to the Big Sioux River, thus added to phosphorous loading into the lake. Skille (1971) calculated that 63% of the phosphorous loading to Lake Poinsett was from the Boswell diversion ditch-Big Sioux River system, and that Lake Poinsett retained 70% of the delivered phosphorous loading in the lake. The South Dakota Department of Game, Fish, & Parks (SDGFP) has jurisdiction over the diversion and recognized the impact that the lower water quality of the Big Sioux River had on Dry Lake and Lake Poinsett and rendered the gates inoperable.

The natural outlet of Lake Poinsett is located in the northeast section of the lake where it delivers its lake water into the Big Sioux River. After flooding in 1986, the natural outlet of Lake Poinsett was modified to include a flood control structure to prevent the backflow of flood waters from the Big Sioux River into the lake. The structure was completed in 1989 and constructed to an elevation of 1,650.5 feet above mean sea level (msl), one foot below the Lake Poinsett ordinary high water mark of 1,651.5 msl.

The Big Sioux River basin’s primary source of income is agriculture and it is also the heaviest populated basin in the state. The Sioux City Journal (May 7, 2012) reported that the advocacy group, Environment America, ranked the Big Sioux River as the nation's 13th dirtiest river. To address the pollution in the Big Sioux River, the SDDENR divided the stream into four large assessment projects; the Upper Big Sioux, the North Central Big Sioux, the Central Big Sioux, and the Lower Big Sioux. The LPWIP subwatershed is located within the North Central Big Sioux River Watershed assessment project and within two Hydrological Units (HU): the Upper Big Sioux HU10170201 and the Middle Big Sioux HU 10170202. See Figure 1-2 for HU boundaries. The five counties within this watershed are Brookings, Codington, Deuel, Hamlin, and Kingsbury.

1.2 Lake Poinsett Watershed Improvement Project Watershed History

The Lake Poinsett watershed project had its beginnings in 1993 when the South Dakota Department of Environment and Natural Resources (SDDENR) began a Phase I Diagnostic Feasibility Study at the request of the Lake Poinsett Water Project District (LPWP). The objective of this assessment was to determine the extent and location of nutrient and sediment inputs into the lake and eliminate their effects on the trophic status of Lake Poinsett. Previous studies by Skille (1971), Thompson (1973), and South Dakota Geological Survey (SDGS, 1971) had already identified that Lake Poinsett was a hypereutrophic system whose trophic state was driven by phosphorous loadings from Lake Albert and the Big Sioux River. Water quality data was collected from 1993-1994, and the restoration alternatives presented in the Phase I study were: (1) expand the sanitary sewer system, (2) reduce the use of lawn fertilizers containing phosphorous, (3) control or eliminate the inflow of water through the Boswell ditch, (4) close the outlet during periods of reverse-flow from the Big Sioux River, (5) address animal feedlots that ranked high on AGNPS, (6) implement Best Management Practices on farmland in the watershed, (7) continue to remove rough fish, and (8) selective dredging on Dry Lake, (9) construction of small dams between the Lake Thisted outlet and Lake Albert Creek.

Figure 1-1. Water Flow through Lake Poinsett Chain-of-Lakes

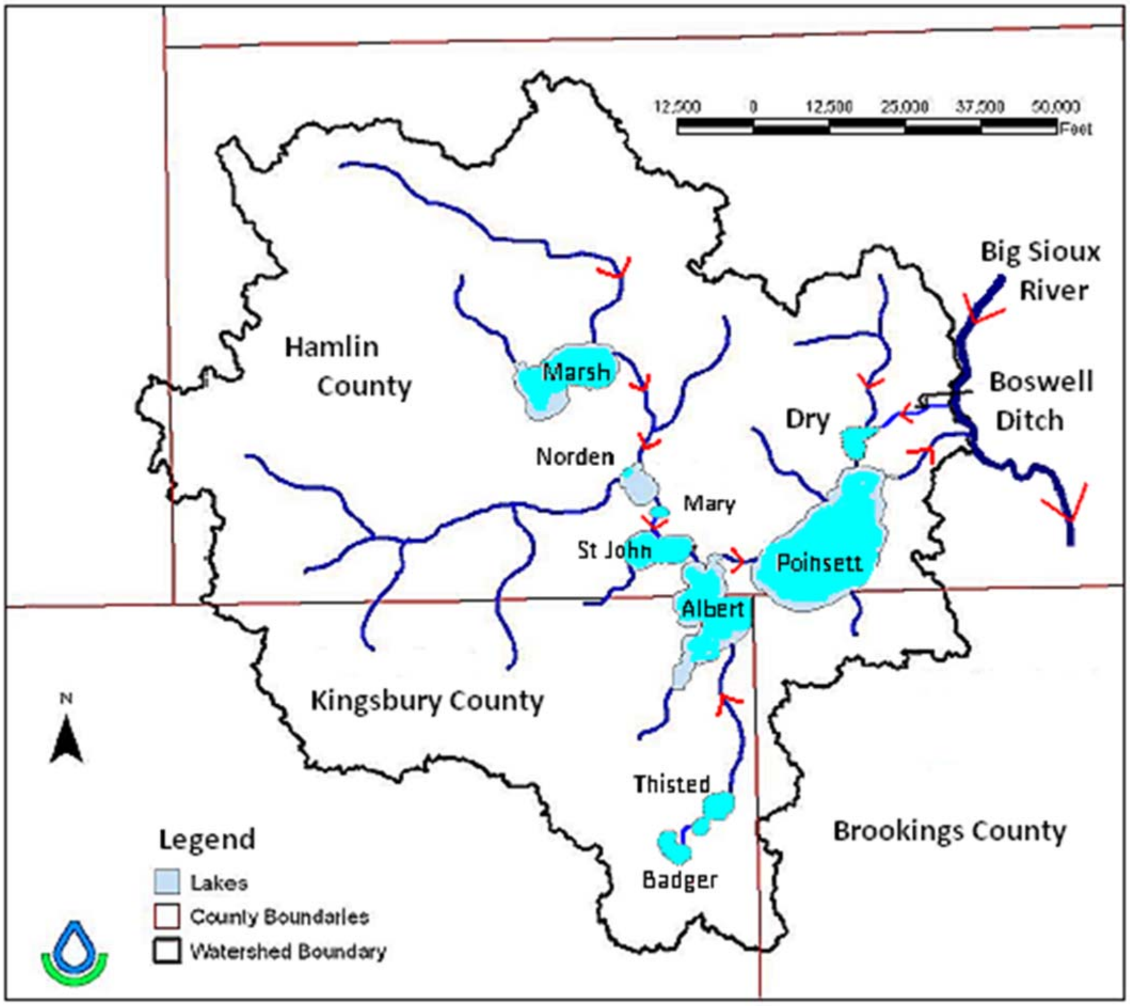
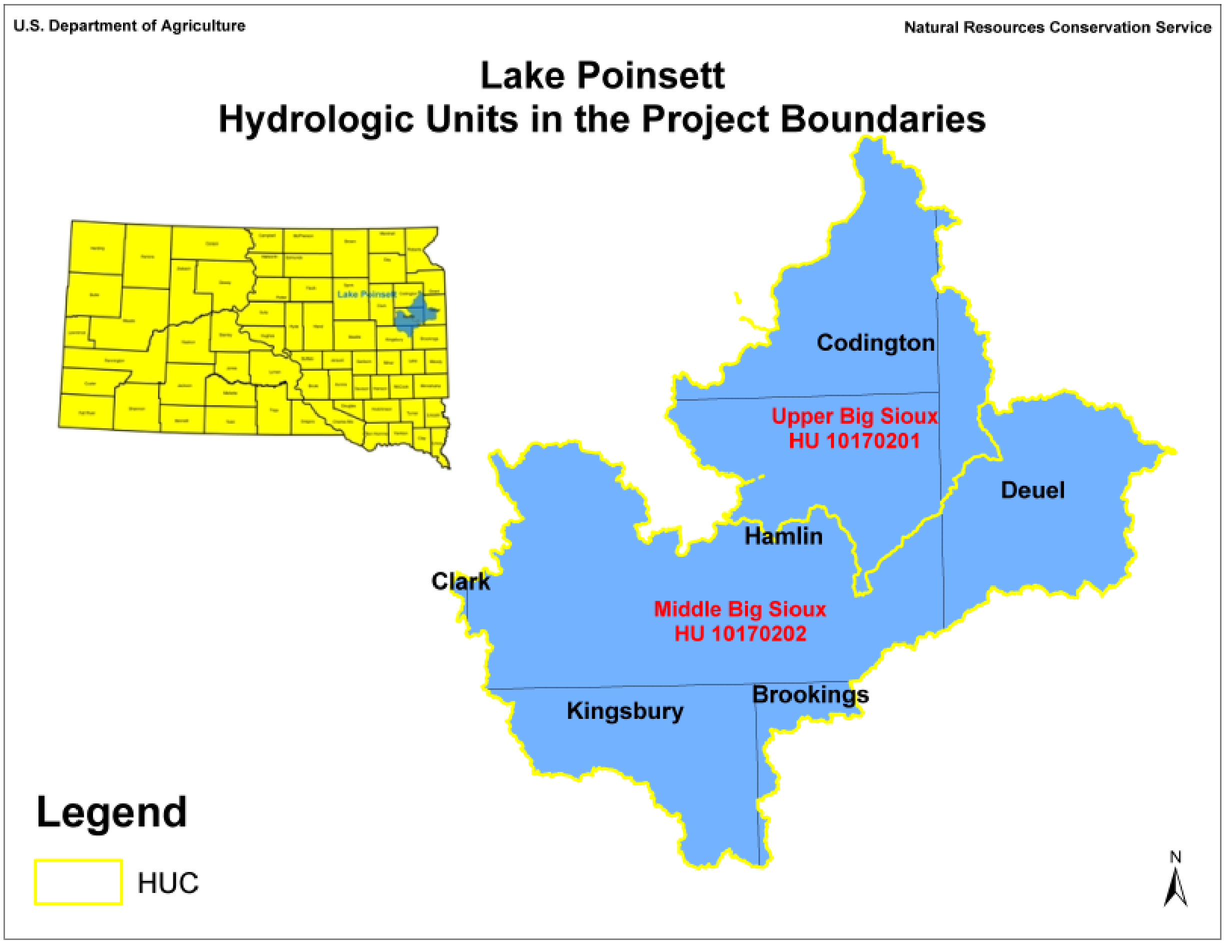


Figure 1-2. Hydrological Units in the LPWIP



The 1995 Lake Poinsett Assessment identified an annual phosphorus loading of 33,642 pounds per year (lbs/yr) and recommended a goal of a 20% reduction in both nutrient and sediment loading. The Hamlin County Conservation District applied for sponsorship for a project implementation program to install Best Management Practices (BMP). When funding became available for Segment 1 of the LPWP, the goal was increased to 40% for both pollutants. The LPWP was amended in 2005 to include the subwatersheds of Lake Marsh and Dolph Creek. The BMP’s implemented from the 1998-2007 LPWP reduced the phosphorous load to the lake by 56%, exceeding the reduction goal set for Segment 1 (Smith 2007). A summary of the BMPs installed in Segment 1 is given in Table 1-1.

Table 1-1. BMPs Installed LPWP 1998-2007				
BMPs	**Quantity**		**BMPs**	**Quantity**
Crop Residue Mgt	**2,060 Ac**		**Streamside Buffers**	**90 Ac**
Grass Established	**5,331 Ac**		**Grassed Waterways**	**11 Ac**
Grazing Plans	**1,350 Ac**		**Shoreline Stabilization**	**12,000 LF**
Sediment Dams	**385 Ac**		**Animal Feedlots**	**13 Lots**

In 2010, the Hamlin County CD amended the Segment 2 LPWIP to include the Willow Creek, Stray Horse Creek, Hidewood Creek, and the adjacent subwatersheds of the Big Sioux River from Watertown to Estelline. See Figure 1-3. This amendment to the Segment 2 of the LPWIP brought 367,665 additional acres into the project area. The project proposals were developed by Hamlin, Codington, Deuel, and Kingsbury Conservation District representatives with assistance from the Lake Poinsett Water Project District, Lake Poinsett Sanitary District, East Dakota Water Development District, the South Dakota Association of Conservation Districts, the South Dakota Department of Environment and Natural Resources, the South Dakota Department of Agriculture, and the Natural Resources Conservation Service, all meeting as a project advisory work group. Past watershed projects implementing these Best Management Practices (BMP) to address resource concerns were the: (1) Rural Clean Water Program, (2) Segment 1 of the LPWP, and (3) the current LPWIP Segment 2 initiated by the Hamlin Conservation District in 2007.

Monies and in-kind match for these implementation projects came from the landowners, Lake Poinsett Water Project District, Hamlin Conservation District, Duck Unlimited, Pheasants Forever, the East Dakota Water Development District completed water sampling and analysis, the South Dakota Department of Environment and Natural Resources Consolidated Facilities Construction Fund and Consolidated Water Facilities Construction Fund, the South Dakota Game, Fish, and Parks Private Lands Program, the South Dakota Department of Agriculture Land and Water Conservation Grant Program, the USDA Natural Resources Conservation Service, the US Environmental Protection Agency 319 funds, the USDA Farm Services Agency, and the US Fish & Wildlife Service.

The Lake Poinsett Watershed Improvement Project (LPWIP) watershed area is largely rural in nature with the City of Watertown having the largest population at 21,482 residents. The second largest city is Clear Lake with a population of 1,273 residents. There are approximately 11 incorporated and unincorporated cities and villages within the watershed. Table 1-2 lists the cities' and the counties' populations in the watershed. A map of the cities, and counties, locations and watershed boundaries is shown in Figure 1-4.

The climate of the LPWIP area is classified as sub-humid continental. The highest mean temperature in the northern part of the basin for the city of Watertown is 82.5 degrees Fahrenheit (^{o}F) in July, while the lowest mean temperature in January is -0.1 ^{o}F; the average median temperature is 42.0 ^{o}F. The highest mean temperature at the south end of the basin for the city of

Brookings is 82.7 °F in July, while the lowest mean in January is 0.3 °F; the average median temperature is 43.12 °F. The annual precipitation in Watertown and Brookings is 21.94 and 22.81 inches, respectively. The weather data references are from the South Dakota State University South Dakota Climate and Weather. Climate conditions are relatively uniform throughout the watershed, which experiences all of the conditions of the temperate continental climate classification; pronounced seasonality with long, cold winters, hot summers, mid-latitude cyclonic storms, and variable precipitation. Strong, persistent, surface wind patterns blow across the watershed from the north and northwest during the colder part of the year.

Figure 1-3. LPWIP Lake Poinsett and North Central Big Sioux River Watershed Areas

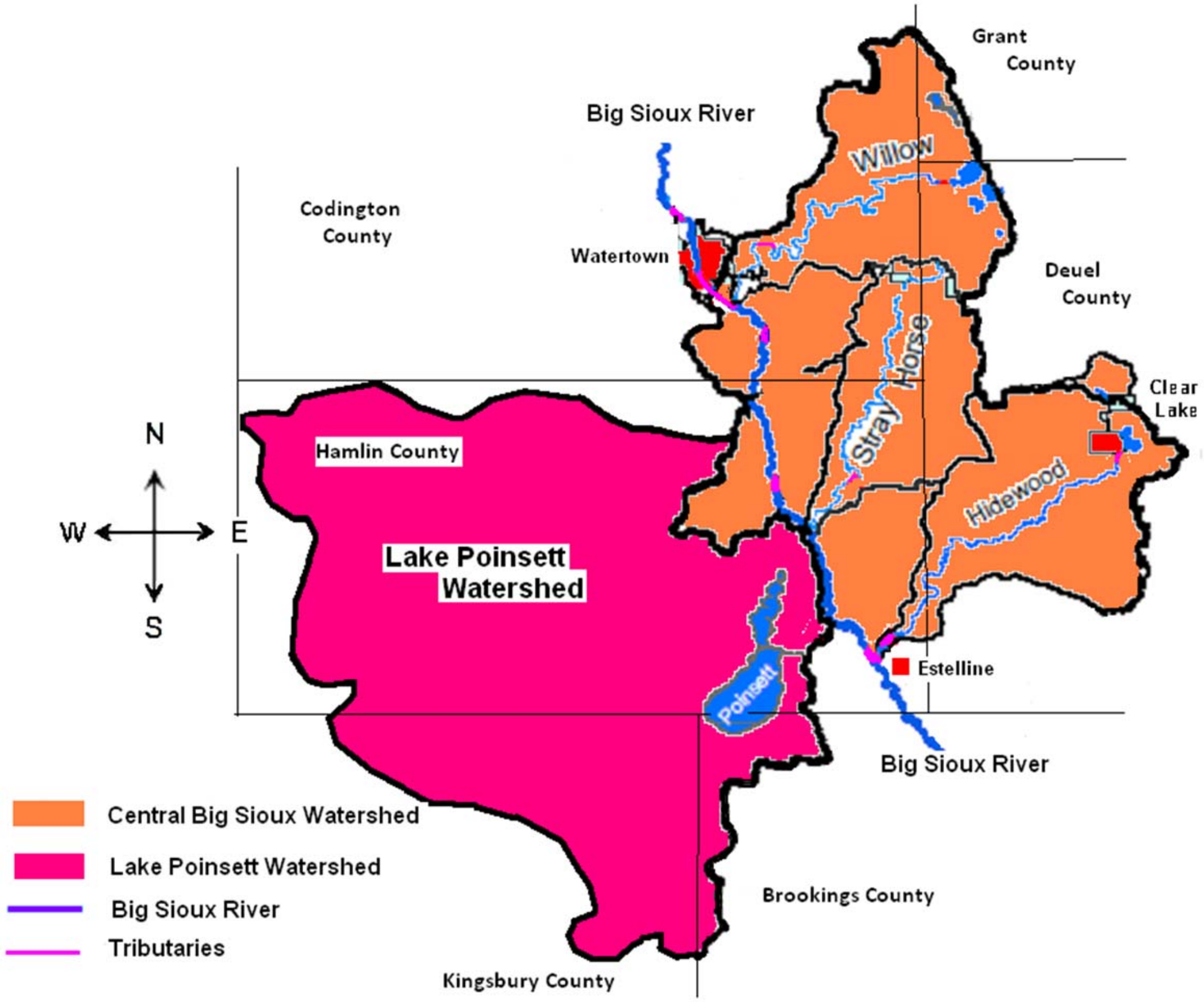
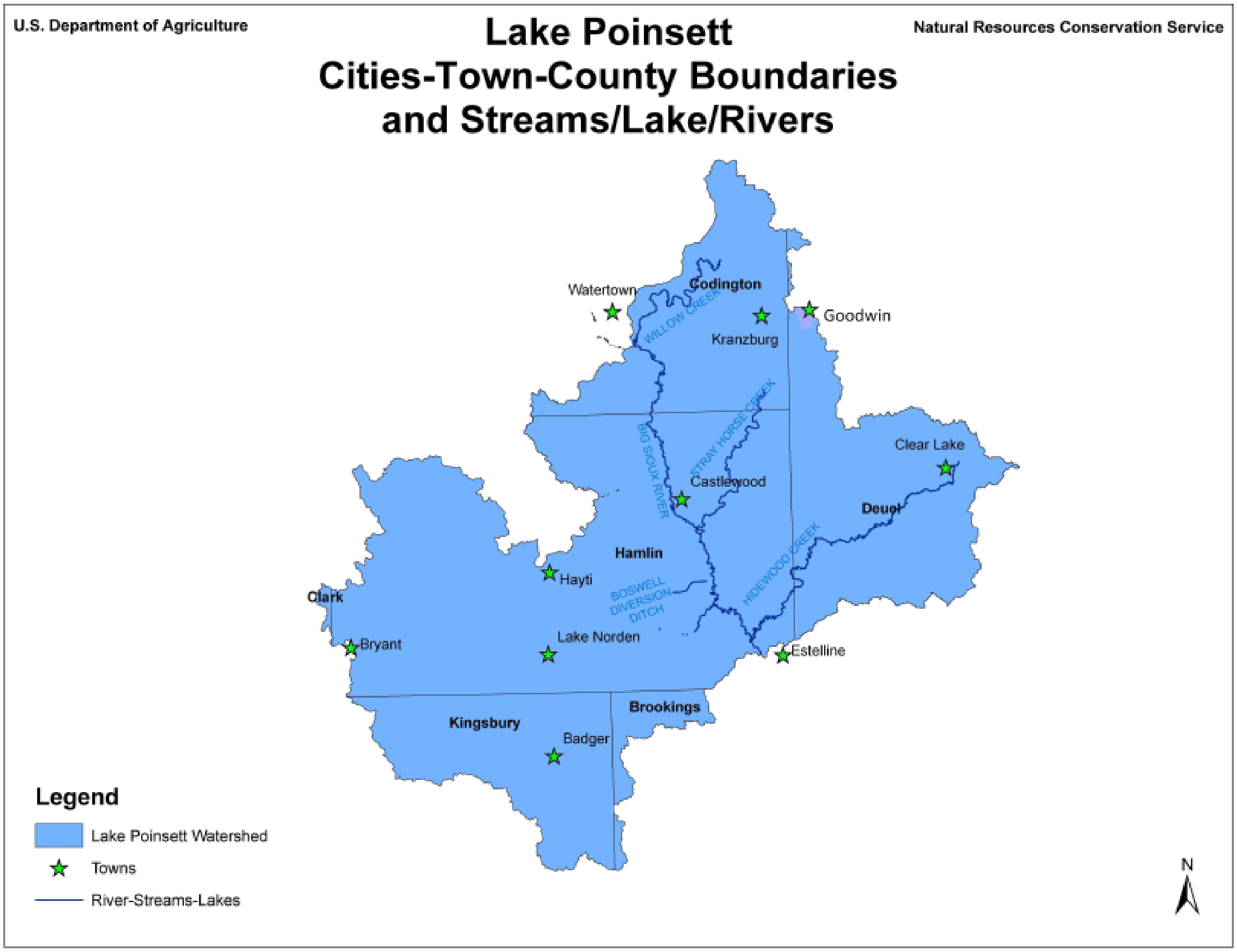


Table 1-2. Population Statistics of the LPWIP

Population Statistics of the LPWIP. US Census Bureau 2010 Census					
City Populations				Total County Populations	
City	Population	County		County	Population
Watertown	21,482	Codington		Codington	27,227
Clear Lake	1,273	Deuel		Deuel	4,364
Estelline	768	Hamlin		Hamlin	5,839
Castlewood	627	Hamlin		Kingsbury	5,159
Lake Norden	467	Hamlin			
Bryant	456	Hamlin			
Hayti	381	Hamlin			
Kranzburg	172	Codington			
Goodwin	146	Deuel			
Badger	107	Kingsbury			
Vienna	45	Hamlin		Total	42,589

Figure 1-4. Cities, Counties, Water Bodies of the LPWIP



1.3 Lake Poinsett Watershed Improvement Project Water Quality Studies

Lake Poinsett was addressed in the SDDENR-IR's of 2000, 2002, and 2004 as only partially meeting its designated beneficial uses for Total Phosphorous (TP) and Trophic State Index (TSI). Early studies had shown the lake to be hypereutrophic and with excessive phosphorous being retained in its system. The LPWIP was active in implementing BMPs, and Lake Poinsett was listed in the SDDENR Integrated Reports as meeting all its designated beneficial uses in 2006 through 2012.

Seven other lakes in the watershed have also been assessed for water quality: Lake Albert, Bullhead Lake, Clear Lake, Lake Marsh, Lake Norden, School Lake, and Lake St. John. All these lakes were classified in the SDDENR-IR 2012 as fully supporting their designated beneficial uses except for: (1) Bullhead Lake which was 303(d) listed for chlorophyll-*a*, and (2) Lake Marsh for which there was insufficient data to make a determination. Based on the

SDDENR IR years from 1998 to 2012, the overall trend of the lakes has been toward the improvement of the water quality. School Lake was listed for Trophic State Index (TSI) and was delisted in 2012; Lake Albert, Lake Norden, and Lake St. John had been listed for TSI and were delisted in 2010; Clear Lake had been listed for TSI and was delisted in 2008; and Lake Poinsett was listed as impaired in 2004 for TSI and was delisted in 2006. The major causes of nonsupport listed in past SDENR Integrated Reports were algal growth, pH, TSI, nutrient enrichment, siltation, and alteration of lake water levels.

Five streams and/or stream segments within the LPWIP were reported on in the 2012 SDDENR-IR. Four segments did not fully support the designated beneficial uses because of *E. coli* and/or fecal coliform bacteria: segment R7 of the Big Sioux River from Willow Creek to Stray Horse Creek, Willow Creek, Stray Horse Creek, and Hidewood Creek. The sources of bacterial contamination of the stream segments were reported as coming from animal feeding operations, livestock defecating while wading in the water, and livestock defecation while grazing on grass lands (SDDENR 2011). The downstream segment R8 of the Big Sioux River from Stray Horse Creek to near Volga was in full support of its designated beneficial uses.

Water quality studies and reports have been completed on the lakes and streams within the Lake Poinsett watershed and the reach of the Big Sioux River from Watertown to Estelline. Short synopses of these reports are given as follows:

- The TMDL for *Escherichia coli* in segment 3 of the Big Sioux River (R7) from Willow Creek to Stray Horse Creek was established in the document *Escherichia coli Total Maximum Daily Load Evaluation of the Big Sioux River, Codington and Hamlin Counties*, South Dakota in January 2011. The source allocation of *E. coli* was attributed to being 99.0% from domestic livestock, either from animal feeding operations or livestock on grass. This segment of the Big Sioux River was listed as 303(d) impaired for Limited Contact Recreation because of *Escherichia coli* and Fecal Coliform bacteria in the SDDENR Integrated Report of 2012.

- The *Lake Poinsett Watershed Project Segment 1 Final Report of 2007* gave a detailed report of the BMP implementation, program activities, and administrative costs of the project from 1998-2007. Load reductions of BMPs were calculated, and the goal of a 40% load reduction for both nutrients and sediment loading were exceeded.

- The *Lake Poinsett Watershed Implementation Project, Segment 2 – Amendment* expanded the LPWIP area to include portions of the North Central Big Sioux River in the Lake Poinsett Project. This 2010 expansion included the portions of the Big Sioux River upstream from the Brookings-Hamlin County line to the discharge area of Willow Creek into the Big Sioux River near Watertown. The subwatersheds of Willow Creek, Stay Horse Creek, Hidewood Creek, and this segment of the Big Sioux River would be addressed with the same criteria as the LPWIP area.

- The *Phase I Watershed Assessment Final Report and TMDLs, North-Central Big Sioux River, Brookings, Hamlin, Deuel, and Codington Counties, South Dakota*, 2005 studied the water quality in the Big Sioux River (Segments R7 & R8), Willow Creek, Stray Horse Creek, and Hidewood Creek from 2001-2006. The goals of this assessment were to determine the sources of impairments, identify feasible restoration alternatives, and to develop TMDLs on the identified pollutants. Segment R7 of the Big Sioux River was listed as 303(d) impaired for Limited Contact Recreation because of *Escherichia coli* and Fecal Coliform bacteria, and the watersheds of Willow Creek, Stray Horse Creek, and Hidewood Creek were listed as 303(d) impaired for Limited Contact Recreation due to Fecal Coliform bacteria in the SDDENR Integrated Report of 2012.

- The TMDL for Fecal Coliform bacteria in river segment SD-BS-R-Big Sioux-03 of the Big Sioux River (R7) from Willow Creek to Stray Horse Creek was established in the document *Total Maximum Daily Load Evaluation (Fecal Coliform Bacteria) for the Big Sioux River (Willow Creek to Stray Horse Creek) Codington and Hamlin Counties,* South Dakota in December 2005. The source allocation of *E. coli* was attributed to being 99.0% from domestic livestock, either from animal feeding operations or livestock on grass. This segment of the Big Sioux River was listed as 303(d) impaired for Limited Contact Recreation because of *Escherichia coli* and Fecal Coliform bacteria in the SDDENR Integrated Report of 2012.

- The chain-of-lakes Bullhead Lake, Round Lake, and Wigdale Lake draining into School Lake were studied in the *Phase I Watershed Assessment Final Report and TMDL, School Lake, Deuel County, South Dakota*. The final report by SDDENR was published in August of 2005, and these lakes were considered hypereutrophic. Although these lakes are not within the LPWIP area, they do drain into Willow Creek. TMDLs were established for Bullhead Lake, Round Lake, and School Lake. Bullhead Lake was 303(d) listed as impaired in the 2012 SDDENR Integrated Report by chlorophyll-*a*, however the source is listed as unknown. Round Lake and Wigdale Lake are not addressed in the 2012 SDDENR Integrated Report. School Lake was not 303(d) listed as impaired in the 2012 SDDENR Integrated Report.

- The TMDL was established for Hidewood Creek by DENR in 2004 in the document *Total Maximum Daily Load for Ammonia in Hidewood Creek near Clear Lake, South Dakota*. Point source ammonia loads at critical low flow condition were primarily due to discharges from the City of Clear Lake's municipal wastewater treatment facility. Water quality controls on this point source loading were established through the TMDL determination. Hidewood Creek was 303(d) listed as impaired in the 2012 SDDENR Integrated Report for Limited Contact Recreation by fecal coliform bacteria.

- Clear Lake was reported on in the 1999 *Phase I Watershed Assessment Final Report, Clear Lake, Deuel County, South Dakota* by the SDDENR. The study utilized the AGNPS computer program to evaluate the Nonpoint Source (NPS) from each subwatershed; to define the critical NPS cells with elevated sediment, nitrogen, and phosphorous; and to rank each Animal Feeding Operation (AFO) based on nutrient load delivery. Clear Lake was not 303(d) listed as impaired in the 2012 SDDENR Integrated Report.

- The 1996 *Phase I Diagnostic Feasibility Report*, *Lake Poinsett*, *Hamlin County, South Dakota*, studied the water quality of Lake Poinsett from 1993-1995. The phosphorous loading results indicated that 73.2% and 23.9% of the load came from the Lake Albert system and Dry Lake system, respectively. The report revealed that the inflow of total phosphorous would need to be reduced by 40% to reduce the algal biomass production from 773.77 tons to an estimated 157.7 tons. The AGNPS computer model was run on the watershed and identified critical areas within the Thisted Lake and Dry Lake areas. The report recommended the installation of a centralized sanitary sewer system, proper operation of the Boswell diversion ditch, construction of Animal Waste Management Systems (AWMS), the reduction in the use of lawn fertilizers, and the implementation of BMPs in identified Critical Areas identified by AGNPS.

- Bullhead Lake, Clear Lake, Lake Norden, Lake Poinsett, and School Lake were reported on in the *1995 South Dakota Lakes Assessment Final Report* published by SDDENR in August 1996. The intention of this report was to provide water quality information and to update the South Dakota Lakes Survey. The report is a database containing morphological and water quality information on 112 selected South Dakota lakes with public access. Bullhead Lake was the only lake of the five listed as 303(d) impaired for Chlorophyll-*a* in the 2012 SDDENR Integrated Report.

- The document *The Rural Clean Water Program: A Report* was prepared by Charles E. Little, May 1989, for the Soil & Water Conservation Society under contract with the U.S Department of Agriculture. The report details the Rural Clean Water Program (RCWP) which was implemented through the 1980 Agriculture Appropriation Act and provided monetary funding for the implementation of BMPs in the Lake Poinsett watershed. The RCWP was implemented in the early 1980's for the watersheds of Lake Poinsett, Dry Lake, Thisted Lake, Lake Albert, and Lake St. John of the current LPWIP.

- Charles W. Thompson completed a Master's Thesis on the *Origin and Transport of Nutrients in the Upper Big Sioux River, South Dakota*, in 1973. He evaluated nutrients from three watersheds: the Big Sioux River Basin above the city of Watertown, the Willow Creek Basin, and the city of Watertown. Approximately 59.5% of the Total Phosphorous (TP) leaving the study area came from the Big Sioux River and Willow Creek Basin and 40.5% from the city of Watertown. He concluded that it was necessary to improve the agricultural watershed and include tertiary-sewer treatment in wastewater treatment plants to improve water quality in the Big Sioux River. He reported that each segment studied, in itself, contributed enough nutrient material to maintain the Big Sioux River in the eutrophic condition.

- A thesis by Jack M. Skille in 1971, *Nutrient Transport in the Lake Poinsett System*, reported that 70% of the phosphorous load transported to the lake was retained by the lake. He reported that 63% of this phosphorous load came from the Big Sioux River-Dry Lake system. The Big Sioux River water entered the lake through the Boswell diversion ditch and was delivering a phosphorous load three times the concentration that was in the Lake Poinsett water. He reported Lake Poinsett was in an advance degree of eutrophication, a state of super-saturation, ascribable to the large annual nutrient loading and degree of retention by the lake system.

- The *Hydrology of Lake Poinsett* was reported on by Assad Barari in June of 1971 in the Report of Investigations Number 102 for the South Dakota Geological Survey. Barari's report indicated that Dry Lake and Lake Poinsett were hydraulically connected by a thick sand and gravel deposit and an extensive aquifer northeast of Lake Poinsett that connected both lakes to the Big Sioux River. The phosphorus levels in the floodwater of the Big Sioux River contained 1.30 parts per million (ppm), while the water of Lake Poinsett contained 0.32 ppm. He reported that high phosphorous levels were attributed to sewage treatment plants that did not include phosphate removal, lake cottages not having adequate sewage systems, and the need for additional soil conservation practices to be installed on agricultural lands.

1.4 Goals of the LPWIP Strategic Plan

The goal of this strategic plan for the Lake Poinsett Watershed Improvement Project is to identify the pollutant sources for the 303(d) listed water bodies and to find suitable Best Management

Practices (BMP) that, when implemented, will result in the delisting of the 303(d) water bodies. The implementation of the BMPs will eliminate or reduce the nutrient, sediment, and fecal coliform bacteria loadings to the LPWIP from its watershed and tributaries. The goal of the LPWIP for the Lake Poinsett watershed is to reduce phosphorus loading by 30% and sediment loading by 40%, while the goal of the Big Sioux River watershed portion will be to reduce fecal coliform bacteria. 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. CAUSES AND SOURCES OF IMPAIRMENTS

2.1 Geography

The Lake Poinsett watershed is located in the Level III Northern Glaciated Plains ecoregion. The Northern Glaciated Plains ecoregion was historically dominated by transitional grassland containing both tall grass and short grass prairie communities. Drift plains, large glacial lake basins, and shallow river valleys, with level to undulating surfaces and deep soils, provide the basis for crop agriculture. The young geologic age has left an immature drainage system, and the ecoregion is dotted with substantial numbers of wetland depressions, ranging in size and permanence. This moderately high concentration of semi-permanent and seasonal wetlands are commonly referred to as Prairie Potholes. The poorly drained soils developed on glacial till and loess east of the Missouri River tend to be clay rich with limited infiltration potential. More than 90 percent of runoff trapped in prairie potholes is typically lost to evapotranspiration (ET). Annual potential ET exceeds precipitation in most years, which explains why most prairie wetlands undergo a wet-dry cycle each year. The land surface is a nearly level to gently sloping, dissected glaciated plain. There are also sub-regional concentrations of glacial formed permanent lakes. Cropland, grassland, wetland, and surface water form the general mosaic of land covers within the Northern Glaciated Plains ecoregion.

The Lake Poinsett Watershed Improvement Project lies in the Central Feed Grains and Livestock Region, Land Resource Region M. The Major Land Resource Areas (MLRA) 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 MRLAs are subdivided into smaller more homogeneous resource areas referred to a Common Resource Areas (CRA). The LPWIP area is completely within the Rolling Till Prairie CRA 102A. See Figure 2-1.

The dominant landforms in this MLRA are stagnation moraines, end moraines, glacial outwash plains, terraces, and flood plains. The MLRA is dominated by till covered moraines. The stagnation moraines are gently undulating to steep and have many depressions and poorly defined drainages. The steepest slopes are on escarpments adjacent to the water courses. Small outwash areas are adjacent to the watercourses. Cretaceous Pierre Shale underlies the till in most of the area.

2.2 Soils

The dominant soil order in this MLRA is Mollisols. The soils dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and loamy. Hapludolls formed in loamy till (Barnes, Forman, and Hokans series), in loess or silty drift over till (Kranzburg, Poinsett, and Waubay series), in eolian deposits (Egeland and Embden series), and in glacial outwash (Arvilla, Fordville, and Renshaw series) on till plains and moraines. Calciudolls (Buse and Balaton series) formed in loamy till on rises and ridges. Argiaquolls (Parnell and Badger series) formed in loamy till and colluvial and alluvial sediment in swales and depressions. Argialbolls (Tonka series) and Endoaquolls formed in colluvial and alluvial sediment in depression (Quan series) and in alluvial sediment on flood plains (Lamoure and Rauville series). Calciaquolls (Marysland and Moritz series) formed in alluvial sediment on flood plains.

The predominant soil associations in the watershed area are shown on Figure 2-2. 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.

Figure 2-1. Common Resource Areas of the LPWIP

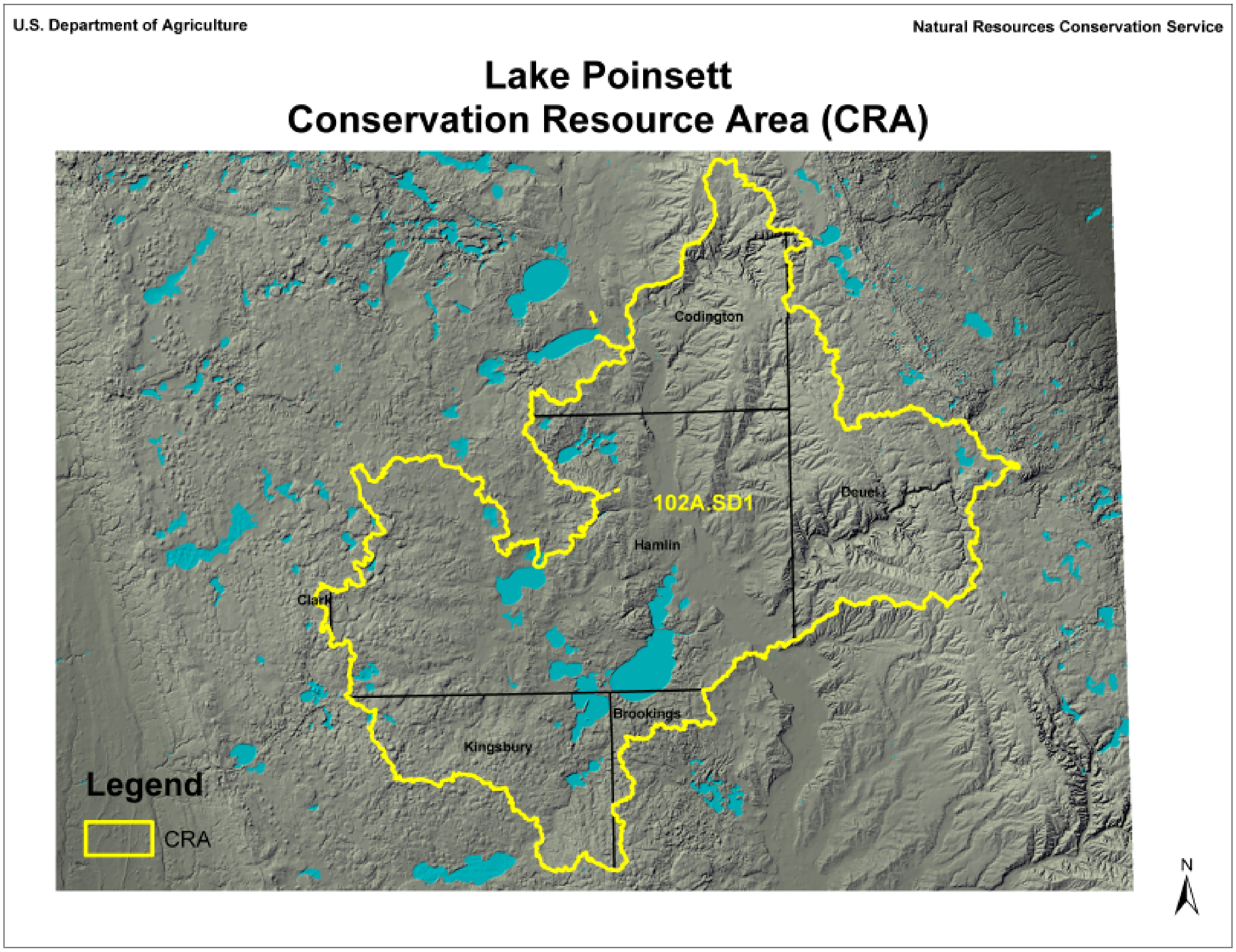
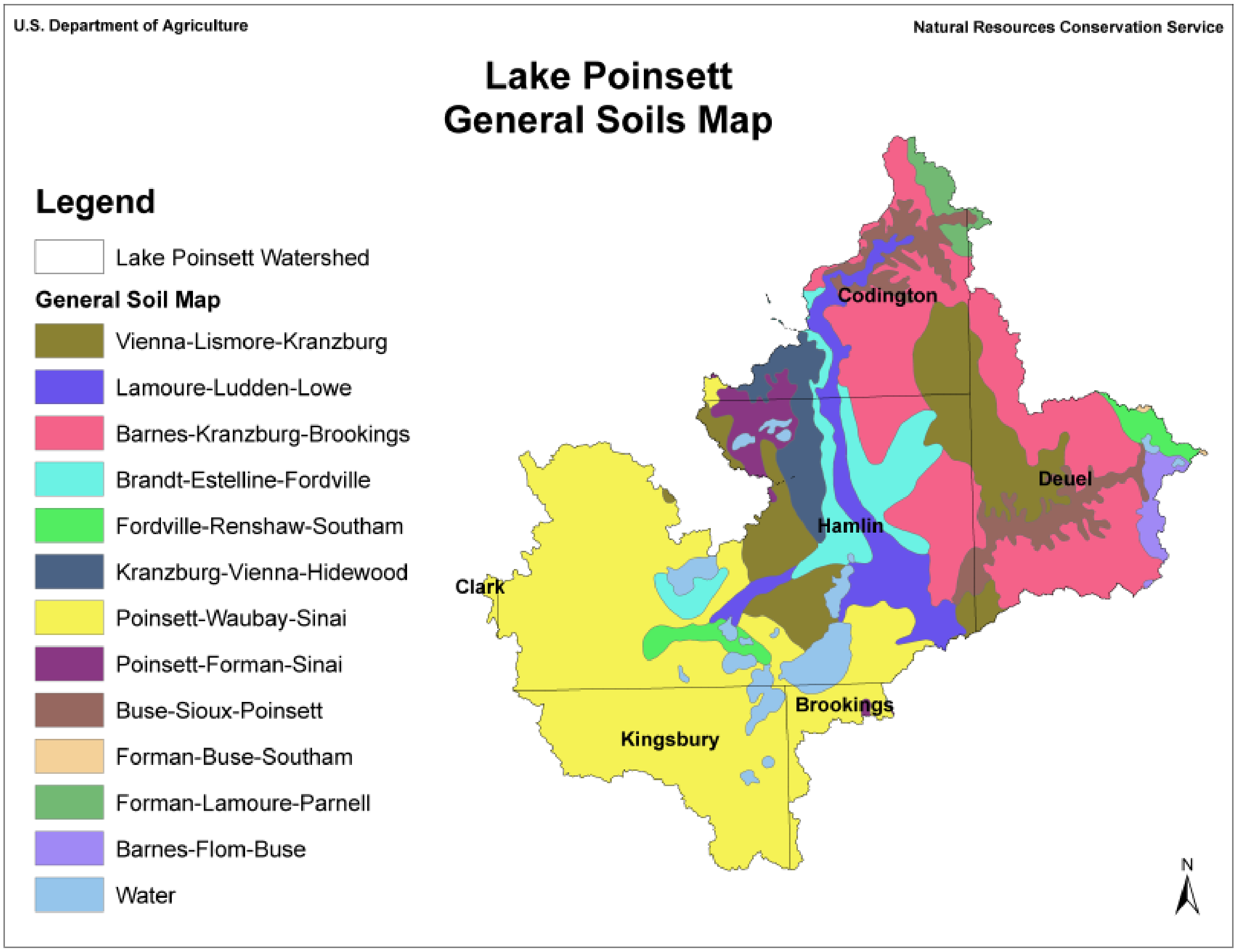


Figure 2-2. General Soils Map of the LPWIP



2.3 Land Use

The LPWIP area lies in the highly productive glaciated soils region in east central South Dakota. The land use of the watershed is estimated at about 61% cropland (Smith 2007) with the production of row crops and hay land as the primary cropland uses. The principal crops are corn, soybeans, alfalfa, spring wheat, and oats. Grazing lands make up approximately 17% of the acres being used for livestock operations. Wildlife lands consist of about 17% of the watershed acres with Forest, Roads, and Other uses comprising 5.0%. See Table 2-1 for the agricultural data of the total county land areas of each county within the LPWIP watershed.

Cropland and Rangeland productivity maps are presented in Figures 2-3 and 2-4, 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 natural lakes within the watershed. The major resource concerns are water erosion, soil wetness, wind erosion on lighter textured soils, maintenance of the content of organic matter and productivity of the soils, irrigation, 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. Preserving the quality of surface water and ground water is an additional concern in this region.

2.4 Water Resources

The total withdrawal of freshwater in the Rolling Till Prairie CRA averages about 145 million gallons per day. About 39 percent is from surface water sources, and 61 percent is from ground water sources. Precipitation is the principal source of moisture for crops, although in some years it is inadequate for maximum crop production. Both surface water and ground water are used for irrigation. Shallow wells in glacial outwash deposits, primarily sand and gravel, provide water for livestock, domestic use, and irrigation in this area. The water is hard but is of good quality with the median level of total dissolved solids at about 350 parts per million.

Ground water obtained from the Big Sioux Aquifer and several other minor aquifers are the sources of most good quality potable water used in the LPWIP. In some areas these aquifers can support the production of 1,000 gallons per minute capacity (SDGS 1997). Water in these surficial aquifers is easily susceptible to contamination from barnyards, feedlots, dump grounds, septic disposal fields, and crop fertilizers because they are near the land surface and covered with permeable material. Currently, three rural water systems provide service to the counties within the project area: Brookings-Deuel Rural Water System (RWS), Kingbrook RWS, and the Sioux RWS.

The Prairie Coteau is the next deep aquifer buried beneath the clay till. Its water is generally of poor quality, and many tested wells were high in nitrates. The most deeply buried aquifer in the glacial drift, lying directly on top of the bedrock surface, is the Altamont aquifer, which is saline, very hard, and high in sulfate. The deeper Dakota Formation is the only bedrock aquifer, but its water is high in boron, fluoride, sodium, sulfate, and, in some areas, chloride.

Table 2-1. Agricultural Data for Counties in LPWIP Watershed

Agricultural Data for Counties in the LPWIP Watershed						
	Brookings	Codington	Deuel	Hamlin	Kingsbury	Data Year
Total Land Area Acres	508,490	440,165	399,094	327,167	536,592	2010
Percent in Watershed	2	15	14	55	14	------
Number of Farms	986	663	583	449	551	2010
Total Cropland Acres	351,302	247,710	199,572	244,785	356,912	2010
Corn Acres	137,500	76,000	84,600	90,700	139,000	2010
Soybean Acres	126,000	85,500	87,500	90,000	137,000	2010
Small Grain Acres	14,700	45,400	24,300	12,700	4,900	2010
Hayland	33,000	35,000	31,000	12,000	34,000	2010
Pasture/Range Acres	18,032	9,129	9,413	9,398	19,936	2007
Cattle	74,000	85,000	51,000	42,000	85,000	2010
Swine	28,015	11,821	6,993*	16,813	8,932	2007
Sheep	7,565	15,256	3,938	1,203	5,591	2007
Data from USDA Agricultural Statistics Service for Total County Land Area. *2002 Data						

Figure 2-3. Cropland Productivity in the LPWIP Area

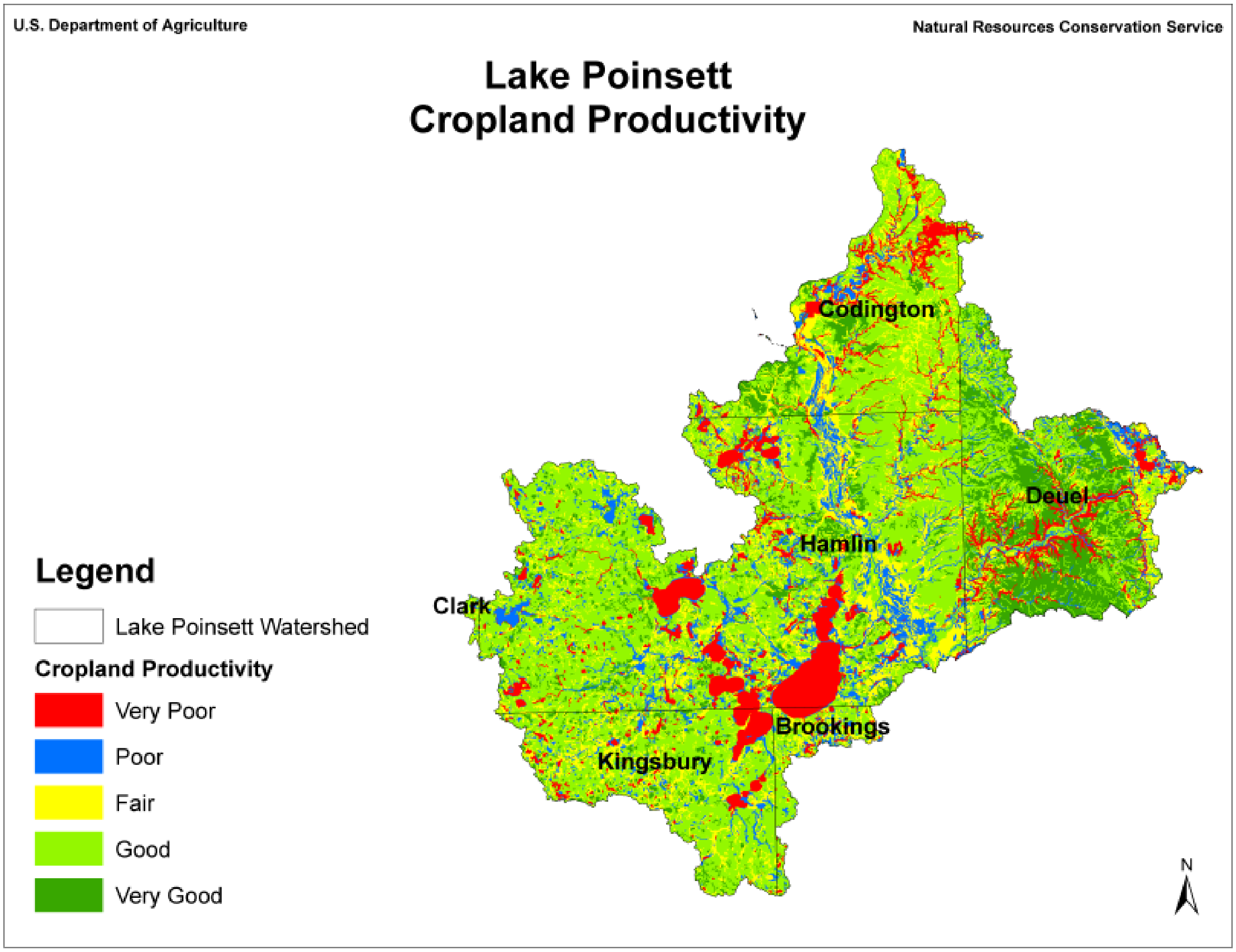
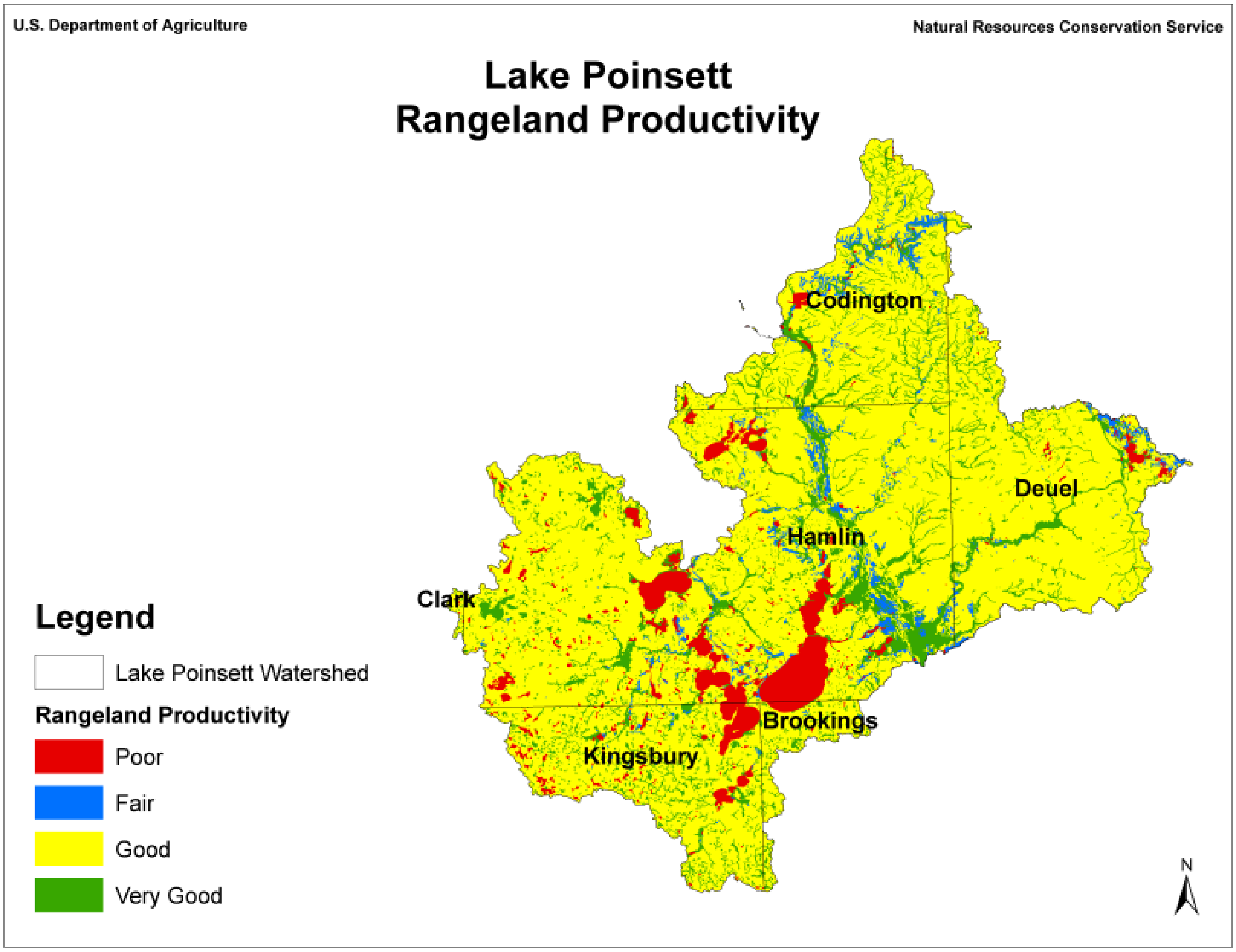


Figure 2-4. Rangeland Productivity in the LPWIP Area



2.5 Water Bodies Current Status

The interest in Lake Poinsett began with the construction of the Boswell diversion ditch in 1929 between the Big Sioux River and Lake Poinsett to add more water to the lake and maintain adequate water levels throughout the year. The lake was well developed for both recreation and commercial uses. Increased sedimentation and nutrients from these flood waters lead to excessive algal blooms which hampered recreational use of the lake. Early investigations identified that excessive nutrients delivered from the watershed were the cause of these severe algal blooms.

The USDA administered Rural Clean Water Program (RCWP) implemented BMPs in the watersheds of Dry Lake, Lake Albert, and Lake Poinsett in the late 1980's and early 1990's. An 1977 EPA study had reported that the water quality of 90% of the drainage basins in the Corn Belt were affected by pollution (Little 1989), and that by far the most common nonpoint source of pollution reported by States was agricultural runoff. The RCWP was a government funded program that cost-shared agricultural BMPs that would improve the water quality of recreational lakes and ground water resources. The Lake Poinsett Comprehensive Monitoring and Evaluation project, a segment of the Oakwood Lakes RCWP project, made significant contributions to the science of nonpoint source (NPS) pollution by monitoring inputs of pollutants to groundwater from crop fields, evaluating inputs of nutrient to lakes from surface and ground water, and evaluating the transient movement of agricultural chemicals in the vadose zone.

As the sources of these water quality issues were identified, the Lake Poinsett Water Project District (LPWPD) requested SDDENR to begin a Phase I Diagnostic/Feasibility study in 1993. The LPWPD acted as the lead sponsor and agreed to undertake the assessment through agreements with the Hamlin, Brookings, and Kingsbury Conservation Districts. A Project Implementation Plan (PIP) was developed to complete a comprehensive monitoring plan, identify critical regions in the watershed, and to develop restoration alternatives. Segment 1 of the watershed Lake Poinsett Watershed Project (LPWP) was initiated in 1998, and the final report completed in July of 2007.

The *2012 South Dakota-DENR Integrated Report for Surface Water Quality Assessment* for Lake Poinsett Watershed Improvement Project reported that Chlorophyll-*a*, *Escherichia coli,* and Fecal Coliform Bacteria were the identified impairments listed within the watershed 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. Figure 2-5 shows the locations of the reaches for the identified water bodies in the LPWIP.

Table 2-2. LPWIP 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
Lake Albert	**Kingsbury**	**L1**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**FULL**			**1**	**No**
SD-BS-L-Albert_01	**County**			**Immersion Recreation**	**FULL**				
				Limited Contact Recreation	**FULL**				
				Warmwater Marginal Fish Life	**FULL**				
Bullhead Lake	**Deuel**	**L6**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**FULL**			**5**	**Yes-2**
SD-BS-L-Bullhead_01	**County**			**Immersion Recreation**	**NON**	**Chlorophyll-a**	**UNK**		
				Limited Contact Recreation	**NON**	**Chlorophyll-a**			
				Warmwater Semipermanent Fish Life	**NON**	**Chlorophyll-a**			
Clear Lake	**Deuel**	**L8**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**FULL**			**1***	**No**
SD-BS-L-Clear_D_01	County			**Immersion Recreation**	**FULL**				
				Limited Contact Recreation	**FULL**				
				Warmwater Marginal Fish Life	**FULL**				
Lake Marsh	**Hamilin**	**L18**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**INS**			**3**	**No**
SD-BS-L-Marsh_01	**County**			**Immersion Recreation**	**NA**				
				Limited Contact Recreation	**NA**				
				Warmwater Marginal Fish Life	**INS**				
Lake Norden	**Hamlin**	**L20**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**FULL**			**1**	**No**
SD-BS-L-Norden_01	**County**			**Immersion Recreation**	**FULL**				
				Limited Contact Recreation	**FULL**				
				Warmwater Marginal Fish Life	**FULL**				
Lake Poinsett	**Hamilin**	**L24**	**DENR**	**Fish/Wildlife Prop, Rec, Stock**	**FULL**			**1***	**No**
SD-BS-L-Poinsett_01	**County**			**Immersion Recreation**	**FULL**				
				Limited Contact Recreation	**FULL**				
				Warmwater Semipermanent Fish Life	**FULL**				

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.

Table 2-2: Continued

WATERBODY AUID	LOCATION	MAP ID	BASIS	USE	SUPPORT	CAUSE	SOURCE	EPA CATEGORY	303(d) Priority
School Lake	Deuel	L26	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			1*	No
SD-BS-L-School_01	County			Immersion Recreation	FULL				
				Limited Contact Recreation	FULL				
				Warmwater Marginal Fish Life	FULL				
Lake St. John	Hamlin	L28	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			1	No
SD-VM-R-St_John_01	County			Immersion Recreation	FULL				
				Limited Contact Recreation	FULL				
				Warmwater Marginal Fish Life	FULL				
Big Sioux River	Willow Creek	R7	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			4A*	No
SD-BS-R-Big_Sioux_03	to		USGS	Irrigation Waters	FULL				
	Stray Horse			Limited Contact Recreation	NON	Escherichia coli	Livestock		
	Creek					Fecal Coliform			
				Warmwater Semipermanent Fish Life	FULL				
Big Sioux River	Stray Horse	R8	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			1	No
SD-BS_R-Big_Sioux_04	Creek		USGS	Irrigation Waters	FULL				
	to			Limited Contact Recreation	FULL				
	Near Volga			Warmwater Semipermanent Fish Life	FULL				
Hidewood Creek	Big Sioux River	R24	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			4A*	No
SD-BS-R-Hidewood_01	to		USGS	Irrigation Waters	FULL				
	US Hy 77			Limited Contact Recreation	NON	Fecal Coliform	Livestock		
				Warmwater Marginal Fish Life	FULL				
Stray Horse Creek	Big Sioux River	R35	DENR	Fish/Wildlife Prop, Rec, Stock	INS			4A*	No
SD-BS-R-Strayhorse_01	to			Irrigation Waters	INS				
	S26-116N-51W			Limited Contact Recreation	INS	Fecal Coliform	Livestock		
				Warmwater Marginal Fish Life	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.

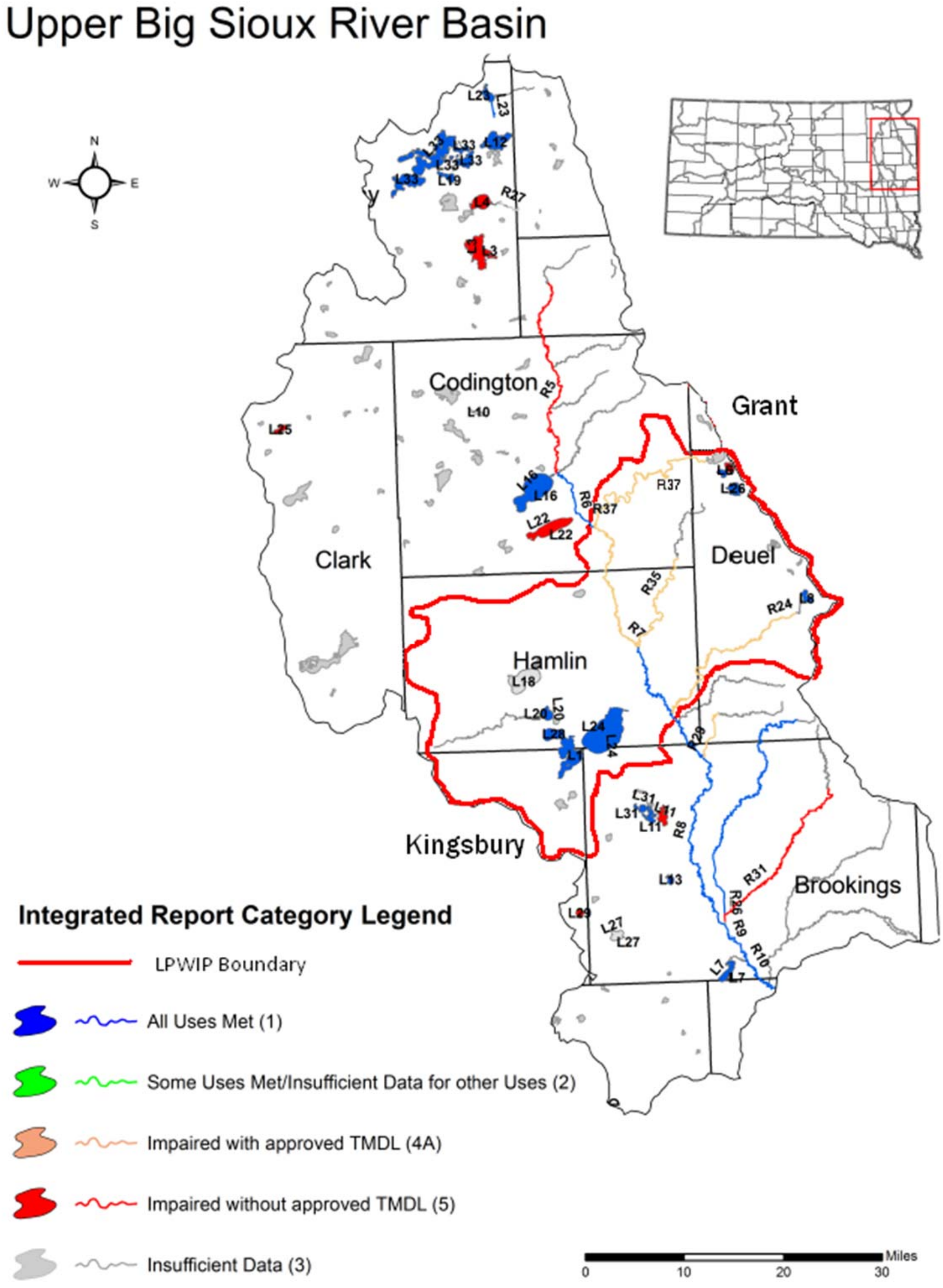
Table 2-2: Continued

WATERBODY		MAP						EPA	303(d)
AUID	LOCATION	ID	BASIS	USE	SUPPORT	CAUSE	SOURCE	CATEGORY	Priority
Willow Creek	Big Sioux River	R37	DENR	Fish/Wildlife Prop, Rec, Stock	FULL			4A*	No
SD-BS-R-Willow _01	to			Irrigation Waters	FULL				
	S7-117N-R50W			Limited Contact Recreation	NON	Fecal Coliform	Livestock		
				Warmwater Marginal Fish Life	FULL				

Table 2-3. Summary of LCWIP Water bodies Listed as 303(d) Impaired

Water Body Impaired	Beneficial Use Impaired	Cause of Impairment
Bullhead Lake - L6	Immersion Recreation	Chlorophyll-a
	Limited Contact Recreation	Chlorophyll-a
	Warmwater Semipermanent Fish Life	Chlorophyll-a
Big Sioux River - R7	Limited Contact Recreation	Escherichia coli
		Fecal Coliform
Hidewood Creek - R24	Limited Contact Recreation	Fecal Coliform
Stray Horse Creek - R35	Limited Contact Recreation	Fecal Coliform
Willow Creek- R37	Limited Contact Recreation	Fecal Coliform

Figure 2-5. 303(d) Listed Water Bodies in the LPWIP



2.6 Description of the Impairments for 303(d) Water Body Listings in the LPWIP

2.6.1 *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.

2.6.2 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 phosphorus instead of nitrogen.

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 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 dissolved oxygen (DO) levels, 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 have on the frequency or intensity of nuisance algal blooms. The reduction of nutrient inputs, primarily phosphorus, into the LPWIP water bodies 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 such as geosmin. 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. It was recommended that lakes having a chlorophyll-*a* level within this range should be sampled for cyanobacteria and microcystin levels. After examining various thresholds and approaches, 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.

2.7 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 (SDDENR), see Table 2-3; 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 LPWIP area by SDDENR to identify the main sources of these impairments.

2.7.1 Point Sources of Impairment

Point sources of pollutants were investigated for the five water bodies listed as 303(d) impaired in the 2012 SDDENR Integrated Report: Bullhead Lake (L6), Big Sioux River (R7), Willow Creek (R37), Stray Horse Creek (R35), and Hidewood Creek (R24).

Segment R7 of the Big Sioux River, from the mouth of Willow Creek to the mouth of Stray Horse Creek, was 303(d) listed for *E. coli* and Fecal Coliform in the 2012 SDDENR Integrated Report. This reach had three potential point sources of discharge (SDDENR 2011). The City of Castlewood has a surface discharge permit but only discharges under emergency situations. Benchmark Foam, Inc. has a National Pollutant Discharge Elimination System (NPDES) permit but does not discharge (SDDENR 2005). The upstream city of Watertown does discharge into segment R6 of the Big Sioux River, immediately upstream of segment R7, but segment R6 was not listed as impaired for any designated beneficial uses. Watertown's Urban Stormwater Runoff was considered as a background contribution to Total Suspended Solids (TSS); however, no violations of TSS standards were found (SDDENR TSS 2005).

Segment R5 of the Big Sioux River, upstream of the LPWIP area and above Lake Kampeska, was 303(d) listed for *E. coli* and low oxygen levels upstream. The immediate downstream Segment R6, from Lake Kampeska to Willow Creek, was reported as fully supporting all of its designated beneficial uses. The next downstream Segment R7, below Willow Creek south to the LPWIP's most southern boundary, was again listed as 303(d) impaired for *E. coli* and Fecal Coliform in the 2012 SDDENR Integrated Report.

The Willow Creek watershed had only one identified National Pollution Discharge Elimination System (NPDES) facility, and the facility did not discharge during the SDDENR 2005 study period. Stray Horse Creek had two NPDES facilities within its watershed, the cities of Kranzburg and Goodwin, both of which did not discharge. There are two NPDES permits within the Hidewood Creek watershed, the City of Clear Lake and Technical Ordinance, Inc., both of which did not discharge fecal coliform bacteria during the SDDENR 2005 study period. Any discharges under the NPDES permits were required to meet the chronic water quality standards in the permit.

These investigations did not identify any significant point discharges in the LPWIP area. This conclusion has been supported by other TMDL watershed studies in South Dakota that evaluated potential point sources of loading. The TMDL studies found that 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 Nonpoint Sources of Impairment

Non point sources of impairment have not been identified for all designated water bodies in the LPWIP area 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. Water bodies that have met the 303(d) criteria of all their designated beneficial uses, per SDDENR IR 2012, were Lake Albert, Clear Lake, Lake Norden, Lake Poinsett, School Lake, Lake St. John, and segment R8 of the Big Sioux River.

The water body of Lake Marsh was reported in the 2012 SDDENR IR to have insufficient water quality data to ascertain whether it met the supporting criteria of all the designated beneficial uses. Lake Marsh was not listed as having any priority under the 303(d) listing in this report. The future status of this water body's evaluation is unknown.

Contributions from rural household septic systems were estimated as a direct accounting of the number of septic systems in use in the watershed were unavailable. It was assumed that 20% of all rural septic systems in the North-Central Big Sioux River watershed were failing (EDWDD 2005). This percentage did not account for die-off or attenuation of fecal coliform bacteria between failing septic systems and the stream. In general, failing septic systems discharge over land for some distance, where a portion of the fecal coliform bacteria may be absorbed on the soil and surface vegetation before reaching the stream. It was assumed that failing septic systems constituted a diminutive amount of the overall contribution because not all of the failing systems would reach the receiving waters. It is implied that comparatively, failing septic systems are having an insignificant effect on the excess fecal coliform loading and were included in the margin of safety portion of the TMDLs established.

Water quality studies in the LPWIP area have concluded that agricultural activities were the major nonpoint source of excessive nutrients to the watershed by sheet and rill erosion from the agricultural lands, manure from livestock feedlots, livestock defecating while wading in water bodies, and defecating while grazing on rangeland and stream bed and bank. 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 Chlorophyll-*a*: Bullhead Lake, L6

Bullhead Lake was listed 303(d) as Chlorophyll-*a* impaired for the support of Immersion Recreation, Limited Contact Recreation, and Warm Water Permanent Fish Life in the 2012 SDDENR IR. The Lake is a part of series of lakes at the headwaters of Willow Creek, a tributary of the Big Sioux River, referred to as the School Lake chain-of-lakes located in northwestern Deuel County. See Figure 2-6. The lake has a surface area of 571 acres with a watershed of approximately 3,374 acres. The lake is fully equipped for the recreational activities of swimming, boating, picnicking, hiking, and fishing. Fish species include northern pike, walleye, yellow perch, and black bullhead. It had been stocked with 68,000 fingerling walleye in 1997 by SD-GF&P. Due to its shallow depth, Bullhead Lake partially winterkills and winterkilled in the year 2000.

The watershed has 22% of its area in cropland, 25% in pastureland and 53% in water. There were no point sources of pollution identified in the Bullhead Lake watershed nor were any animal feeding operations assessed. The northeast area of the lake was occupied by eight summer cabins. It was recommended that the septic systems be checked to ensure they are in compliance with regulations and did not discharge directly into the lake.

Inlake responses to watershed nutrient loading reductions were calculated using the BATHTUB model (SDDENR 2005). The amount of phosphorus that entered Bullhead Lake was relatively small; therefore, the reductions of watershed phosphorus contributions would not improve the Trophic State Index (TSI). Ninety-one percent (91%) of the phosphorus loading was attributed to internal lake loading from sediment within the lake from previous watershed runoff. Phosphorus can be released after sediment is resuspended in the water due to wave action. Excessive siltation can also cause an overabundance of phosphorus, as the sediment releases phosphorus during periods of low oxygen (anoxia). The average TSI value of Bullhead Lake was 68.7, placing it in a hypereutrophic state. This high TSI score correlates with very high levels of nutrients and corresponding excessive plant and algae growth that is detrimental to aquatic life.

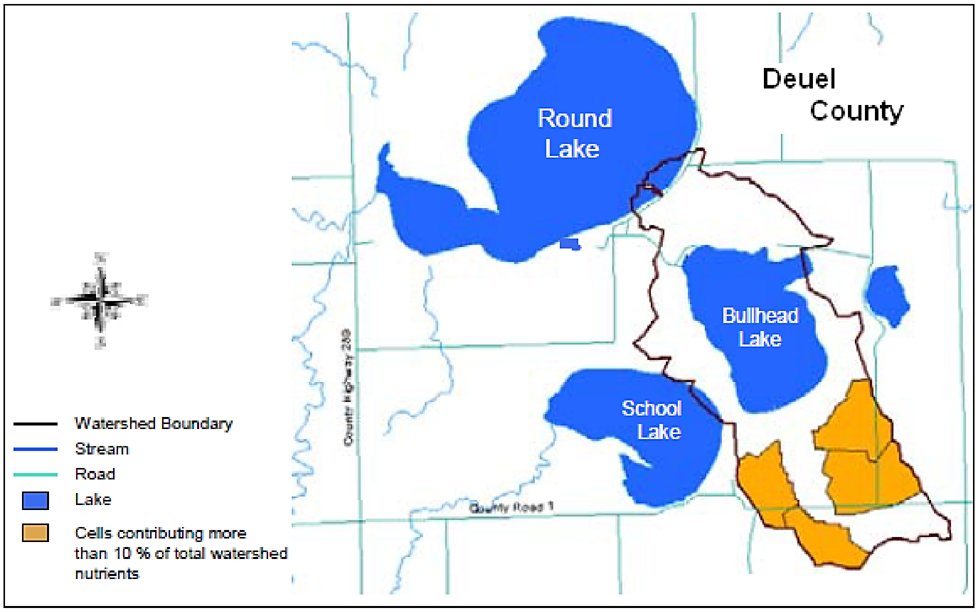
Bullhead Lake is very shallow lake that has little freshwater input, non-existent flushing of lake water, and high organic matter. Excessive sediment can cause a loss of water depth, an increase of nutrients, and an increase of aquatic macrophytes (SDDENR 1991). Excavating sediment and deepening a lake by dredging reduces the exposure of phosphorous rich bottom sediments to wind and wave action, thereby reducing inorganic water turbidity and internal phosphorus loading. A sediment survey of Punished Woman Lake, located in northeastern Codington County, (SDDENR 2000) found approximately 2.7 million cubic yards of soft sediment in the lake. The removal of 15.5% of the sediment in Punished Woman Lake had a dramatic effect on beneficial uses as lake water clarity improved and suspended solids were reduced. It was recommended that sediment samples be taken to determine the areas in need of dredging in Bullhead Lake before any dredging attempts, as dredging of the entire lake was not recommended.

Sediment removal and sediment sealing are highly effective means of reducing nutrients and sediment (SDDENR 2005). However, both are extremely expensive and will not work unless sources of external loadings are reduced first. Sediment sealing involves sealing the bottom sediments with an aluminum sulfate treatment. This may not work very effectively on Bullhead Lake as it is very shallow and wave action alone can break the seal that this chemical makes with bottom sediment. Biomanipulation and plant management were recommended for Bullhead Lake before any sediment removal projects be attempted.

Levels of pH in Bullhead Lake also exceeded the maximum recommended pH level of 9.0, with readings taken in 2003 from 9.02 to 9.66. Algal and macrophyte photosynthesis acts to increase a lake's pH, and water pH levels tend to increase as lakes become more eutrophic. This higher productivity is likely caused by excessive nutrient loading. Bullhead Lake was not listed as impaired for pH in the SDDENR 2012 Integrated Report; however, high pH readings are indicative of aquatic plant growth and the production of chlorophyll-*a*. The BATHTUB model was used to calculate the lake's response to reductions in watershed loading. Bullhead Lake would require nutrient reductions higher that 80% in order to meet the beneficial uses assigned to it. BATHTUB predicted a reduction of 83% of the current total phosphorus ungaged runoff load would be necessary to reduce the average TSI value from 68.7 to 64.9. This phosphorus load reduction would also help suppress excessive algal growth.

Recommended BMPs were improvements to riparian areas, shoreline stabilization, the checking of private septic waste systems along the lake, removal of carp biomass in the lake, and fertilizer management. Internal lake sources of phosphorus should also be considered even though controlling the ungaged runoff would accomplish the TMDL goal (SDDENR 2005).

Figure 2-6. Bullhead Lake Watershed and Critical AGNPS Cells



2.7.2.2 *Escherichia coli* – Fecal Coliform. Big Sioux River, R7; Hidewood Creek, R24; Stray Horse Creek, R35; Willow Creek, R37.

The Big Sioux River (R7), Hidewood Creek (R24), Stray Horse Creek (R35), and Willow Creek (R37) are listed as 303(d) impaired for *Escherichia coli* and/or Fecal Coliform for the support of Limited Contact Recreation in the 2012 SDDENR-IR. The beneficial use of Limited Contact Recreation (LCR) is effective during the recreation season, May 1- September 30 (SDDENR April 2012). The *E. coli* criteria for LCR requires that water samples not exceed 1,178 Colony Forming Units per 100 milliliters (cfu/ml) and the geometric mean of a minimum of five samples collected during separate 24-hour periods must not exceed 630 cfu/100ml during any 30-day period.

Fecal coliform bacteria are usually not harmful, but they can indicate the presence of other harmful bacteria, viruses and/or parasites. Examples include the pathogenic strain of *E. coli* that is 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. The FLUX program was used to determine total nutrient loads; the Agricultural Nonpoint Pollution Source Feedlot Model (AGNPS) was used to rank feedlots on a scale of 0-100, with a score of 50 identifying those most likely to deliver pollutant loads. The AnnAGNPS model was used to compare sediment, nitrogen, and phosphorous loadings for multiple year periods with simulated conservation practices (SDDENR 2005). The SDDENR Phase 1 Watershed Assessment Final Report (2005) identified 226 Animal Feeding Operations within these subwatersheds with 102 having an AGNPS score of 50 or greater.

2.7.2.2.1 Big Sioux River, Segment R7; from Willow Creek to Castlewood

Segment R7 of the Big Sioux River (SD-BS-R-Big_Sioux_03) is a 22.4 mile reach of the river that flows from near Watertown to Estelline that is listed as 303(d) impaired. This reach was separated (SDDENR 2005) into the ‘Castlewood North’ area that runs from its confluences with Willow Creek to Stray Horse Creek, near the city of Castlewood (Figure 2-7); and the ‘Castlewood to Estelline’ area from Stray Horse Creek to Hidewood Creek (Figure 2-8). The 144,371 acre watershed encompasses the Big Sioux River main stem and that of Willow Creek (R37) which discharges into this segment of the Big Sioux River (EDWDD 2005). Willow Creek also includes the subwatersheds of School Lake, Bullhead Lake, Round Lake, and Wigdale Lake; for which a separate watershed study was completed on these four lakes (SDDENR, School Lake, 2005). The land use in this reach is approximately 70% cropland and 26% rangeland/grassland. The immediate upstream segment R6 of the Big Sioux River meets all of it designated beneficial uses.

There were 81 Animal Feeding Operations (AFO) within the Castlewood North area, mostly consisting of cattle (SDDENR 2005). The TMDL document (EDWDD 2005) identified 44

AFOs that had an AGNPS score of 50 or higher. See Figure 2-9. Wastes from the AFOs contributed higher fecal bacteria amounts during runoff storm events, whereas, livestock in the streams contribute to higher fecal counts during periods of low stream flow. Willow Creek accounted for a portion of the bacteria load entering this reach of the Big Sioux River, and it was determined reductions in this tributary would aid in attaining bacteria load reductions. The study recommended that emphasis in the Willow Creek watershed should be focused on the lower reaches because fecal decay rates suggested that areas further than 10 kilometers away are not a significant source of bacteria to the Big Sioux River.

There were four NPDES permitted facilities including the City of Watertown, Northern Con-Agg, Inc., Oak Valley Farms, and the Dakota Sioux Casino. Their contributions were calculated and determined to be insignificant by SDDENR (2005). Therefore, it was recommended that the activities for fecal coliform bacteria reductions should focus on nonpoint pollution sources.

Figure 2-7. Big Sioux River Watershed (R7), Willow Creek to Castlewood

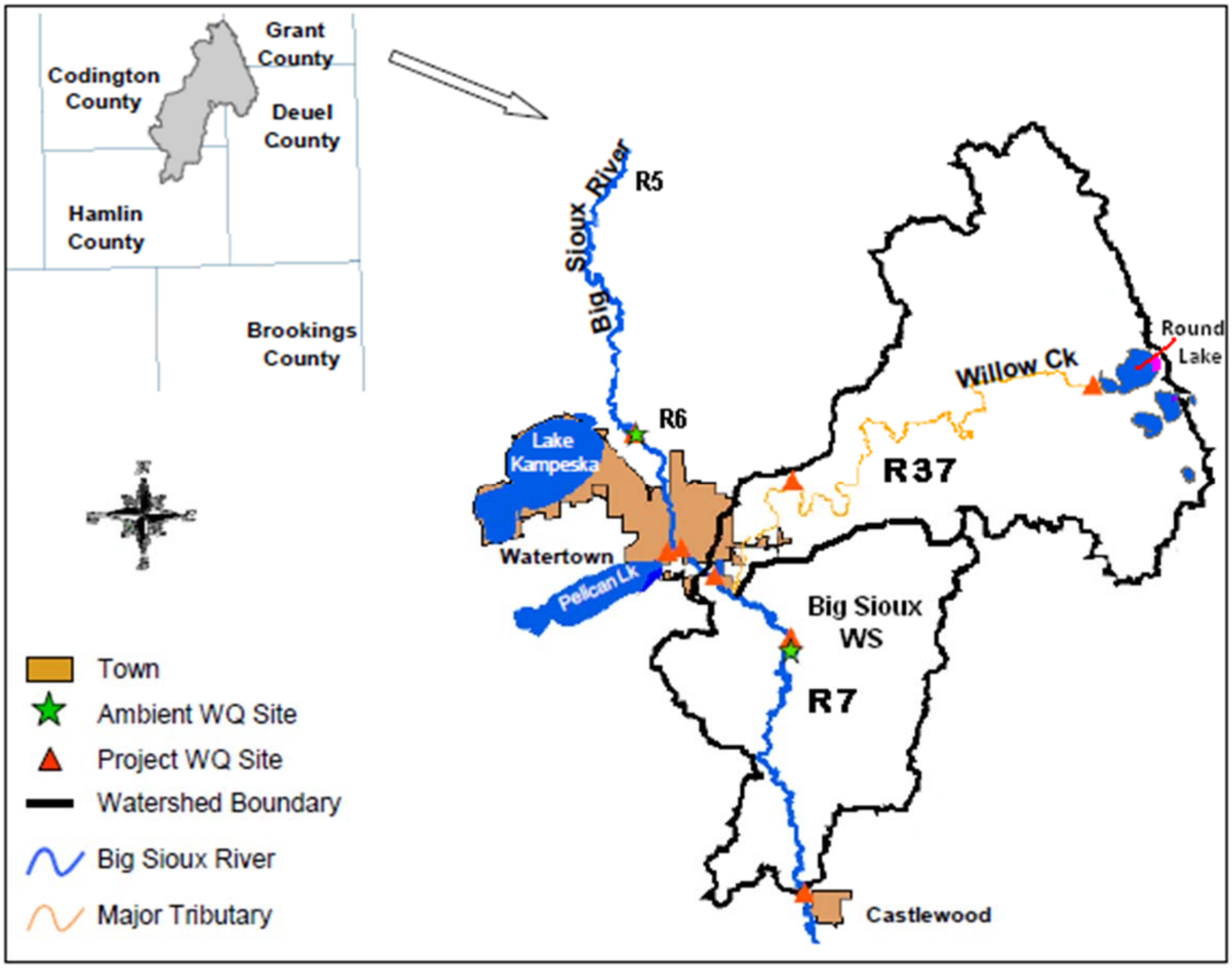


Figure 2-8. Big Sioux River Watershed (R7), Castlewood to Estelline

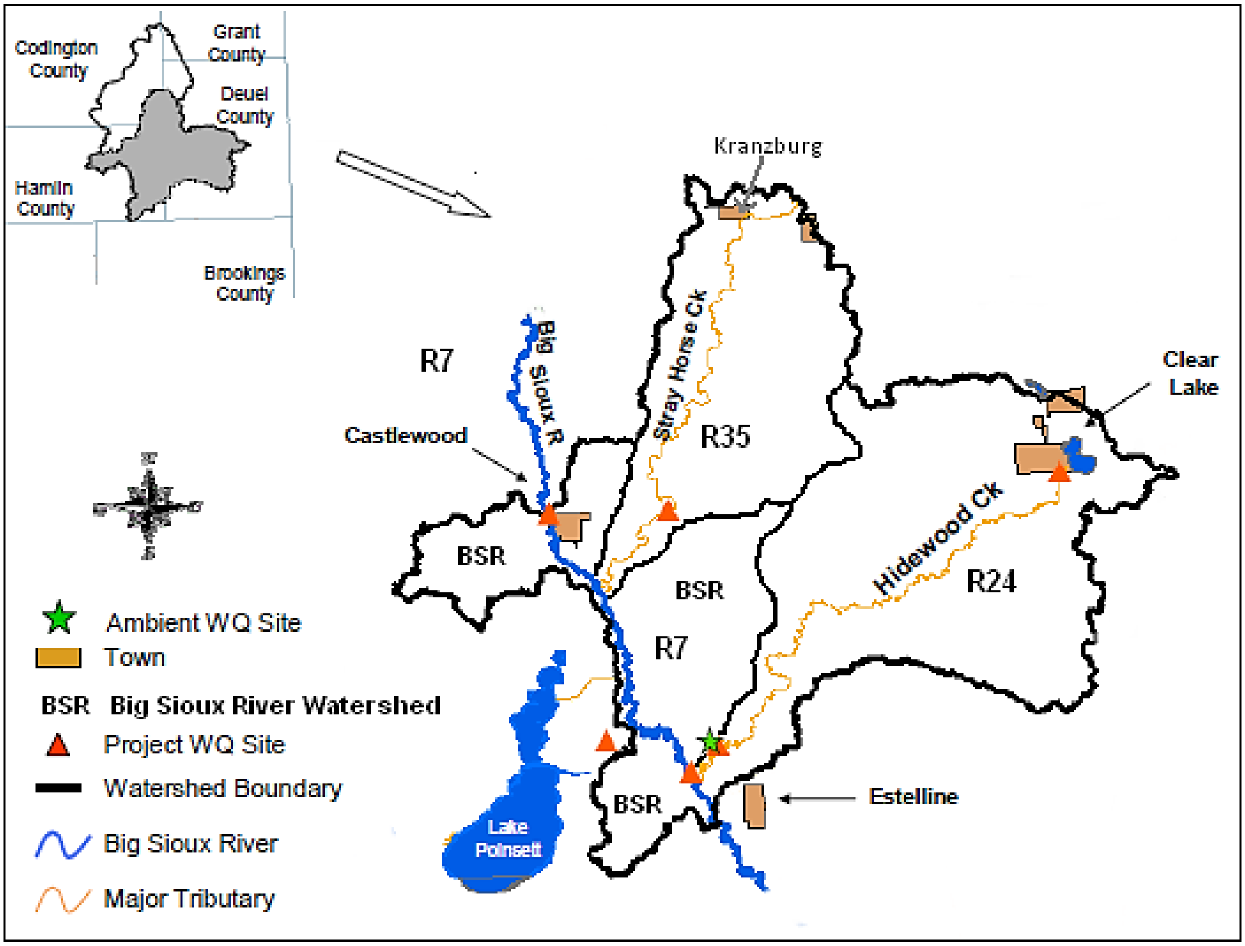
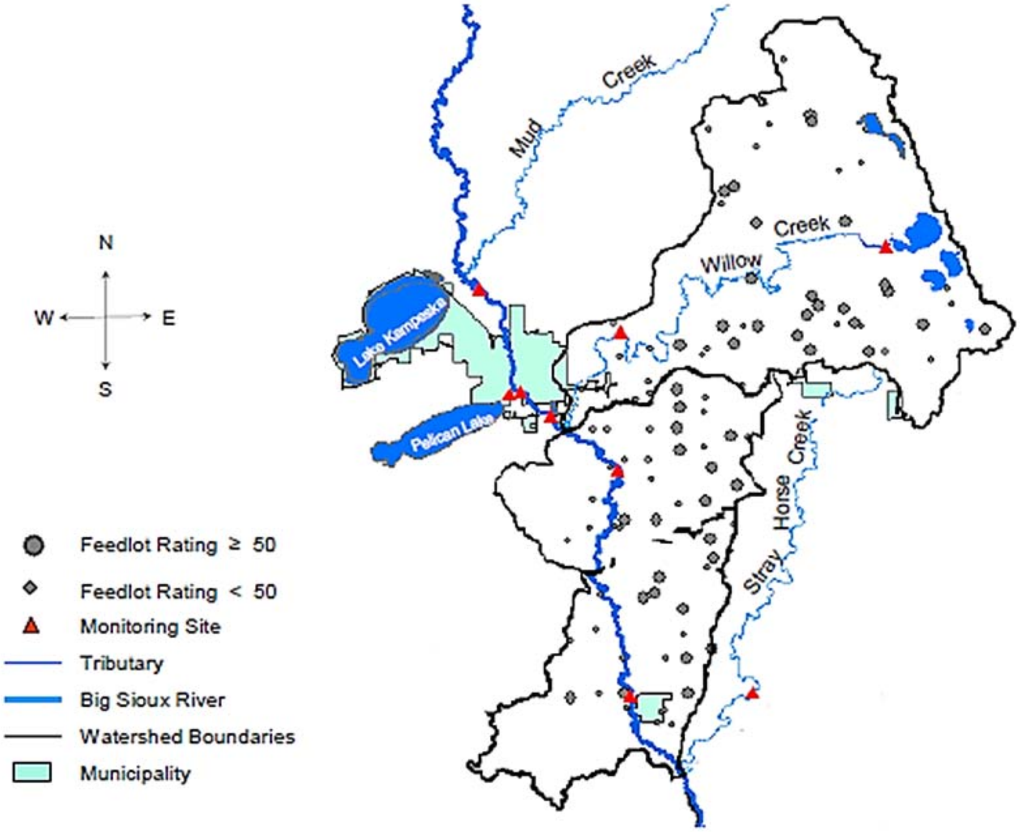


Figure 2-9. Animal Feeding Operations from Willow Creek to Castlewood



2.7.2.2.2 Big Sioux River, Segment R7; from Castlewood to Estelline

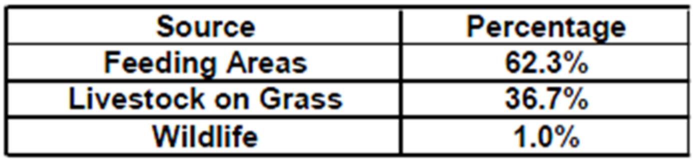
This lower reach of Segment R7 of the Big Sioux River extends from Castlewood to Estelline and includes the watershed of its main stem, the Lake Poinsett outlet, the watersheds of Stray Horse Creek and Hidewood Creek, encompassing approximately 132,843 acres. See Figure 2-8. Land use is predominately agriculture with 44% of the area as cropland and 35% grassland and pastureland.

Point source discharges were evaluated for potential impact to this segment of the Big Sioux River (SDDENR 2011). The city of Castlewood had an NPDES permit but only discharges under emergency conditions and, therefore, does not contribute a load to this impaired segment. Five NPDES permitted facilities were evaluated in the watershed (SDDENR 2005; the cities of Castlewood, Clear Lake, and Kranzburg; the Lake Poinsett Sanitary District, and Technical Ordinance, Inc. Only one was identified as a point source that discharged during the sampling period; however, no fecal coliform data was documented. Reductions in fecal coliform bacteria were, therefore, recommended to be focused on nonpoint sources of pollution.

There were 126 animal feeding operations screened in TMDL evaluation by SDDENR in 2011. See Figure 2-10. Fecal decay rates indicated that only AFOs within 10 kilometers of a water body would have a high load delivery rate to the water body. Selecting AFOs within this distance reduced the number of AFOs to 98 and, of that number, 27 AFOs were considered to be a high priority. It was reported that reducing the contributions of these 27 AFOs would result in the most efficient used of BMP implementation resources to reduce *E. coli* loadings to the Big Sioux River.

Manure from livestock is a potential source of *E. coli* to the river. Livestock contribute *E. coli* directly to the river by defecating while wading in the stream and by defecating while grazing on grasslands or in feeding areas, which is then washed off during precipitation events. Livestock grazing areas may be a significant source of *E. coli*, as approximately one third of the watershed is grassland. The majority of the grassland is located in close proximity to stream corridors, increasing the likelihood that fecal material may be washed off into streams. Table 2-4 allocates the sources of bacteria production in the watershed into three primary categories. Cropland with manure applied as fertilizer may also be a source if not applied properly.

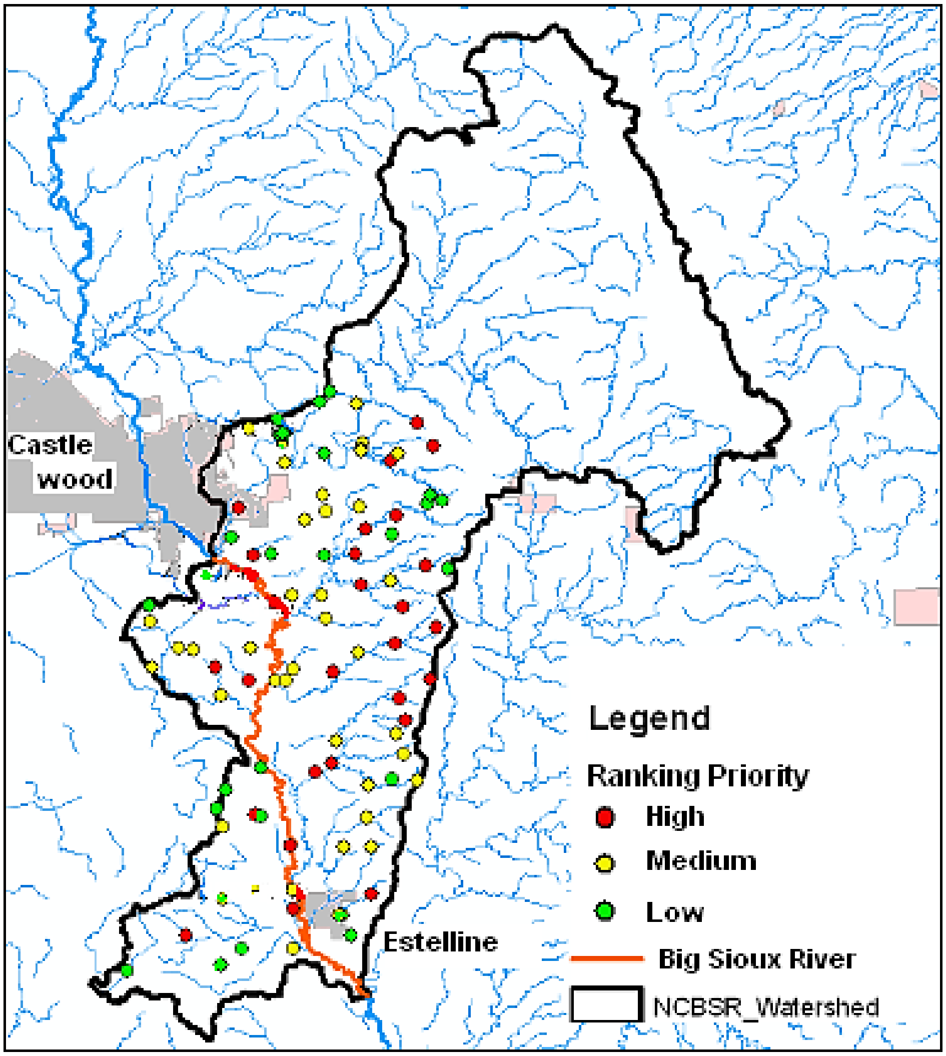
Table 2-4. *E. coli* Source Allocations for the Big Sioux River (R7), SDDENR 2011



Source	Percentage
Feeding Areas	62.3%
Livestock on Grass	36.7%
Wildlife	1.0%

E. coli load reductions necessary to fully attain TMDL water quality standards (SDDENR 2011) for the various flow zones of the Big Sioux River were as follows: 89% in the high flow zone; 74% in the moist flow zone; 71% in the mid-range flow zone; 90% in the dry flow zone; and 67% in the low flow zone. The recommendation from the SDDENR 2011 study was to focus on implementation of BMPs on the 27 animal feeding areas identified and on grazing areas within close proximity to the Big Sioux River and its tributaries, particularly those within a distance of 10 kilometers.

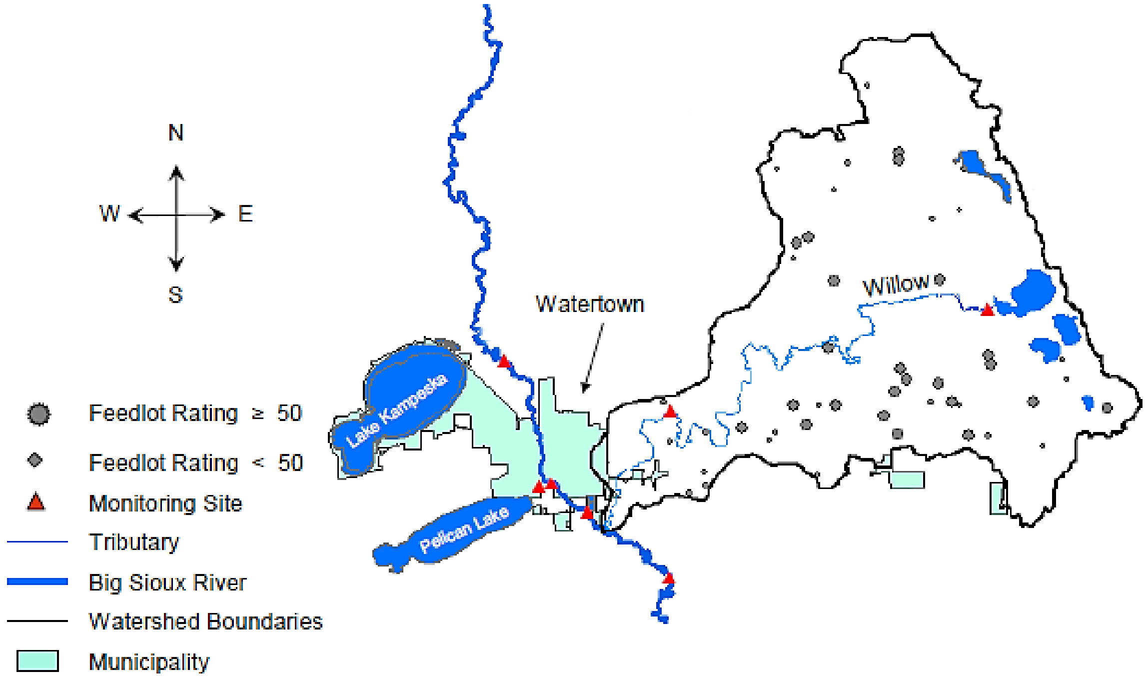
Figure 2-10. Animal Feeding Operations Castlewood to Estelline



2.7.2.2.3 Willow Creek Watershed (R37)

Willow Creek begins at the outlet of Round Lake and flows for approximately 25.2 miles, outletting into the Big Sioux River about one mile south of Watertown. See Figure 2-7, page 40. The land use in the Willow Creek to Castlewood segment is approximately 62% cropland and 33% rangeland/grassland within a 79,931 acre watershed. There were 23 feedlots that had an AGNPS rating of 50 or greater (EDWDD 2005) in this subwatershed. See Figure 2-11. Willow Creek was found to carry fecal coliform as more that 25% of the values exceeded the limits for fecal coliform bacteria. Benchmark Foam, Inc. was the only identified NPDES facility within this area, and its total fecal coliform bacteria contribution during the study period was zero, as the facility did not discharge (EDWDD 2005).

Figure 2-11. Animal Feeding Operations in the Willow Creek Watershed



2.7.2.2.4 Stray Horse Creek (R35)

The main stem of Stray Horse Creek begins south of Kranzburg and flows approximately 23.2 miles entering the Big Sioux River two miles southeast of Castlewood. See Figure 2-12. Land use is predominately agriculture with 79% of the area as cropland and 18% grassland with a watershed of approximately 57,548 acres. NPDES facilities within this watershed are the cities of Kranzburg and Goodwin; however, both facilities did not discharge. There were 32 feedlots that had an AGNPS rating of 50 or greater (EDWDD 2005). See Figure 2-13 for animal feeding operations.

Figure 2-12. Stray Horse Creek and Hidewood Creek Watersheds

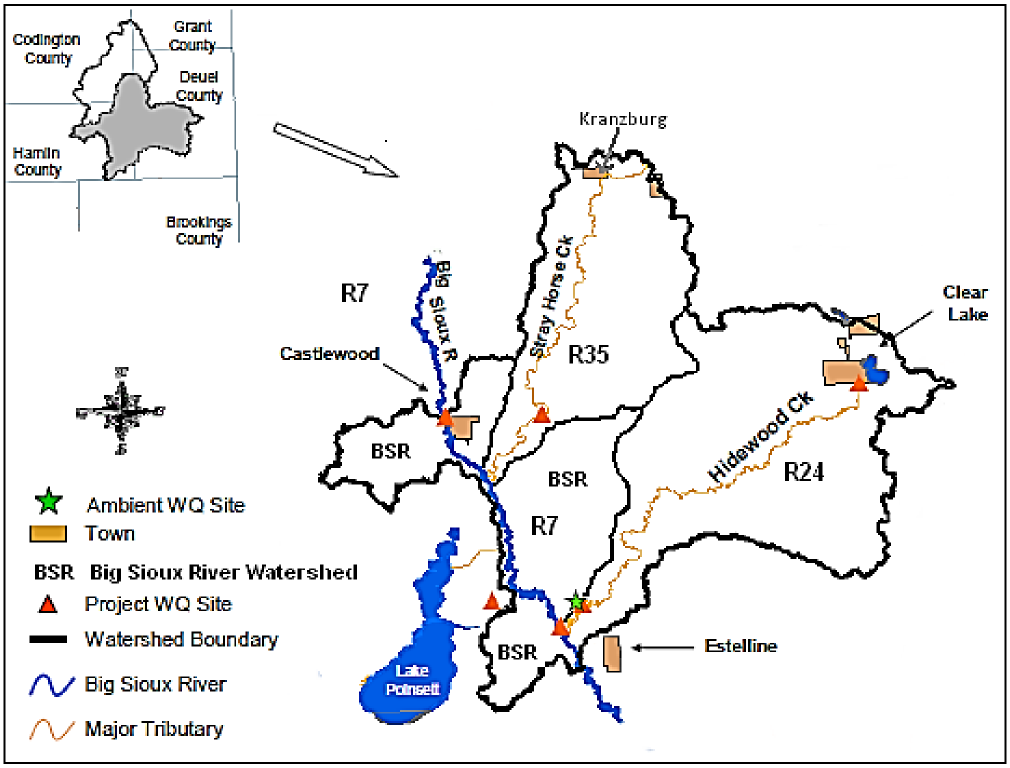
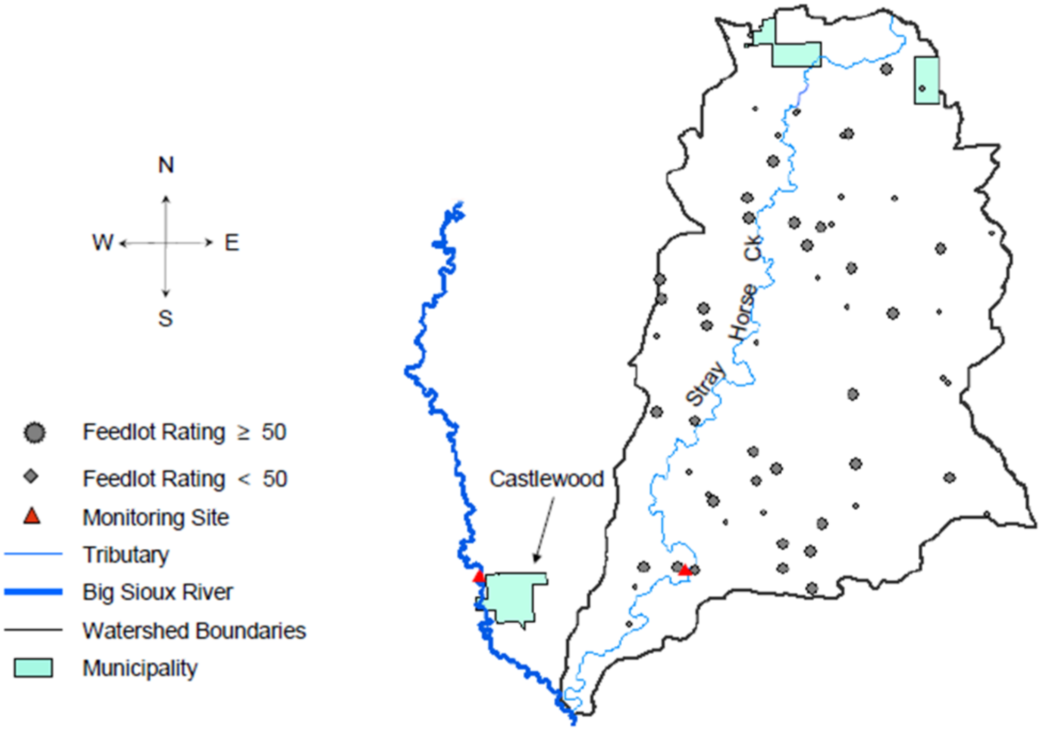


Figure 2-13. Animal Feeding Operations in the Stray Horse Creek Watershed

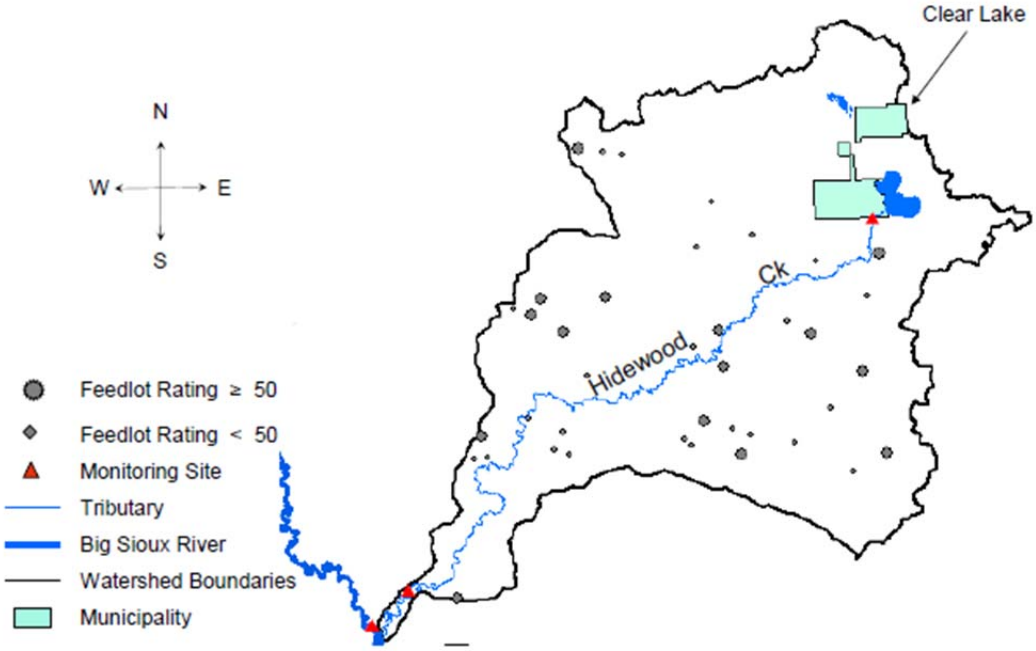


2.7.2.2.5 Hidewood Creek (R24)

Hidewood Creek is a 25.7 mile tributary with a watershed of approximately 85,815 acres. The creek begins at the outlet of Clear Lake and joins the Big Sioux River two miles north of Estelline. Land use is predominately agriculture with 68% of the area as cropland and 30% grassland and pastureland.

There were two NPDES facilities within this watershed: the City of Clear Lake and Technical Ordinance, Ind. The City of Clear Lake did not discharge fecal coliform bacteria, and Technical Ordinance, Inc. did not discharge during the study periods (SDDENR 2005, EDWDD 2005). There were 15 animal feedlots that had an AGNPS score of 50 or greater. See Figure 2-14 for animal feeding operations.

Figure 2-14. Animal Feeding Operations in Hidewood Creek Watershed

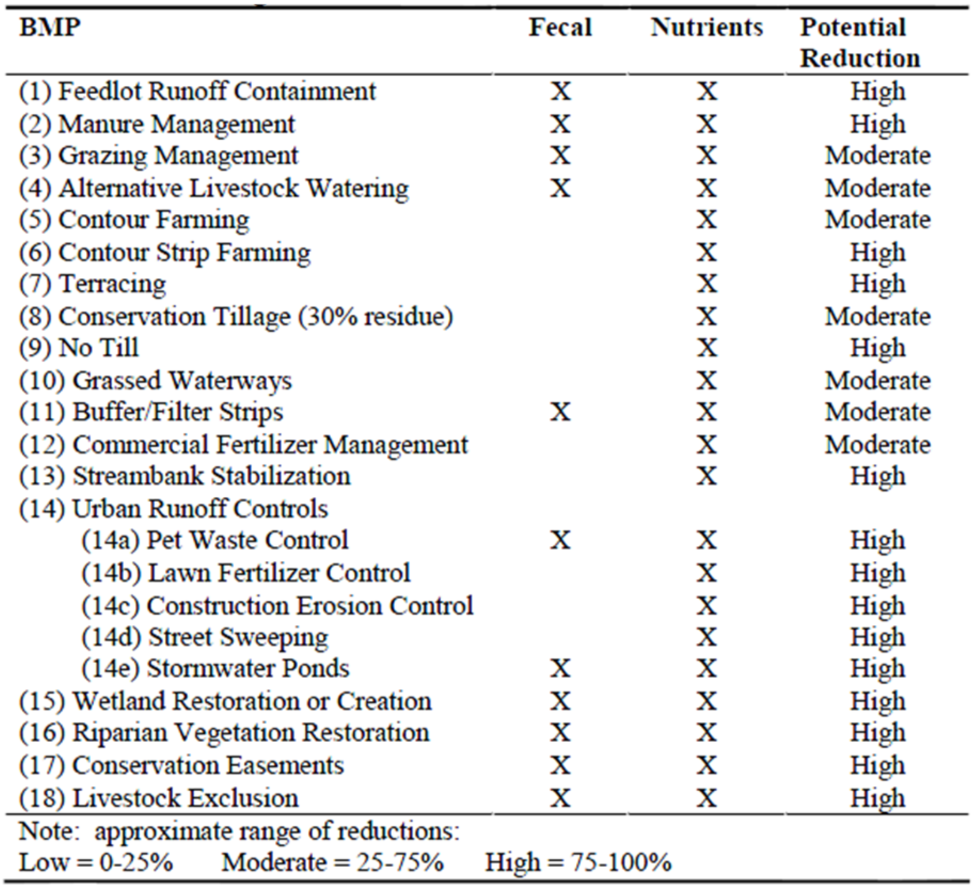


3. NONPOINT SOURCE MANAGEMENT MEASURES

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. Evan et al. (2003/2008) studied predicted load reductions for NRCS Best Management Practices.

The Phase I Watershed Assessment final Report and TMDLs for the North-Central Big Sioux River (2005) completed a review of the BMPs with the pollutant they are effective on and their potential load reductions. Table 3-1 presents the effectiveness of each BMP, and Table 3-2 lists its range of achievable load reductions. This data that was adapted from the Minnesota Pollution Control Agency study of 1990. Table 3-3 presents the BMPs most suited to the five hydrologic stream conditions and the recommended management practices to help reduce loads. High flow is representative of conditions when precipitation intensity exceeds the rate of water infiltration into the soil and may cause flooding. Moist conditions are representative of those periods when the soils are already saturated and runoff is occurring. Mid-range flows are representative of subsequent rain events and of a time when saturation is beginning to lessen. Dry conditions are representative of those times when rain is sparse. Low flows are representative of conditions when rain is absent, and there is a drought situation. The Nonpoint Source Measures will be described and referenced to Best Management Practices (BMPs) as defined by the Natural Resources Conservation Service (NRCS), USDA. A comparison of load reduction data are also presented in Table 3-4 by Evan's et al. (2003/2008), as he studied predicted load reductions for NRCS Best Management Practices. Any related NRCS practices may also be selected and added to supplement these identified BMPs as necessary to achieve load reductions.

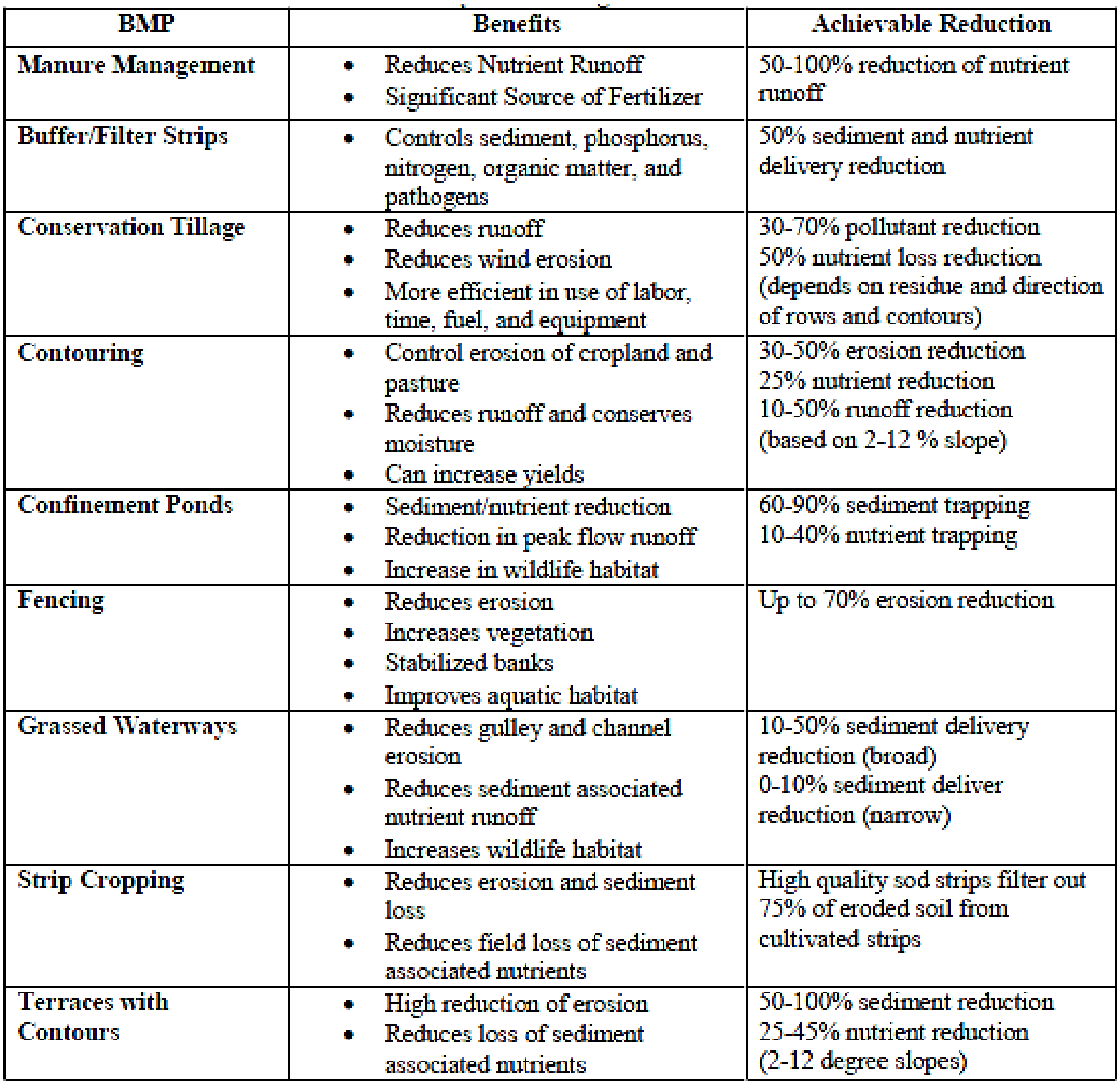
Table 3-1. BMPs, Pollutants Affected, Potential Load Reductions, SDDENR 2005



BMP	Fecal	Nutrients	Potential Reduction
(1) Feedlot Runoff Containment	X	X	High
(2) Manure Management	X	X	High
(3) Grazing Management	X	X	Moderate
(4) Alternative Livestock Watering	X	X	Moderate
(5) Contour Farming		X	Moderate
(6) Contour Strip Farming		X	High
(7) Terracing		X	High
(8) Conservation Tillage (30% residue)		X	Moderate
(9) No Till		X	High
(10) Grassed Waterways		X	Moderate
(11) Buffer/Filter Strips	X	X	Moderate
(12) Commercial Fertilizer Management		X	Moderate
(13) Streambank Stabilization		X	High
(14) Urban Runoff Controls			
(14a) Pet Waste Control	X	X	High
(14b) Lawn Fertilizer Control		X	High
(14c) Construction Erosion Control		X	High
(14d) Street Sweeping		X	High
(14e) Stormwater Ponds	X	X	High
(15) Wetland Restoration or Creation	X	X	High
(16) Riparian Vegetation Restoration	X	X	High
(17) Conservation Easements	X	X	High
(18) Livestock Exclusion	X	X	High

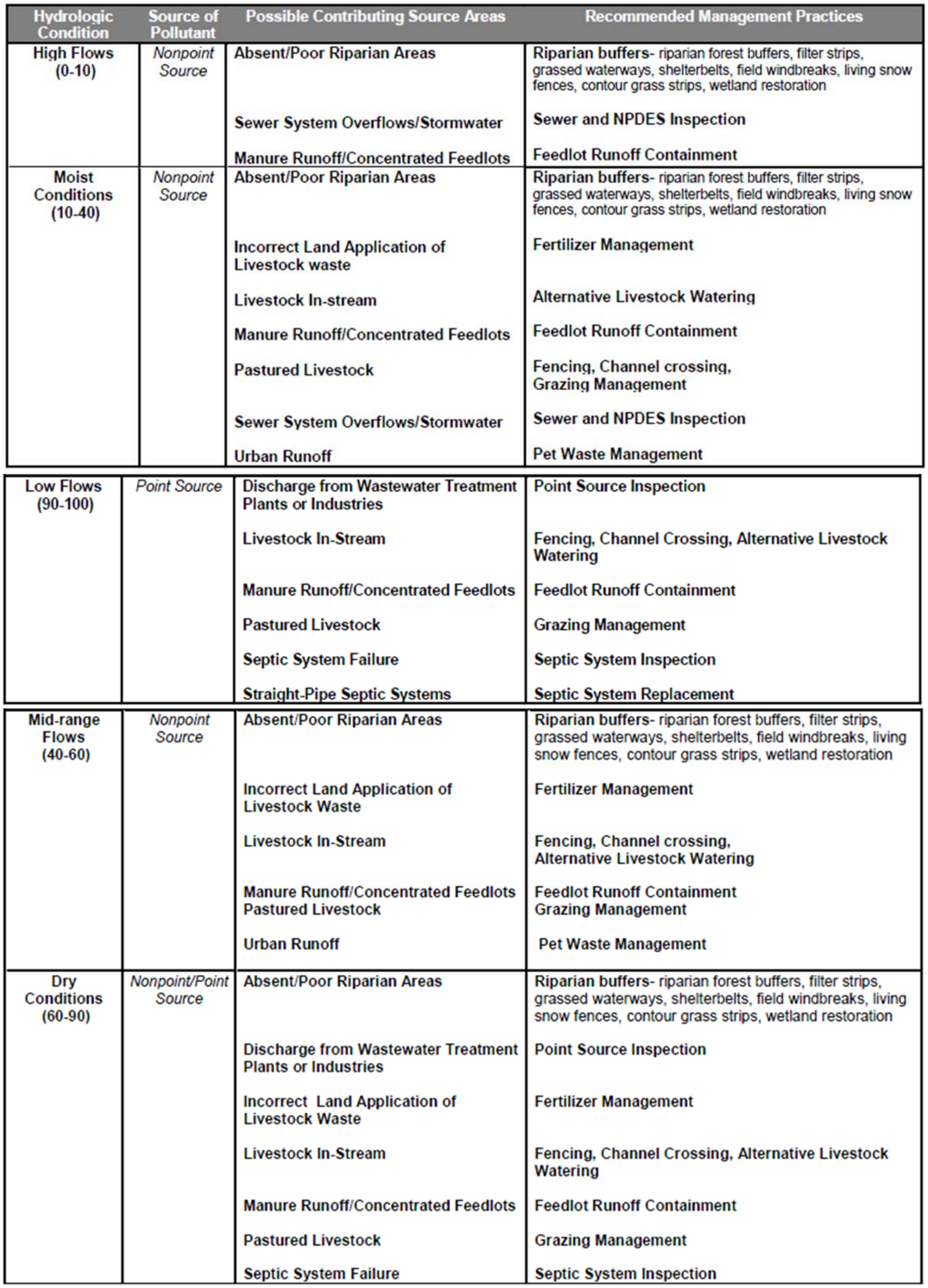
Note: approximate range of reductions:
Low = 0-25% Moderate = 25-75% High = 75-100%

Table 3-2: BMP Benefits and Achievable Reductions in North-Central Big Sioux



BMP	Benefits	Achievable Reduction
Manure Management	- Reduces Nutrient Runoff - Significant Source of Fertilizer	50-100% reduction of nutrient runoff
Buffer/Filter Strips	- Controls sediment, phosphorus, nitrogen, organic matter, and pathogens	50% sediment and nutrient delivery reduction
Conservation Tillage	- Reduces runoff - Reduces wind erosion - More efficient in use of labor, time, fuel, and equipment	30-70% pollutant reduction 50% nutrient loss reduction (depends on residue and direction of rows and contours)
Contouring	- Control erosion of cropland and pasture - Reduces runoff and conserves moisture - Can increase yields	30-50% erosion reduction 25% nutrient reduction 10-50% runoff reduction (based on 2-12 % slope)
Confinement Ponds	- Sediment/nutrient reduction - Reduction in peak flow runoff - Increase in wildlife habitat	60-90% sediment trapping 10-40% nutrient trapping
Fencing	- Reduces erosion - Increases vegetation - Stabilized banks - Improves aquatic habitat	Up to 70% erosion reduction
Grassed Waterways	- Reduces gulley and channel erosion - Reduces sediment associated nutrient runoff - Increases wildlife habitat	10-50% sediment delivery reduction (broad) 0-10% sediment deliver reduction (narrow)
Strip Cropping	- Reduces erosion and sediment loss - Reduces field loss of sediment associated nutrients	High quality sod strips filter out 75% of eroded soil from cultivated strips
Terraces with Contours	- High reduction of erosion - Reduces loss of sediment associated nutrients	50-100% sediment reduction 25-45% nutrient reduction (2-12 degree slopes)

Table 3-3. Fecal Coliform Bacteria BMP Recommendation by Hydrologic Condition



Hydrologic Condition	Source of Pollutant	Possible Contributing Source Areas	Recommended Management Practices
High Flows (0-10)	*Nonpoint Source*	**Absent/Poor Riparian Areas**	**Riparian buffers-** riparian forest buffers, filter strips, grassed waterways, shelterbelts, field windbreaks, living snow fences, contour grass strips, wetland restoration
		Sewer System Overflows/Stormwater	**Sewer and NPDES Inspection**
		Manure Runoff/Concentrated Feedlots	**Feedlot Runoff Containment**
Moist Conditions (10-40)	*Nonpoint Source*	**Absent/Poor Riparian Areas**	**Riparian buffers-** riparian forest buffers, filter strips, grassed waterways, shelterbelts, field windbreaks, living snow fences, contour grass strips, wetland restoration
		Incorrect Land Application of Livestock waste	**Fertilizer Management**
		Livestock In-stream	**Alternative Livestock Watering**
		Manure Runoff/Concentrated Feedlots	**Feedlot Runoff Containment**
		Pastured Livestock	**Fencing, Channel crossing, Grazing Management**
		Sewer System Overflows/Stormwater	**Sewer and NPDES Inspection**
		Urban Runoff	**Pet Waste Management**
Low Flows (90-100)	*Point Source*	**Discharge from Wastewater Treatment Plants or Industries**	**Point Source Inspection**
		Livestock In-Stream	**Fencing, Channel Crossing, Alternative Livestock Watering**
		Manure Runoff/Concentrated Feedlots	**Feedlot Runoff Containment**
		Pastured Livestock	**Grazing Management**
		Septic System Failure	**Septic System Inspection**
		Straight-Pipe Septic Systems	**Septic System Replacement**
Mid-range Flows (40-60)	*Nonpoint Source*	**Absent/Poor Riparian Areas**	**Riparian buffers-** riparian forest buffers, filter strips, grassed waterways, shelterbelts, field windbreaks, living snow fences, contour grass strips, wetland restoration
		Incorrect Land Application of Livestock Waste	**Fertilizer Management**
		Livestock In-Stream	**Fencing, Channel crossing, Alternative Livestock Watering**
		Manure Runoff/Concentrated Feedlots	**Feedlot Runoff Containment**
		Pastured Livestock	**Grazing Management**
		Urban Runoff	**Pet Waste Management**
Dry Conditions (60-90)	*Nonpoint/Point Source*	**Absent/Poor Riparian Areas**	**Riparian buffers-** riparian forest buffers, filter strips, grassed waterways, shelterbelts, field windbreaks, living snow fences, contour grass strips, wetland restoration
		Discharge from Wastewater Treatment Plants or Industries	**Point Source Inspection**
		Incorrect Land Application of Livestock Waste	**Fertilizer Management**
		Livestock In-Stream	**Fencing, Channel Crossing, Alternative Livestock Watering**
		Manure Runoff/Concentrated Feedlots	**Feedlot Runoff Containment**
		Pastured Livestock	**Grazing Management**
		Septic System Failure	**Septic System Inspection**

Table 3-4. Estimated BMP Reduction Efficiencies by Pollutant Type

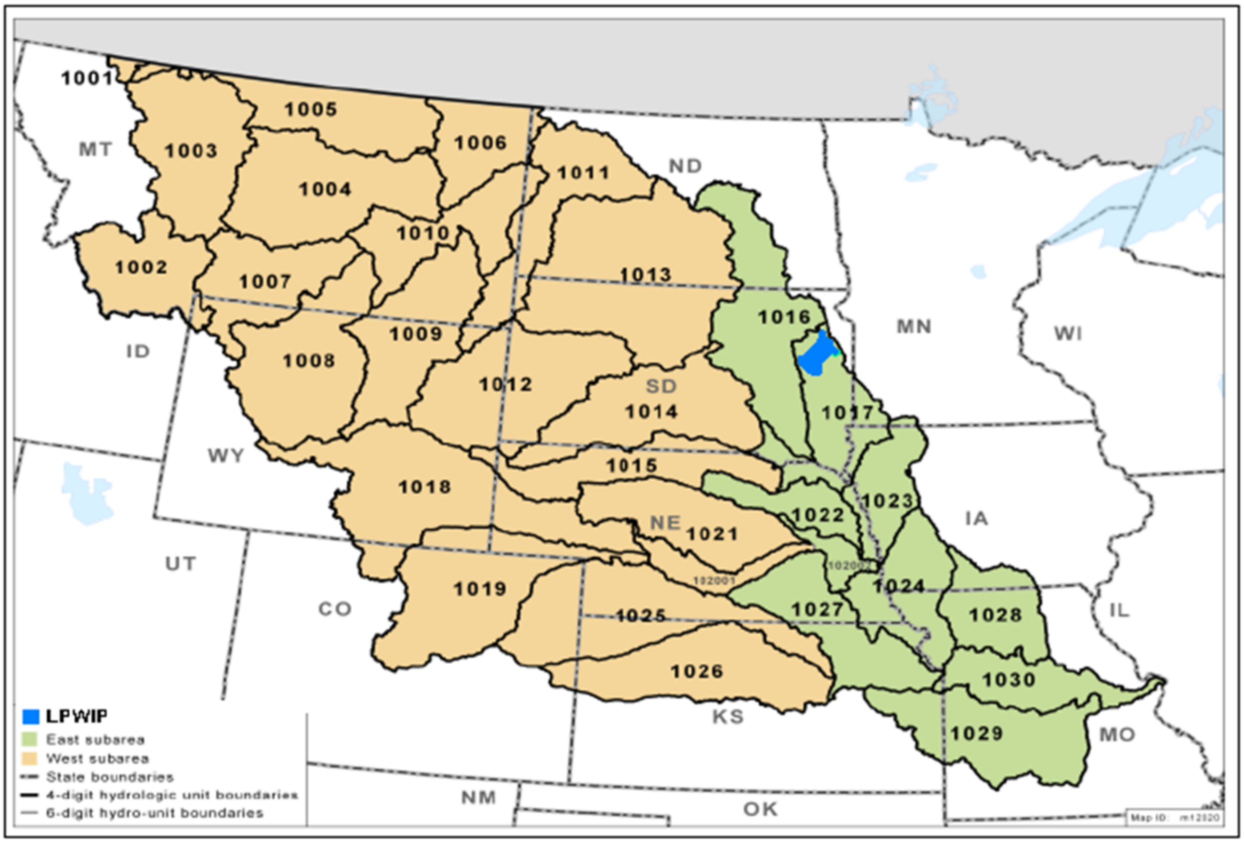
BMP SYSTEM/TYPE	NRCS PRACTICE	NITROGEN	PHOSPHOROUS	SEDIMENT	FECAL
Crop Residue Manage	329 & 345	50%	38%	64%	-
Vegetated Buffer	390	54%	52%	58%	70%
Grazing Land Manage	528	43%	34%	13%	-
Streambank Protect	580	65%	78%	76%	-
Nutrient Manage Plan	590	70%	28%	-	-
Grassed Waterways	428	54%	52%	58%	-
Constructed 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 in the Conservation Effects Assessment Project (CEAP). See Figure 3-1 for the watersheds covered in the study. The goals of CEAP were to estimate conservation benefits, to establish the scientific understanding of the effects and benefits of conservation practices at the watershed scale, and to provide research and assessment on how to best use conservation practices in managing agricultural landscapes to protect and enhance environmental quality. The studied subregion included in the LPWIP area is the Missouri-Big Sioux-Lewis-Clark Lake (code 1017) with approximately 68.6 percent of its watershed in cultivated cropland and 21.6 percent in permanent grass.

The CEAP study used the computer model HUMUS/SWAT to evaluate conservation practices in use on cultivated cropland. The model estimated that conservation practices reduced sediment, nutrient, and atrazine loads delivered to rivers and streams from cultivated cropland sources per year, on average, by 54 percent for nitrogen, 60 percent for phosphorus, 76 percent for sediment, and 36 percent for atrazine.

A Field-Level Cropland Model called APEX, used to simulate the effects of conservation practices at the field level, showed 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.

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



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

A Waste Storage Facility 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.

Assessment projects within the LPWIP identified a total of 349 animal feeding operations (SDDENR 1996, SDDENR 2005) with 102 having an AGNPS ranking of fifty or greater and 25 identified as significant pollutant sources but with an unknown AGNPS ranking. Load reductions reported for the LPWIP Segment 2 AWMSs were 907 pounds of phosphorus per system. Nitrogen load reductions were not reported. The adjacent Kingsbury Lakes project constructed nine AWMSs and had an average system nitrogen reduction of 15,996 pounds per year and a phosphorous reduction of 2,818 pounds per year.

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 as a plant nutrient source 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 spread on fields as estimated by Evans (2003, 2008) of 70% for nitrogen and 28% for phosphorous.

The assessment of conservation practices for the entire Missouri River Basin (NRCS 2012) found the second highest percentage of cropped acres with manure applied for all subregions was the Missouri-Big Sioux-Lewis-Clark Lake (code 1017), as it had manure applied to 16 percent of its total cropland acres. The LPWIP Segment 1 Final Report (Smith 2007) summary sheet reported that the high fecal coliform levels were associated with animal livestock feeding operations, livestock use of riparian areas, and the lack of prescribed grazing systems; which may 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. 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 studies within the LPWIP that have identified livestock grazing as an additional source of nutrients and fecal bacteria were the Big Sioux River Segment 3 (SDDENR 2011), North-Central Big Sioux River and TMDL Big Sioux Segment 3 (SDDENR 2005), School Lake (SDDENR 2005), and Lake Poinsett (SDDENR 1996). Load reductions for Segment 2 of the LPWIP for grazing management were 0.71 pounds of phosphorus per acre and 0.49 tons of sediment per acre. The Kingsbury Lakes study (Strom 2008) reported load reductions of 8.63 pounds of nitrogen/acre/year, 1.57 pounds of phosphorous/acre/year, and 0.93

tons of sediment/acre/year on 1,337 acres of grazing land management. 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.

The application of prescribed grazing 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. 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 shorelines could be restricted by fencing the stream corridors off and keeping cattle out of the stream channel area. Since livestock may have direct contact with water bodies during hotter weather, grazing should be limited to cooler and less erosive periods of the year. 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 Missouri-Big Sioux-Lewis/Clark Lake subregion (code 1017) had 5.2 percent of its subregion acres listed as under-treated. The delivery rates of nitrogen, phosphorous, and sediment per acre in this subregion was 6.52 lbs/ac/year, 0.38 lbs/ac/year, and 0.11 ton/ac/year, respectively. The Missouri River basin-wide averages were 5.82 N lbs/ac/year, 0.38 P lbs/ac/year, and 0.17 Sediment t/ac/year, respectively.

Eighty-two 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 recommended 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.

3.5 Stream Bank & Channel Stabilization. NRCS Practice Code 580

Stream bank stabilization is a treatment used to stabilize and protect the banks of streams and the shorelines 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 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.

A shoreline survey was completed in 1995 (SDDENR 1996) on Lake Poinsett to document the extent and severity on the lake. Of the total 78,672 linear feet (LF) of shoreline: 2,755 LF were identified as severely eroded; 1,895 LF as intermediate; and 5,550 LF as having moderate erosion. Most of the areas classified as undergoing severe erosion were cliff embankments that were very susceptible to wind and wave action.   Lake Poinsett has experienced high water conditions since that date with high lake water levels in 2011 causing severe shoreline erosion from flood conditions.   Shoreline stabilization projects installed on Lake Poinsett, as reported by Smith (2007), reduced phosphorus by 0.4 pounds/linear foot (lbs/LF) and reduced sediment by 10.0 tons/LF.

Bank failure along streams has been linked to livestock use of the riparian areas and the loss of riparian vegetation from cattle grazing. Properly functioning riparian areas can significantly reduce nonpoint source pollution by intercepting surface runoff, filtering and storing sediment and associated pollutants, and stabilizing banks. Stream bank stability is directly related to the species composition of the riparian vegetation and the distribution and density of these species (Sheffield 1997). Proposed BMPs to address riparian area degradation in this study 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.

Smith (2007) reported grassed waterways to reduce phosphorus by 2.45 pounds/acre and sediment by 4.9 tons/acre. Other projects have reported higher savings, as Kringen, in the James River watershed (2010), reported nitrogen load reductions of 124.3 pounds/acre/year; phosphorous by 32.6 pounds/acres/year; and sediment by 16.7 tons/acre/year. 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 only proceeds through the ammonification step 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 School/Bullhead Lakes study (SDDENR 2005) removed 1,833 acres of impoundments, 10 acres or larger, to run the AnnAGNPS scenario of ‘no impoundments’ to compare to the existing watershed conditions. The removal of the impoundments caused an increase loading of mass nitrogen by 41%, of mass phosphorus by 21%, and a 98% increase in sediment loading; demonstrating the importance of impoundments in filtering nutrients, which is especially true of wetland areas.

Smith (2007) reported a phosphorus savings of 2.5 pounds/acre and 5.0 tons of sediment per acre for sediment retention dams installed in the LPWIP. 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. Total phosphorus and sediment reductions on 51 multi-purposed ponds with 5,846 acres of watershed were reported as load reductions of 1.49 pounds/acre and 0.78 tons/acre, respectively, for the expected 20 year pond lifespan. For this reason, wetland restoration, pond construction, water and sediment control structures, and structures for water control will be part of the Lake Poinsett watershed 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 identify critical cells throughout the Lake Poinsett/North Central Big Sioux River Basin and evaluate them before BMP's are installed.

Smith reported a savings of 3.7 pounds/acre of nitrogen, 1.14 pounds/acre of phosphorus and 0.79 tons/acre of sediment for grass establishment in the Lake Poinsett Watershed Project (2007). Kringen (2010) reported similar 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).   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 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 crop; and 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 LPWIP 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 one of the following: perennial grass; legume grown for use as forage, seed for planting, or green manure; legume-grass mixture; or a small grain grown in combination with a grass or legume green manure crop whether inter-seeded or planted in rotation.

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. Conventional tillage on a 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 study (NRCS 2012), 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 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.

During a comprehensive conservation planning process, the conservation resource needs of the land and producer are evaluated and addressed. 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. Load reductions for tree planting were not reported in the LPWIP; however, Strom reported (2008) on converting 25.1 acres of cropland to trees in adjacent Kingsbury county that obtained load reductions on nitrogen of 9.2 lbs/ac/year; 3.17 lbs of phosphorus/ac/year; and 2.37 tons/ac/year of sediment.

3.11 Nutrient Management Plan - Cropland. NRCS Practice Code 590

This Nutrient Management Practice 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 nonpoint 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 nutrient management plan efficiency at 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 Lake Poinsett Watershed Improvement Project.

3.12 Terraces - NRCS Practice Code 600

A terrace is an earth embankment, or a combination or 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. Contouring 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 lbs/acre/year in non-tiled drained watersheds and greater than 20 lbs/acre/year in tile-drained watersheds. Terraces may be used in the LPWIP 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 could and would need to be managed. Management of livestock may be needed which allows only seasonal access, rotational grazing, and/or time limitations, to reduce the intensity and duration of grazing. Load reductions on grazed buffer strips were reported in Segment 2 of the LPWIP at the rates of 8.62 lbs/acre of nitrogen, 3.64 lbs/acre of phosphorous, and 2.42 tons/acre for sediment. These rates will be used for the non-CRP filter strips.

4. LOAD REDUCTIONS

4.1 Animal Waste Storage Facilities

The Lake Poinsett Watershed Improvement Project area identified over 349 animal feeding operations. Based on the percentages of AFO's analyzed by AnnAGNPS in other studies, as many as 113 feedlots were determined to be potential priority operations requiring the construction of an animal waste management system. Since that assessment, approximately 28 feedlots have had Animal Waste Storage Facilities (AWSF) constructed under various programs and 10 priority lots have ceased operations. The field offices (FO) estimated 35 AWSF would need to be built; with an average yearly construction rate of slightly less than 3 AWSF per year, it will take additional years beyond this Strategic Plan to complete the needed AWSF. Load reductions of nitrogen were those calculated from AWSF installed in the Vermillion River watershed that averaged reductions of 15,810 pounds of nitrogen per system. Load reductions of 907 pounds of phosphorus per system were those calculated from Segment 2 of the LPWIP. Refer to Table 4-1 for projected load reductions and yearly applications.

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

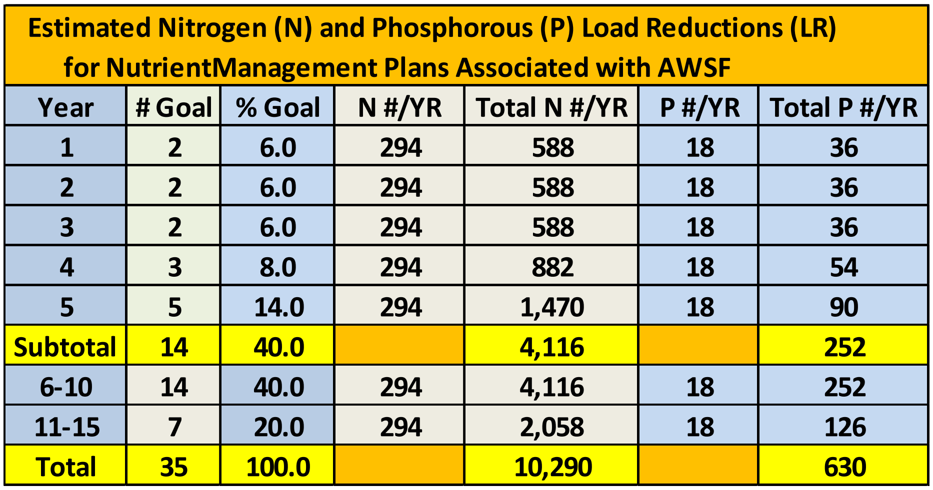
Estimated Nitrogen (N) and Phosphorous (P) Load Reductions (LR) Associated with Animal Waste Storage Facilities (AWSF)						
Year	# Goal	% Goal	N #/System	Total N #/Syst	P #/System	Total P #/Syst
1	2	6.0	15,810	31,620	907	1,814
2	2	6.0	15,810	31,620	907	1,814
3	3	8.0	15,810	47,430	907	2,721
4	4	12.0	15,810	63,240	907	3,628
5	3	8.0	15,810	47,430	907	2,721
Subtotal	14	40.0		221,340		12,698
6-10	14	40.0	15,810	221,340	907	12,698
11-15	7	20.0	15,810	110,670	907	6,349
Total	35	100.0		553,350		31,745

Nutrient reduction estimates from STEPL. N from Vermillion River Basin and P from LPWIP Segment 2

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. An average facility with 300 animal units would require approximately 300 acres in the NMPs; however, only about 30 acres (10%) would receive the manure each year. Load reductions used will be those of Kringen's (2010), in the James River watershed, where he calculated 9.8 pounds of nitrogen/acre/year and 0.6 pounds of phosphorous/acre/year for an applied NMP. 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 NutrientManagement Plans Associated with AWSF

Year	# Goal	% Goal	N #/YR	Total N #/YR	P #/YR	Total P #/YR
1	2	6.0	294	588	18	36
2	2	6.0	294	588	18	36
3	2	6.0	294	588	18	36
4	3	8.0	294	882	18	54
5	5	14.0	294	1,470	18	90
Subtotal	14	40.0		4,116		252
6-10	14	40.0	294	4,116	18	252
11-15	7	20.0	294	2,058	18	126
Total	35	100.0		10,290		630

Nutrient reduction estimates from STEPL Kringen 2010

4.3 Prescribed Grazing Systems

4.3.1 Upland Prescribed Grazing Systems

The field offices in the LPWIP area were contacted for the number of acres of grazing lands that need a grazing management system for each county. The estimated need was for 25,700 acres of prescribed grazing systems to be planned and implemented. The estimated yearly average implementation rate was 560 acres per year. At the end of this five year Strategic Plan only 2,800 acres (10.0%) would be implemented. Additional years of planning to meet the projected grazing plan goals would be needed. Load reductions are presented in Table 4-3-1 using nitrogen load reduction estimates as documented in the Vermillion River watershed of 1.64 pounds of nitrogen/acre/year. The LPWIP Segment 2 calculated 0.71 pounds of phosphorus/ acre/year and 0.49 tons of sediment/acre/year. Prescribed grazing systems are figured on approximately 260 acres per system, with a rural water hook-up, two tanks, water pipeline footage of 2,000 feet, and 5,000 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 (Sed) 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	560	2.0	1.64	918.4	0.71	397.6	0.490	274.4
2	560	2.0	1.64	918.4	0.71	397.6	0.490	274.4
3	560	2.0	1.64	918.4	0.71	397.6	0.490	274.4
4	560	2.0	1.64	918.4	0.71	397.6	0.490	274.4
5	560	2.0	1.64	918.4	0.71	397.6	0.490	274.4
Subtotal	2,800	10.0		4,592.0		1,988.0		1,372.0
6-10	2,800	10.0	1.64	4,592.0	0.71	1,988.0	0.490	1,372.0
11-Plus	20,100	80.0	1.64	32,964.0	0.71	14,271.0	0.490	9,849.0
TOTAL	25,700	100.0		42,148.0		18,247.0		12,593.0

Nutrient and Sediment Load Reduction estimates from STEPL. N Estimates from Vermillion River; P and Sediment from LPWIP Segment 2

4.3.2 Riparian Area Grazing Management

Riparian area grazing management systems were estimated to be needed on 450 acres throughout the LPWIP area by field offices to reduce nutrient and sediment transport to water bodies. At a rate of 20 acres per year implementation, additional years would be needed to resolve resource problems. Load reductions were calculated from filter strips installed in the Vermillion River Basin project. 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 riparian management in the LPWIP are during the first five years of the Strategic Plan.

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

Riparian Area Management Load Reductions of Nitrogen, Phosphorous, and Sediment								
Year	Acres Planned	% Goal	N Reduction Lbs/Ac	Total N Reduction Lbs/Year	P Reduction Lbs/Ac	Total P Reduction Lbs/Year	Sediment Reduction Tons/Ac	Total Sediment Tons/Year
1	20	4.4	8.62	172.4	3.64	72.8	2.42	48.4
2	20	4.4	8.62	172.4	3.64	72.8	2.42	48.4
3	20	4.4	8.62	172.4	3.64	72.8	2.42	48.4
4	20	4.4	8.62	172.4	3.64	72.8	2.42	48.4
5	20	4.4	8.62	172.4	3.64	72.8	2.42	48.4
Subtotal	100	22.0		862.0		364.0		242.0
6-10	100	22.0	8.62	862.0	3.64	364.0	2.42	242.0
11- Plus	250	56.0	8.62	2,155.0	3.64	910.0	2.42	605.0
TOTAL	450	100.0		3,879.0		1,638.0		1,089.0

Nutrient and Sediment Load Reduction estimates from STEPL. N, P, and Sediment estimates from Segment 2 LPWIP

4.4 Residue & Tillage Management on Cropland

Field Offices estimated 63,000 acres of conservation tillage would be needed to solve resource concerns. At the rate of 3,860 acres per year, additional years would be necessary to achieve this targeted goal. 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 Vermillion River project reported a load reduction using conservation tillage on cropland of 3.49 pounds of nitrogen per acre, and Segment 1 of the LPWIP reported 1.75 pounds of phosphorus and 3.5 tons of soil saved per acre. 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								
Year	Acres	% Goal	N #/Ac/Yr	Total #/Yr	P #/Ac/Yr	Total #/Yr	Sed T/Ac/Yr	Total T/Yr
1	3,860	6.1	3.49	13,471.4	1.75	6,755.0	3.50	13,510.0
2	3,860	6.1	3.49	13,471.4	1.75	6,755.0	3.50	13,510.0
3	3,860	6.1	3.49	13,471.4	1.75	6,755.0	3.50	13,510.0
4	3,860	6.1	3.49	13,471.4	1.75	6,755.0	3.50	13,510.0
5	3,860	6.1	3.49	13,471.4	1.75	6,755.0	3.50	13,510.0
Subtotal	19,300	30.5		67,357.0		19,300.0		67,550.0
6-10	19,300	30.5	3.49	67,357.0	1.75	33,775.0	3.50	67,550.0
11-15	19,300	30.5	3.49	67,357.0	1.75	33,775.0	3.50	67,550.0
16-20	5,100	8.5	3.49	17,799.0	1.75	8,925.0	3.50	17,850.0
TOTAL	63,000	100.0		219,870.0		95,775.0		220,500.0

Nutrient and Sediment Load Reduction estimates from STEPL. N from Vermillion River project. Phosphorous and Sediment from Segment 1 LPWIP.

4.5 Stream Bank Stabilization

The planned stream bank stabilization footages needed in the LPWIP area were estimated by field office staff as 44,800 linear feet (LF). Approximately 2,360 LF would be installed per year. This would require additional years to achieve 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). Phosphorus and sediment estimates are from Segment 1 LPWIP.

Table 4-5. Stream Bank Stabilization Load Reductions by Linear Feet

Stream Bank Stabilization and Load Reductions								
Year	Linear Feet (LF) Planned	% Total Goal	N Reduction Lbs/LF	Total N Reduction Lbs/LF	P Reduction Lbs/LF	Total P Reduction Lbs/LF	Sediment Reduction Tons/LF	Total Sediment Tons/LF
1	2,360	5.2	2.60	6,136.0	0.4	944.0	10.0	23,600.0
2	2,360	5.2	2.60	6,136.0	0.4	944.0	10.0	23,600.0
3	2,360	5.2	2.60	6,136.0	0.4	944.0	10.0	23,600.0
4	2,360	5.2	2.60	6,136.0	0.4	944.0	10.0	23,600.0
5	2,360	5.2	2.60	6,136.0	0.4	944.0	10.0	23,600.0
Subtotal	11,800	26.0		30,680.0		4,720.0		118,000.0
6-10	11,800	26.0	2.60	30,680.0	0.4	4,720.0	10.0	118,000.0
11-15	11,800	26.0	2.60	30,680.0	0.4	4,720.0	10.0	118,000.0
16-20	9,400	22.0	2.60	24,440.0	0.4	3,760.0	10.0	94,000.0
TOTAL	44,800	100.0		116,480.0		17,920.0		448,000.0

Nutrient and Sediment Load Reduction estimates from STEPL. Nitrogen from Strom 2010. Phosphorous, and Sediment from LWIP Segment 1.

4.6 Grassed Waterways

The constructed acres of grassed waterways estimated by field offices for the total treatment of gullies were 112. At 7 acres per year, 35 acres will be completed in the five years of the Strategic Plan, which is 31.0% of the needed estimate. More years will be needed to complete the necessary linear feet of grassed waterways. Nitrogen, phosphorous, and sediment load reduction estimates used were the waterway calculations used by Kringen (2010) for the James River basin as no data was available for the LPWIP. 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	Acres (AC) Planned	% Goal	N Reduction Lbs/AC	Total N Reduction Lbs/Year	P Reduction Lbs/AC	Total P Reduction Lbs/Year	Sediment Reduction Tons/AC	Total Sediment Tons/Year
1	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
2	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
3	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
4	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
5	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
Subtotal	35	31.25		4,333.0		85.8		171.5
6-10	35	31.25	123.8	4,333.0	2.45	85.8	4.9	171.5
11-15	35	31.25	123.8	4,333.0	2.45	85.8	4.9	171.5
16-20	7	6.25	123.8	866.6	2.45	17.2	4.9	34.3
Total	112	100.0		13,865.6		274.6		548.8

Nutrient and Sediment Load Reduction estimates from STEPL. N from. Kringen 2010. P and Sediment from LWIP Segment 1.

4.7 Wetland Restoration, Pond, and Basin Construction

Planned restoration numbers of wetlands, pond construction, and water and sediment control basin numbers were estimated by field office personnel to be 33 to meet estimated load reductions. With an average of under seven basins restored or constructed each year, this goal will be met at the end of the Strategic Plan. See Table 4-7.

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 load reductions. However, the water and sediment basins should result in similar control of the sediment delivery and sediment attached phosphorous. The average size of the restored basins in the LPWIP was 35 watershed (WS) acres. Calculated load reductions in the Vermillion basin for wetland restorations were 4.06 lbs/ac/year of nitrogen. Calculated load reductions in the LPWIP were 2.5 lbs/ac/year of phosphorous and 5.0 tons/ac/year for sediment per project.

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

Wetland Restoration and Pond Construction Load Reductions									
Year	No. Ponds Wetlands Planned	% Goal	Acres Protected	N Reduction Lbs/WS Ac Year	Total Lbs N Reduction Year	P Reduction Lbs/WS Ac Year	Total Lbs P Reduction Year	Sed Reduct Tons/ WS Ac Year	Total Tons Sed/Reduct Year
1	5	15.2	175	4.06	710.5	2.50	437.5	5.00	875.0
2	7	21.2	245	4.06	994.7	2.50	612.5	5.00	1,225.0
3	7	21.2	245	4.06	994.7	2.50	612.5	5.00	1,225.0
4	7	21.2	245	4.06	994.7	2.50	612.5	5.00	1,225.0
5	7	21.2	245	4.06	994.7	2.50	612.5	5.00	1,225.0
Total	33	100.0	1,155.0		4,689.3		2,887.5		5,775.0

Nutrient and Sediment Load Reduction estimates from STEPL. N from Vermillion River Basin. P and Sediment LPWIP Seg 1

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 1,060 acres for the LPWIP area. Two hundred and thirty acres were estimated to be completed each year. At the end of the five year plan this goal would be met. The LPWIP Segment 2 had estimated the calculated load reductions of 3.7 pounds/acre for nitrogen, phosphorous at 1.14 pounds/acre, and sediment load reductions at 0.79 tons/acre. 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	140	12.0	3.70	518.0	1.14	159.6	0.79	110.6
2	230	22.0	3.70	851.0	1.14	262.2	0.79	181.7
3	230	22.0	3.70	851.0	1.14	262.2	0.79	181.7
4	230	22.0	3.70	851.0	1.14	262.2	0.79	181.7
5	230	22.0	3.70	851.0	1.14	262.2	0.79	181.7
Total	1,060	100.0		3,922.0		1,208.4		837.4

Nutrient and Sediment Load Reduction estimates from STEPL segment 2 LPWIP.

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 74,300 acres for the LPWIP area. An estimated 4,290 acres would be installed each year resulting in only 29% of this goal being achieved at the end of the five year Strategic Plan. This goal will only be met with additional project implementation years. 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 LPWIP. 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 subwatersheds 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%. Therefore, 22.1 lbs. of delivered total nitrogen/acre/year could be reduced by 31% or 6.85 lbs./ac/year and 5.2 lbs. of delivered total phosphorous/acre/year could be reduced by 31% or 1.6 lb./ac/year.

The analysis of the sediment transport and deliverability throughout the watershed to Clear Lake indicated that for an average year approximately 3,084 tons (0.121 tons/acre) of sediment entered the lake. Hargrove's report found soil losses to be reduced from 42% - 92%, again a conservative application to the Clear Lake study would be a 42% reduction in soil loss and resultant 42% in sediment load delivery. The load reduction is estimated at 0.121 tons/acre/year multiplied by 42% reduction equals a load reduction of 0.05 ton/acre/year. These load reductions from the use of a cover crop are applied 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	**4,290**	**5.8**	**6.85**	**29,386.5**	**1.61**	**6,906.9**	**0.05**	**214.5**
2	**4,290**	**5.8**	**6.85**	**29,386.5**	**1.61**	**6,906.9**	**0.05**	**214.5**
3	**4,290**	**5.8**	**6.85**	**29,386.5**	**1.61**	**6,906.9**	**0.05**	**214.5**
4	**4,290**	**5.8**	**6.85**	**29,386.5**	**1.61**	**6,906.9**	**0.05**	**214.5**
5	**4,290**	**5.8**	**6.85**	**29,386.5**	**1.61**	**6,906.9**	**0.05**	**214.5**
Subtotal	**21,450**	**29.0**		**146,932.5**		**34,534.5**		**1,072.5**
6-10	**21,450**	**29.0**	**6.85**	**146,932.5**	**1.61**	**34,534.5**	**0.05**	**1,072.5**
11- Plus	**31,400**	**42.0**	**6.85**	**215,090.0**	**1.61**	**50,554.0**	**0.05**	**1,570.0**
Totals	**74,300**	**100.0**		**508,955.0**		**119,623.0**		**3,715.0**

Projected Estimates from Hargrove 1991 and TMDL Clear Lake SDDENR 1999

4.10 Windbreak/Shelterbelt Establishment

Windbreak or Shelterbelt Establishment typically consists of trees and/or shrub plantings designed to solve a conservation resource concern. Field offices estimated the need for 455 acres of trees to address resource concerns in the LPWIP. At the rate of 23 acres annually, only 37% of this goal will be reached in five years. Strom (2008) reported load reductions gained by converting cropland to trees within the Lake Thompson watershed averaged a nitrogen load reduction at 9.20 pounds/acre/year, phosphorus at 3.17 pounds/acre/year, and sediment at 2.37 tons/acre/year. Estimated load reductions 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	23	5.0	3.65	84.0	2.52	58.0	0.87	20.01
2	23	5.0	3.65	84.0	2.52	58.0	0.87	20.01
3	23	5.0	3.65	84.0	2.52	58.0	0.87	20.01
4	23	5.0	3.65	84.0	2.52	58.0	0.87	20.01
5	23	5.0	3.65	84.0	2.52	58.0	0.87	20.01
Subtotal	115	25.0		420.0		290.0		100.05
6-10	115	25.0	3.65	420.0	2.52	290.0	0.87	100.05
11 Plus	225	50.0	3.65	821.3	2.52	567.0	0.87	195.75
TOTAL	455	100.0		1,661.3		1,147.0		395.85

Load reduction estimates from STEPL. Strom 2008

4.11 Nutrient Management Plan - Cropland

This nutrient management practice is intended for cropland acres where animal manures are not used on cropland fields, and the fields are fertilized with commercial fertilizers. The field offices estimated a total need of 67,200 acres of nutrient management plans on cropland where manure is not applied in the LPWIP. With approximately 3,860 NMP acres targeted annually, it will require additional years of project implementation to meet their goal. A nutrient management plan (NMP) will be developed for nitrogen, phosphorus, and potassium that considers all potential sources of nutrients including commercial fertilizer, crop residues, and legume credits. The NMP would also require that NRCS practice standards be met for Conservation Tillage. Load reductions for NMPs were computed from the Vermillion River Basin project load deliveries for conservation tillage and multiplied by Evans (2003/2008) estimated load reduction percentages of nitrogen (70%) and phosphorus (28%). These estimated load reductions attributed solely to the NMP for the LPWIP 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	Acres	% Goal	N #/AC/YR	Total N #/YR	P #/YR/AC	Total P #/YR
1	3,860	5.8	1.04	4,014.4	0.10	386.0
2	3,860	5.8	1.04	4,014.4	0.10	386.0
3	3,860	5.8	1.04	4,014.4	0.10	386.0
4	3,860	5.8	1.04	4,014.4	0.10	386.0
5	3,860	5.8	1.04	4,014.4	0.10	386.0
Subtotal	19,300	29.0		20,072.0		1,930.0
6-10	19,300	29.0	1.04	20,072.0	0.10	1,930.0
11-Plus	28,600	42.0	1.04	29,744.0	0.10	2,860.0
Total	67,200	100.0		69,888.0		6,720.0

Nutrient Load Reduction Estimates from STEPL. Vermillion River Project

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 35,000 LF of terrace construction to address these steeper slopes in the LPWIP area; completing 1,250 LF per year would require additional years to accomplish this goal. Soil loss calculations projected before and after terrace construction were based on average soil losses computed in the LPWIP. The average soil loss of steeper field slopes that would need terracing was estimated at 9.0 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 are 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 released 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 erosion and sediment yields. 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 using a 77% load reduction for both nitrogen and phosphorous are presented in Table 4-12. The acres of cropland protected are based on terrace length times an estimated 180 feet of protected cropping area.

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

Terrace Load Reductions for Nitrogen, Phosphorous, 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	1,250	5.2	3.6	25.4	131.1	9.8	50.6	5.0	25.8
2	1,250	5.2	3.6	25.4	131.1	9.8	50.6	5.0	25.8
3	1,250	5.2	3.6	25.4	131.1	9.8	50.6	5.0	25.8
4	1,250	5.2	3.6	25.4	131.1	9.8	50.6	5.0	25.8
5	1,250	5.2	3.6	25.4	131.1	9.8	50.6	5.0	25.8
Subtotal	6,250	26.0	18.0		655.5		253.0		129.1
6-10	6,250	26.0	18.0	25.4	655.5	9.8	253.0	5.0	130.0
11-Plus	22,500	92.9	64.0	25.4	2,360.3	9.8	910.7	5.0	464.6
Total	35,000	144.9	100.0		3,671.3		1,416.7		723.7

4.13 Filter Strips - Non-CRP

The need for Non-CRP filter strips was estimated by field offices to be 630 acres within the LPWIP area. Installing 23 acres annually would require additional years to meet the estimated goal. It is unknown whether the non-CRP filter strips will be harvested for hay or grazed, therefore, the load reduction calculations will be based on the more severe land use of grazing. The load reduction for nitrogen, phosphorous, and sediment for grassed filter strips were calculated from 830 acres of rotational grazing installed and reported in the Segment 2 LPWIP. 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	23	3.7	2.88	66.2	0.71	16.3	0.49	11.27
2	23	3.7	2.88	66.2	0.71	16.3	0.49	11.27
3	23	3.7	2.88	66.2	0.71	16.3	0.49	11.27
4	23	3.7	2.88	66.2	0.71	16.3	0.49	11.27
5	23	3.7	2.88	66.2	0.71	16.3	0.49	11.27
SubTotal	115	18.5		331.0		81.5		56.35
6-10	115	18.5	2.88	331.0	0.71	81.5	0.49	56.35
11-Plus	400	63.0	2.88	1,152.0	0.71	284.0	0.49	196.00
TOTAL	630	100.0		1,814.0		447.0		308.70

N, P, and Sediment Load Reductions Estimated data from STEPL. Segment 2 LPWIP.

5. TECHNICAL AND FINANCIAL ASSISTANCE NEEDED

The Hamlin Conservation District is the lead sponsor and administratively responsible for the project implementation. A project coordinator will manage all water quality project activities among the watershed counties and cooperate with 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 continue to be provided through existing partnerships with the local Conservation Districts, the Lake Poinsett Water Project District, the Lake Poinsett Development Association, Ducks Unlimited, Pheasants Forever, East Dakota Central Water Development District, the SD Association of Conservation Districts, SD Department of Environment and Natural Resources, SD Department of Agriculture, SD Game, Fish and Technical Assistance Programs, SD Extension Service, USDA-Farm Service Agency, USDI-Fish & Wildlife Service, and USDI-Environmental Protection Agency.

Funding sources for the implementation of the BMPs will be solicited from the Hamlin Conservation District; SD Department of Agriculture; SD Game, Fish &Parks Wildlife Partnership Program and Wetland and Grassland Habitat Program; SD Department of Environment and Natural Resources; USDI-Fish & Wildlife Service Grassland and Wetland Easement Programs and Private Land Programs; US Environmental Protection Agency; the USDA-NRCS Environmental Quality Incentive Program and Wetland Reserve Program; and the USDA-FSA Conservation Reserve Program.

Funds expended in past BMP implementation projects for the Rural Clean Water Program, Lake Poinsett Watershed Protection Segment 1, and the current Lake Poinsett Watershed Implementation Project Segment 2 include: 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 and Natural Resource, Consolidated Water Facilities Construction Fund Program; USDA-NRCS, Environmental Quality Incentive (EQIP), Wildlife Habitat Incentive (WHIP); and USDA-FSA Conservation Reserve Program (CRP).

The Lake Poinsett Watershed Implementation Plan area land use is fairly homogenous, and the impairment problems have been consistently identified as agricultural in nature for both cropland and animal uses. The financial extrapolations have been conservative with the BMP goals estimated by the local county field offices. This Five Year Strategic Plan is intended to describe and detail the funding needed for the proposed BMPs 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	2	$ 40,000	Grazing System, EA	$ -	2	$ -
	AWSF	$200,000	2	$ 400,000	Rural Water, EA	$ 2,500	2	$ 5,000
	Const Mgmt	$ 18,750	2	$ 37,500	Pipeline, LF	$ 5	4,000	$ 20,000
	NMP	$ 2,500	2	$ 5,000	Tanks, EA	$ 1,500	4	$ 6,000
	Cultural Study	$ 500	2	$ 1,000	Fencing, LF	$ 1	10,000	$ 10,000
				$ 483,500				$ 41,000
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	20	$ -	Rock, Fabric/LF	$ 110	2,360	$ 259,600
	Fencing LF	$ 1	4,000	$ 4,000				$ -
				$ 4,000				$ 259,600
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	3,860	$ 38,600	Dirt Work, Seed/ LF	$ 2.20	7,000	$ 15,400
				$ 38,600				$ 15,400
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	140	$ 6,440
				$ 14,000				$ 6,440
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	$ 40	4,290	$ 171,600	Cost Incentive/AC	$ 3.58	3,860	$ 13,819
				$ 171,600				$ 13,819
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
1	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	23	$ 9,200	Dirt Work/LF	$ 3.50	1,250	$ 4,375
				$ 9,200				$ 4,375
Year	BMP - Filter Strips, Non-CRP							
1	Components	Costs	Quantity	Total Costs				
	Cost Incentive/AC	$ 46	23	$ 1,058				
				$ 1,058	TOTAL BMP COSTS			$ 1,062,592

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	2	$ 40,000	Grazing System, EA	$ -	2	$ -
	AWSF	$200,000	2	$ 400,000	Rural Water, EA	$ 2,500	2	$ 5,000
	Const Mgmt	$ 18,750	2	$ 37,500	Pipeline, LF	$ 5	4,000	$ 20,000
	NMP	$ 2,500	2	$ 5,000	Tanks, EA	$ 1,500	4	$ 6,000
	Cultural Study	$ 500	2	$ 1,000	Fencing, LF	$ 1	10,000	$ 10,000
				$ 483,500				$ 41,000
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	20	$ -	Rock, Fabric/LF	$ 110	2,360	$ 259,600
	Fencing LF	$ 1	4,000	$ 4,000				$ -
				$ 4,000				$ 259,600
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	3,860	$ 38,600	Dirt Work, Seed/ LF	$ 2.20	7,000	$ 15,400
				$ 38,600				$ 15,400
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	7	$ 19,600	Tillage/Seeding AC	$ 46	230	$ 10,580
				$ 19,600				$ 10,580
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	$ 40	4,290	$ 171,600	Cost Incentive/AC	$ 3.58	3,860	$ 13,819
				$ 171,600				$ 13,819
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
2	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	23	$ 9,200	Dirt Work/LF	$ 3.50	1,250	$ 4,375
				$ 9,200				$ 4,375
Year	BMP - Filter Strips, Non-CRP							
2	Components	Costs	Quantity	Total Costs				
	Cost Incentive/AC	$ 46	23	$ 1,058				
				$ 1,058	TOTAL BMP COSTS			$ 1,072,332

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	$ -	2	$ -
	AWSF	$200,000	3	$ 600,000	Rural Water, EA	$ 2,500	2	$ 5,000
	Const Mgmt	$ 18,750	3	$ 56,250	Pipeline, LF	$ 5	4,000	$ 20,000
	NMP	$ 2,500	2	$ 5,000	Tanks, EA	$ 1,500	4	$ 6,000
	Cultural Study	$ 500	4	$ 2,000	Fencing, LF	$ 1	10,000	$ 10,000
				$ 743,250				$ 41,000
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	20	$ -	Rock, Fabric/LF	$ 110	2,360	$ 259,600
	Fencing LF	$ 1	4,000	$ 4,000				$ -
				$ 4,000				$ 259,600
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	3,860	$ 38,600	Dirt Work, Seed/ LF	$ 2.20	7,000	$ 15,400
				$ 38,600				$ 15,400
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	7	$ 19,600	Tillage/Seeding AC	$ 46	230	$ 10,580
				$ 19,600				$ 10,580
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	$ 40	4,290	$ 171,600	Cost Incentive/AC	$ 3.58	3,860	$ 13,819
				$ 171,600				$ 13,819
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
3	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	23	$ 9,200	Dirt Work/LF	$ 3.50	1,250	$ 4,375
				$ 9,200				$ 4,375
Year	BMP - Filter Strips, Non-CRP							
3	Components	Costs	Quantity	Total Costs				
	Cost Incentive/AC	$ 46	23	$ 1,058				
				$ 1,058	TOTAL BMP COSTS			$ 1,332,082

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	5	$ 100,000	Grazing System, EA	$ -	2	$ -
	AWSF	$200,000	4	$ 800,000	Rural Water, EA	$ 2,500	2	$ 5,000
	Const Mgmt	$ 18,750	4	$ 75,000	Pipeline, LF	$ 5	4,000	$ 20,000
	NMP	$ 2,500	3	$ 7,500	Tanks, EA	$ 1,500	4	$ 6,000
	Cultural Study	$ 500	5	$ 2,500	Fencing, LF	$ 1	10,000	$ 10,000
				$ 985,000				$ 41,000
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	20	$ -	Rock, Fabric/LF	$ 110	2,360	$ 259,600
	Fencing LF	$ 1	4,000	$ 4,000				$ -
				$ 4,000				$ 259,600
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	3,860	$ 38,600	Dirt Work, Seed/ LF	$ 2.20	7,000	$ 15,400
				$ 38,600				$ 15,400
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	7	$ 19,600	Tillage/Seeding AC	$ 46	230	$ 10,580
				$ 19,600				$ 10,580
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	$ 40	4,290	$ 171,600	Cost Incentive/AC	$ 3.58	3,860	$ 13,819
				$ 171,600				$ 13,819
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
4	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	23	$ 9,200	Dirt Work/LF	$ 3.50	1,250	$ 4,375
				$ 9,200				$ 4,375
Year	BMP - Filter Strips, Non-CRP							
4	Components	Costs	Quantity	Total Costs				
	Cost Incentive/AC	$ 46	23	$ 1,058				
				$ 1,058	TOTAL BMP COSTS			$ 1,573,832

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	1	$ 20,000	Grazing System, EA	$ -	2	$ -
	AWSF	$200,000	3	$ 600,000	Rural Water, EA	$ 2,500	2	$ 5,000
	Const Mgmt	$ 18,750	3	$ 56,250	Pipeline, LF	$ 5	4,000	$ 20,000
	NMP	$ 2,500	5	$ 12,500	Tanks, EA	$ 1,500	4	$ 6,000
	Cultural Study	$ 500	1	$ 500	Fencing, LF	$ 1	10,000	$ 10,000
				$ 689,250				$ 41,000
Year	BMP - Riparian Areas				BMP - Bank Stabilization			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Grazing AC	$ -	20	$ -	Rock, Fabric/LF	$ 110	2,360	$ 259,600
	Fencing LF	$ 1	4,000	$ 4,000				$ -
				$ 4,000				$ 259,600
Year	BMP - Residue & Tillage Manage				BMP - Grassed Waterways			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$ 10	3,860	$ 38,600	Dirt Work, Seed/ LF	$ 2.20	7,000	$ 15,400
				$ 38,600				$ 15,400
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	7	$ 19,600	Tillage/Seeding AC	$ 46	230	$ 10,580
				$ 19,600				$ 10,580
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	$ 40	4,290	$ 171,600	Cost Incentive/AC	$ 3.58	3,860	$ 13,819
				$ 171,600				$ 13,819
Year	BMP - Windbreak/Shelterbelt				BMP - Terraces			
5	Components	Costs	Quantity	Total Costs	Components	Costs	Quantity	Total Costs
	Cost Incentive/AC	$400	23	$ 9,200	Dirt Work/LF	$ 3.50	1,250	$ 4,375
				$ 9,200				$ 4,375
Year	BMP - Filter Strips, Non-CRP							
5	Components	Costs	Quantity	Total Costs				
	Cost Incentive/AC	$ 46	23	$ 1,058				
				$ 1,058	TOTAL BMP COSTS			$ 1,278,082

TABLE 5-6. SUMMARY OF 5 YEAR COSTS - LAKE POINSETT WATERSHED IMPROVEMENT PROJECT

BMP IMPLEMENTATION COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TASK TOTAL
Animal Waste Manage System	$483,500	$483,500	$743,250	$985,000	$689,250	$3,384,500
Prescribed Grazing	$41,000	$41,000	$41,000	$41,000	$41,000	$205,000
Riparian Area	$4,000	$4,000	$4,000	$4,000	$4,000	$20,000
Bank Stabilization	$259,600	$259,600	$259,600	$259,600	$259,600	$1,298,000
Residue & Tillage Manage	$38,600	$38,600	$38,600	$38,600	$38,600	$193,000
Grassed Waterways	$15,400	$15,400	$15,400	$15,400	$15,400	$77,000
Wetland/Pond/Basin Restoration	$14,000	$19,600	$19,600	$19,600	$19,600	$92,400
Cropland Conversion to Grass	$6,440	$10,580	$10,580	$10,580	$10,580	$48,760
Conservation Cover Crop & Rotation	$171,600	$171,600	$171,600	$171,600	$171,600	$858,000
Nutrient Manage Plan, Non AWMS	$13,819	$13,819	$13,819	$13,819	$13,819	$69,095
Windbreak/Shelterbelt	$9,200	$9,200	$9,200	$9,200	$9,200	$46,000
Terraces	$4,375	$4,375	$4,375	$4,375	$4,375	$21,875
Filter Strips Non-CRP	$1,058	$1,058	$1,058	$1,058	$1,058	$5,290
BMP SUB TOTAL COSTS	$1,062,592	$1,072,332	$1,332,082	$1,573,832	$1,278,082	$6,318,920
PERSONNEL SUPPORT						
Project Coordinator	$60,000	$61,800	$63,700	$65,600	$67,600	$318,700
Secretarial, Part-time	$2,000	$2,060	$2,120	$2,190	$2,250	$10,620
OPERATIONS						
Vehicle, Fuel, Travel, Insurance	$12,000	$13,300	$14,700	$16,000	$17,300	$73,300
ADMINISTRATION						
Tours & Workshops	$1,500	$1,500	$1,500	$1,500	$1,500	$7,500
Computer, Supplies, Telephone, Office, Postage	$8,700	$9,300	$10,000	$10,700	$11,300	$50,000
PERS/ADMIN SUB TOTAL COSTS	$84,200	$87,960	$92,020	$95,990	$99,950	$460,120
YEARLY TOTALS	$1,146,792	$1,160,292	$1,424,102	$1,669,822	$1,378,032	$6,779,040

6. PUBLIC OUTREACH

The Lake Poinsett watershed assessment project was initiated by SDDENR in 1993 at the request of the Lake Poinsett Water Project District (LPWPD). The initial water quality concerns were the severe algal blooms caused by excessive nutrients delivered to the lake. The watershed assessment was completed in 1996. The preliminary results revealed the high concentrations of phosphorus, nitrogen, sediment, and fecal coliform from the Big Sioux River and the Thisted Lake to Lake Albert drainage areas. The sources of pollutants identified were private sewers, improper operation of the Big Sioux River and Lake Poinsett control gates, animal feeding operations, cropland fields, and the use of lawn fertilizers. This assessment developed into the Lake Poinsett Watershed Project (LPWP) in 1998, the goal of which is to restore and implement practices that will maintain a long term full realization of all designated beneficial uses of the surface waters identified. The project initiated the installation of BMPs to achieve full support of all designated beneficial uses of the river.

Public outreach activities during Segment 1 of the LPWP included: 7 workshops on grazing, nutrient and sediment reduction with 621 attendees; 13 public tours of installed BMPs with 422 attendees; 15 watershed newsletter distributed; the mailing of 3,000 brochures explaining the project; 14 radio spots; and the attendance of 35 organizational meetings to explain the LPWP. Segment 2 of the LPWIP has had one producer tour, two public/media tours, one grazing conference, and two newsletters distributed. Currently, four articles a year are posted on the Lake Poinsett Area Development Association website and twelve LPWIP updates are sent by email to a mailing list of 300 land users annually.

The Hamlin Conservation District is currently the LPWIP sponsor and is responsible for the completion of the goals, objectives, and tasks. The Hamlin Conservation District has entered into a cooperative agreement with the Codington, Deuel, Brookings, and Kingsbury County Conservation Districts and formed a steering committee. This steering committee will advise the project sponsor in developing priorities, practice manuals, work plans, and strategies for the project. They will meet at least two times each year to provide input for project management and coordination of resources to the Hamlin Conservation District. The USDA NRCS offices are usually co-located with the CDs. Staff from 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.

Other local, state and federal agencies, and organizations providing technical and financial assistance are: the Lake Poinsett Development Association; Lake Poinsett Sanitary District; Lake Poinsett Water Project District; Hamlin County Livestock Improvement Association; Kingsbury County Cattlemen Association; Hamlin County Cooperative Extension Service and County Commission; East Dakota Water Development District; SD Game, Fish & Parks; SD Department

Environmental Natural Resources; SD Department of Agriculture; SD Association of Conservation Districts; SD State University Extension Service; USDA Natural Resources Conservation Service; USDA Farm Service Agency; and the US Fish & Wildlife Service. Segments I and II of the LPWIP have utilized monies from participant local match, State funding, EPA 319, and USDA EQIP.

Public involvement is encouraged through the participation in Local Work Groups (LWG). These LWGs are sponsored by each of the four counties' Soil and Water Conservation Districts in the LPWIP. 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 on the needs of the watershed. Other outreach activities will be through notice in WEB sites, conservation district newsletters, information presentations, and newspaper and radio advertisements.

7. IMPLEMENTATION SCHEDULE

The implementation of this project will be through voluntary programs with producers and landowners over a four 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 implement the voluntary tasks scheduled. The County Conservation Districts have a field office located in each county that does business with the landowners and agricultural producers. The BMPs will be implemented 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			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		14		2		2	2	2	3	2	1	
Animal Waste Storage Facilities		14		2		2		3		4		3
Construction Management		14		2		2		3		4		3
Nutrient Management Plan		14		2		2		2		3		5
Cultural Resource Study		14		2		2	2	2	3	2	1	
Task 2: Grassland Management	1,2,4											
Product 2: Prescribed Grazing Systems (Ac)		2,800		560		560		560		560		560
Product 3: Riparian Areas (Ac)		100		20	10	10	10	10	10	10	10	10
Task 3: Streambank Stabilization	2,4											
Product 5: Streambank Stabilization (LF)		11,800		2,360	0	2,360	0	2,360	0	2,360	0	2,360
Task 4: Cropland Management	1,2,4											
Product 6: Residue & Tillage Manage (Ac)		19,300		3,860	1,860	2,000	1,860	2,000	1,860	2,000	1,860	2,000
Product 7: Grassed Waterways (LF)		35,000		7,000		7,000		7,000		7,000		7,000
Product 8: Wetland & Pond Construct (No)		33		5	2	5	2	5	2	5		7
Product 9: Conversion of Crop to Grass (Ac)		1,060		140		230		230		230		230
Product 10: Conservation Rotation/Cover Crop (Ac)		21,450		4,290		4,290		4,290		4,290		4,290
Product 11: Cropland NMP (Ac)		19,300		3,860		3,860		3,860		3,860		3,860
Product 12: Windbreak/Shelterbelt (Ac)		115		23		23		23		23		23
Product 13: Terraces (LF)		6,250		1,250		1,250		1,250		1,250		1,250
Product 14: Filter Strips, Non-CRP (Ac)		115		23		23		23		23		23
OBJECTIVE 2: INFORMATION OUTREACH												
Task 5: Information Distribution												
Product 15: Articles, Newsletter, Radio, WEB	1,2,3,4											
CD Newsletters		20	2	2	2	2	2	2	2	2	2	2
Newspaper Articles, Radio Spots, Email		80	8	8	8	8	8	8	8	8	8	8
Tours & Workshops		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. 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 BMPs 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 research as reducing fecal coliform bacteria, *Escherichia coli*, and Chlorophyll-*a*. 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 Lake Poinsett Watershed Improvement Project. 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	14 No.	2	2	4	4	8	5	13	1
Animal Waste Storage Facilities	14 No.	2	2	4	3	7	4	11	3
Construction Management - AWMS	14 No.	2	2	4	3	7	4	11	3
Nutrient Management Plan	14 No.	2	2	4	2	6	3	9	5
Cultural Resource Study - AWMS	14 No.	2	2	4	4	8	5	13	1
Prescribed Grazing Systems	2,800 Ac.	560	560	1,120	560	1,680	560	2,240	560
Riparian Areas	100 Ac.	20	20	40	20	60	20	80	20
Streambank Stabilization	11,800 LF	2,360	2,360	4,720	2,360	7,080	2,360	9,440	2,360
Residue & Tillage Manage	19,300 Ac.	3,860	3,860	7,720	3,860	11,580	3,860	15,440	3,860
Grassed Waterways	35,000 LF	7,000	7,000	14,000	7,000	21,000	7,000	28,000	7,000
Wetland/Pond/Basin Construction	33 No.	5	7	12	7	19	7	26	7
Conversion of Crop to Grass	1,060 Ac.	140	230	370	230	600	230	830	230
Conservation Cover & Crop Rotation	21,450 Ac.	4,290	4,290	8,580	4,290	12,870	4,290	17,160	4,290
Nutrient Management Plan Crop	19,300 Ac	3,860	3,860	7,720	3,860	11,580	3,860	15,440	3,860
Windbreak/Shelterbelt	115 Ac.	23	23	46	23	69	23	92	23
Terraces	6,250 LF	1,250	1,250	2,500	1,250	3,750	1,250	5,000	1,250
Filter Strips Non-CRP	115 Ac.	23	23	46	23	69	23	92	23
CD Newsletters	20	4	4	8	4	12	4	16	4
Newspaper Articles, Radio Spots	80	16	16	32	16	48	16	64	16
Tours & Workshops	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. 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 AnnAGNPS can be used to identify specific feeding operations or cropland practices where the BMPs should be implemented, and the models can again be used to quantify the changes in load reductions.

The SDDENR and USGS maintain (five) ambient water quality monitoring (WQM) sites within the watershed. Four stations are located on the Big Sioux River. USGS site #6479512 is located in Codington County south of Watertown; SDDENR site WQM-1 and USGS site #6479520 is located in Codington County between the confluences of Willow Creek and Stray Horse Creek; USGS site # 6478525 is near the Lake Poinsett outlet; and SDDENR site BS08 is on the Big Sioux River near the mouth of Hidewood Creek; USGS site #6479515 is on the tributary of Willow Creek.. The data from these five water quality monitoring stations can also be used by the project director to make comparisons of installed practices. This data can be collected from SDDENR and USGS on an annual basis as BMPs are installed and results evaluated.

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, STEPL models, and GIS. The AnnAGNPS model can be used to identify specific feeding operations or cropland practices where the BMPs should be implemented, and the models can again be used to quantify the changes in load reductions. 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.

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