TOTAL DISSOLVED CADMIUM TOTAL MAXIMUM DAILY LOAD EVALUATION FOR STRAWBERRY CREEK, LAWRENCE COUNTY, SOUTH DAKOTA

South Dakota Department of Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

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Strawberry Creek Total Maximum Daily Load

Entity ID:	SD-BF-R-STRAWBERRY_01
Location:	HUC Code: 10120202
Size of Watershed:	753 acres
Water body Type:	River/Stream
303(d) Listing Parameter:	Cadmium
Initial Listing date:	1998
TMDL Priority Ranking:	2
Listed Stream Miles:	From the headwaters to the mouth at Bear Butte Creek (Total Length 2 miles)
Designated Use of Concern:	Coldwater Marginal Fish Life Propagation
Analytical Approach:	Load Duration Curve Framework
Target:	To meet applicable water quality standards (74:51:01:55
Indicators:	Total Dissolved Cadmium
Waste Load Allocation:	NA
High Flow Zone LA:	0
High Flow Zone WLA:	4,669 mg/day
High Flow Zone MOS:	927 mg/day
High Flow Zone TMDL:	5,596 mg/day

1.0 Introduction

The intent of this document is to clearly identify the components of the TMDL submittal to support adequate public participation and facilitate the US Environmental Protection Agency (EPA) review and approval. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the dissolved cadmium impairment of Strawberry Creek from the headwaters of Strawberry Creek downstream to the confluence with Bear Butte Creek, SD-BF-R-STRAWBERRY_01.

1.1 Watershed Characteristics:

Strawberry Creek drains 753 acres of land in the Black Hills of western South Dakota and discharges into Bear Butte Creek which runs through Sturgis, South Dakota. (Figures 1, 2, & 3) The site is located about four miles southeast of Lead, South Dakota. Strawberry Creek is a cold-water marginal fishery as well as a headwater to municipal water supplies of the northern Black Hills. It receives runoff from a former 258-acre open pit, cyanide heap-leach gold mine (Gilt Edge Mine). Nearly a decade ago, the mine operator, Brohm Mining Company (BMC) went bankrupt, leaving 150 million gallons of acidic, heavy-metal-laden water in three open pits, as well as millions of cubic yards of acid-generating waste rock that requires cleanup and long-term treatment.

Sulfide waste rock and exposed ore zones contain heavy metals, including arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc. Elevated nitrates and sulfates are also present in heap leach residues. Copper, cadmium and zinc contaminated Strawberry Creek. While controlled, the site presents no immediate threat to human health. If uncontrolled, the large volumes of contaminated waters could threaten the well-water supplies of downstream users, including the city of Sturgis.

Segment SD-BF-R-STRAWBERRY_01 was listed for pH (high and low), cadmium, copper, and zinc in South Dakotas 2008 Integrated Report (IR). This TMDL will only address the total dissolved cadmium listing.

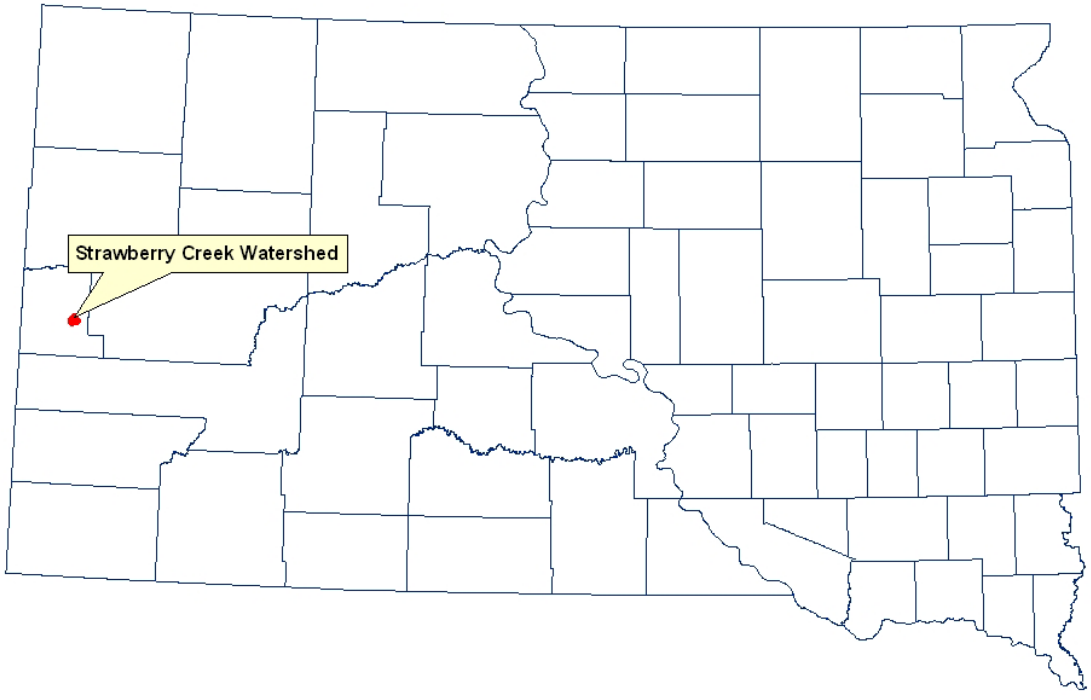

Figure 1. Strawberry Creek Location in South Dakota

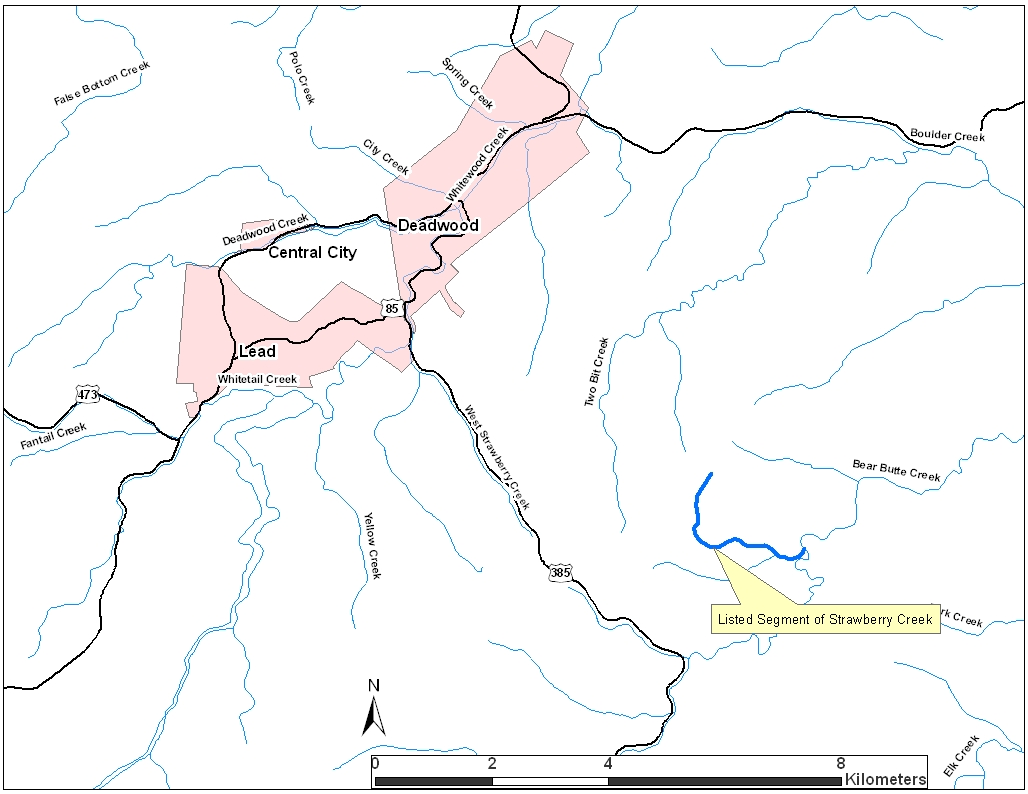

Figure 2. Strawberry Creek Location

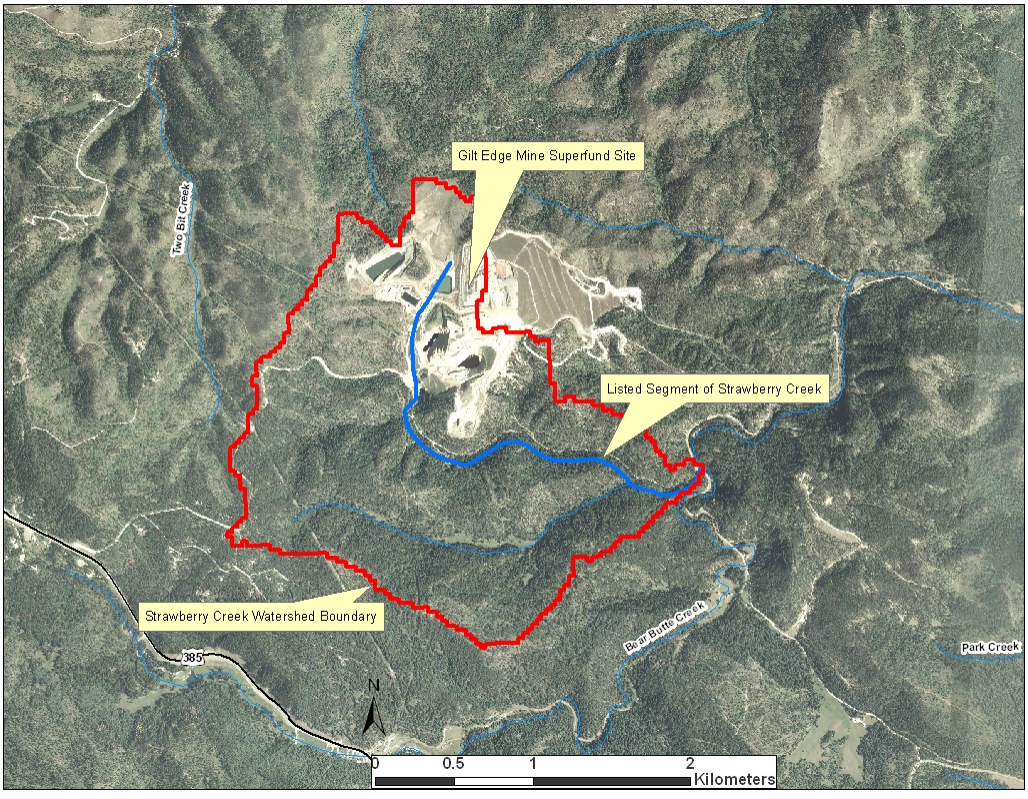

Figure 3 Strawberry Creek Watershed and Gilt Edge Superfund Site

2.0 Water Quality Standards

Each water body within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated the use of fish and wildlife propagation, recreation and stock watering. All streams are assigned the use of irrigation. Additional uses may be assigned by the state based on a beneficial use analysis of each water body. Water quality standards have been defined in South Dakota Administrative Rules in support of these uses. These standards consist of suites of numeric criteria that provide physical and chemical benchmarks from which management decisions can be developed.

Chronic standards, including geometric means and 30-day averages, are applied to a calendar month. For hardness-based metals, the hardness and metal concentrations were averaged for the calendar month. While not explicitly described within the states water quality standard, this is the method used in the IR as well as in permit development.

Additional "narrative" standards that may apply can be found in the "Administrative rules of South Dakota: Articles 74:51:01:05; 06; 08; 09 and 12. These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, or pollutants negatively impacting aquatic communities

Table 1 includes the numeric water quality standards that apply to the listed segment of Strawberry Creek. In addition to the numeric standards in Table 1, toxic pollutants and chemicals prioritized in 40 C.F.R. Part 131 (July 1, 2008) are also addressed in South Dakota Water Quality Standards. The relevant pollutant of concern for this TMDL is dissolved cadmium (Cd); following are the applicable equations used in determining acceptable levels of this pollutant.

Toxic Criteria Equations for Cadmium, ug/L

Hardness-dependent criteria in ug/L. Values given are examples only and were based on a CaCO3 hardness of 100 mg/L. Criteria for each case must be calculated using the following equations taken from National Recommended Water Quality Criteria: 2002 (EPA-822-R-02-047, November 2002).

Chronic = (*0.909)$\mathbf{e}$(0.7409[ln(hardness)]-4.719)

Acute = (*0.944)$\mathbf{e}$(1.0166[ln(hardness)]-3.924)

*Conversion factors are hardness-dependent. The values shown are with a hardness of 100 mg/L as calcium carbonate ($CaCO_3$). Conversion factors (CF) for any hardness can be calculated using the following equations:

Chronic: CF = 1.101672 - [(ln hardness)(0.041838)]

Acute: CF = 1.136672 - [(ln hardness)(0.041838)]

Table 1. State Water Quality Standards for Strawberry Creek.

Parameter	Criteria	Unit of Measure	Beneficial Use Requiring this Standard
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L	Coldwater marginal fish propagation
	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L	
Dissolved Oxygen	≥ 5.0	mg/L	Coldwater marginal fish propagation Limited contact recreation
Undisassociated hydrogen sulfide	≤ 0.002	mg/L	Coldwater marginal fish propagation
pH	≥ 6.5 - ≤ 9.0	units	Coldwater marginal fish propagation
Total Suspended Solids	≤ 90	mg/L	Coldwater marginal fish propagation
	≤ 158	mg/L	Coldwater marginal fish propagation
Temperature	≤ 75	°F	Coldwater marginal fish propagation
Dissolved Cadmium	Equal to or less than the result from Equation 9 in Appendix A of Surface Water Quality Standards	µg/L	Coldwater marginal fish propagation
Conductivity	≤2,500 (mean) ≤4,375 (single sample)	mhos/cm @ 25° C	Irrigation Waters
Sodium Adsorption Ratio	< 10	ratio	Irrigation Waters
Nitrogen, nitrate as N	≤50 (mean) ≤88 (single sample)	mg/L	Wildlife Propagation and Stock Watering
Solids, total dissolved	≤2,500 (mean) ≤4,375 (single sample)	mg/L	Wildlife Propagation and Stock Watering
Alkalinity ($CaCO_3$)	≤750 (mean) ≤1,313 (single sample)	mg/L	Wildlife Propagation and Stock Watering
Total Petroleum Hydrocarbon	≤10	mg/L	Wildlife Propagation and Stock Watering
Oil and Grease	≤10		
Eschericia coli (May 1 – September 30)	≤ 630 (geometric mean)	count/100 mL	Limited contact recreation waters
	≤ 1178 (single sample)		
Fecal Coliform (May 1 - September 30)	<1000 (geometric mean)	count/100 mL	Limited contact recreation waters
	<2000 (single sample)		

3.0 Significant Sources

3.1 Point Sources

Data analysis for this TMDL will be limited to review of past and present conditions and the establishment of necessary reductions to meet the water quality standards. It is widely accepted that the Gilt Edge Mine contributes the entire load of dissolved cadmium. This abandon mine is now the focus of an EPA Superfund cleanup. Detailed information on the remediation site and cleanup effort is included in the Record of Decision (ROD) which is available at: http://www.epa.gov/region8/superfund/sd/giltedge/

3.2 Non Point Sources

There are no known measurable background sources (natural or manmade) of cadmium within the Strawberry Creek drainage. Throughout the Black Hills, the only sources of dissolved cadmium are all mine related.

4.0 Technical Analysis

4.1 Data Collection Method

Data on Strawberry Creek was collected on a monthly basis from water quality monitoring site 460116 (WQM-116 on map) by South Dakota Department of Environment and Natural Resources (SDDENR) Surface Water Quality Program staff (Figure 4). Data from this site were originally used to list the segment and continues to be collected from this location.

In 2000, EPA placed the Gilt Edge Mine on the National Priorities List. Camp Dresser McGee (CDM) a consulting, engineering, construction, and operations firm facilitated the site from the initiation of the cleanup through the development of this TMDL. Through the project, data were collected from numerous sites throughout the drainage. Much of these data were used to monitor the cleanup efforts of the mining site. The more important (in regards to this TMDL) sites include data collected from the site discharge pipe (WTP End of Pipe on map) and site CP-001 located at the downstream end of the reach prior to Strawberry Creek entering Bear Butte Creek. For the purposes of this TMDL, the site with the greatest importance is CP-001, which reflects the cumulative effects of the entire reach.

The water treatment facility accounts for a majority of the flow in the stream, which discharges at site WTP End of Pipe in Figure 4. Additional flow is added to the stream from a number of seeps between the End of Pipe and CP001. These seeps are hydraulically connected to the portions of the mine site that were not receiving treatment at the completion of this report. The Record of Decision (ROD) includes a significant amount of detail covering the hydraulic connections, on site sources of cadmium, and the plans for mitigating the site. As the only source of dissolved cadmium in the drainage, Gilt Edge will be treated as a single waste load in this TMDL. The various hydraulic connections to the stream and their individual contributions and mitigation plans are addressed in the ROD.

Figure 4. Strawberry Creek Site Locations

4.2 Flow Analysis

Flow data for Strawberry Creek were available for over 3,200 days of record (Figures 5 and 6) providing sufficient information for the development of an accurate load duration curve. The gap in the data represents the time period between the mine closing that sites placement on the national priorities list. Individual daily flows are available from either SD DENR or EPA. Flow rates are reported in gallons per minute (gpm). The reason the lowest flow zone break was moved from the 90th to the 80th percentile will be discussed in greater detail towards the end of section 4.3.

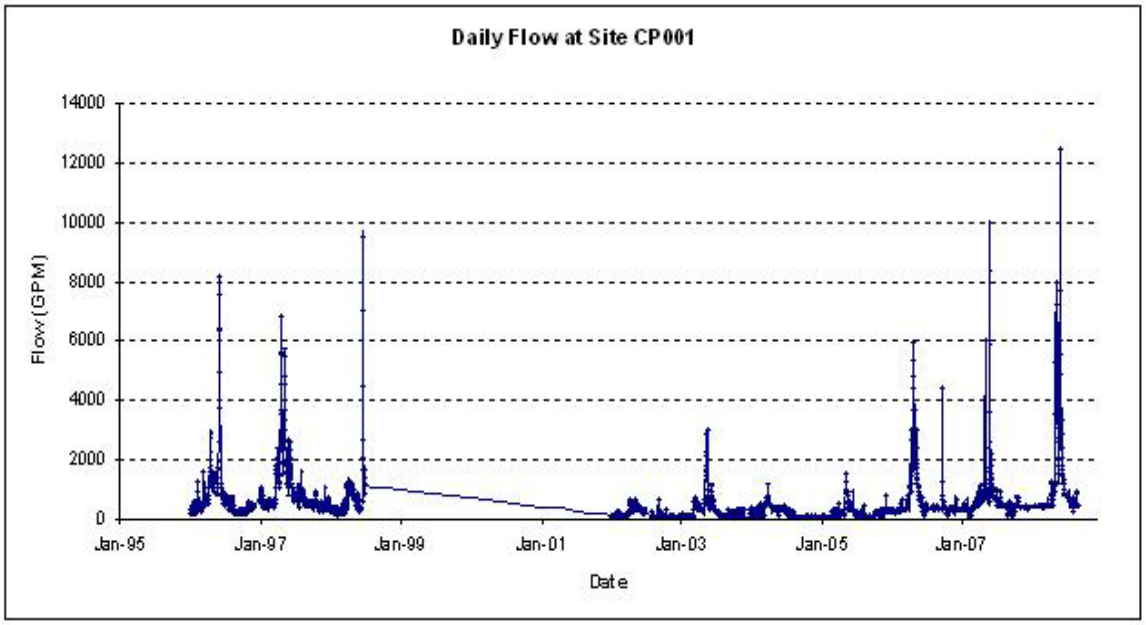

Figure 5. Daily Flow at Site CP001 on Strawberry Creek

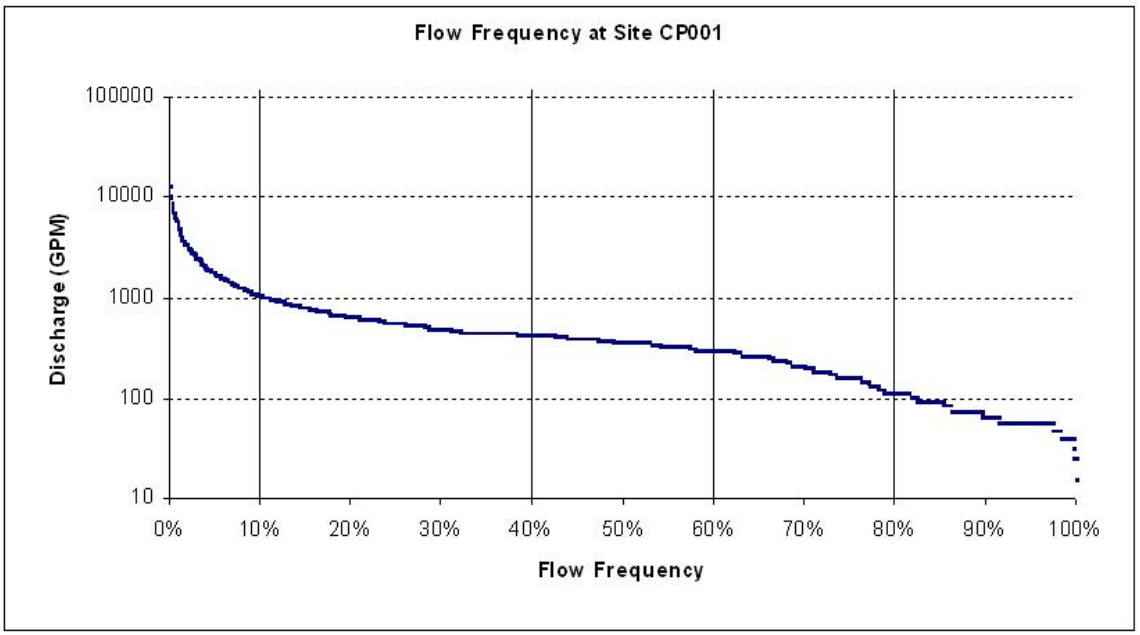

Figure 6. Flow Frequency at Site CP001 on Strawberry Creek

4.3 Sample Data

Weekly samples were collected from Site CP-001 from August 13, 2002 and were ongoing at the development of this TMDL. The final sample used for this TMDL was collected on May 11, 2009 for a total of 385 samples. A chronological chart of the sample data is depicted in Figure 7. Of the 385 samples collected, 147 were found to be below the detection limit while an additional 140 samples were measured at the detection limit.

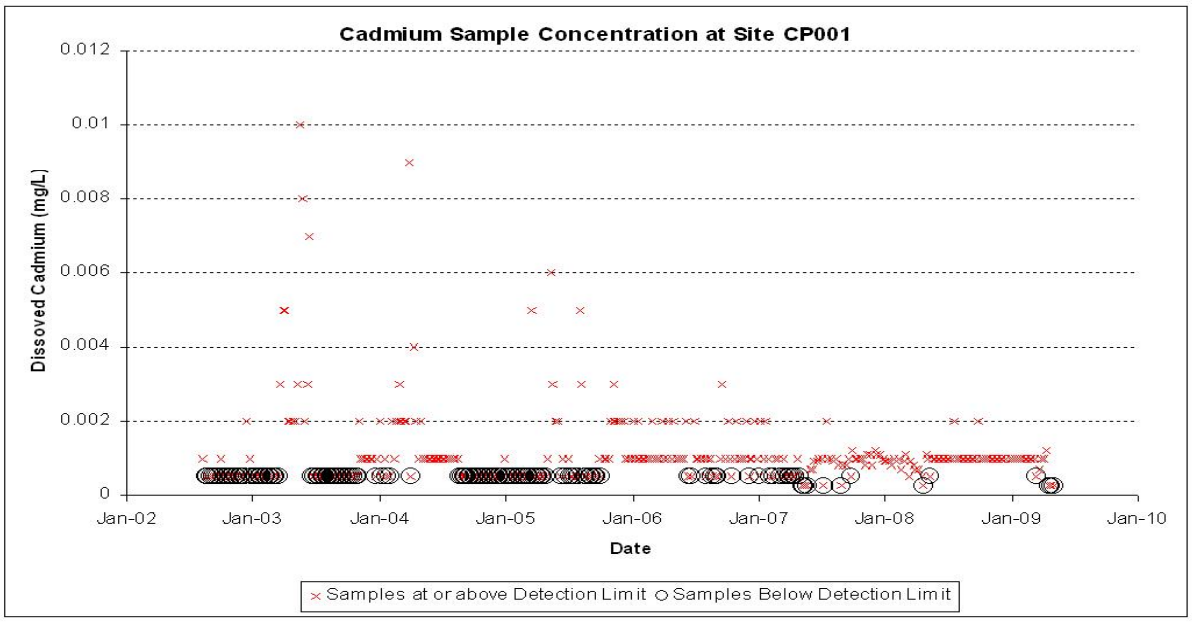

Figure 7. Dissolved Cadmium Samples at Site CP-001

The high incidence of samples collected at or below the detection limits results in inconclusive trend analysis. It is evident from the chart that the frequency and intensity of samples that exceed the water quality standard steadily decreased from the onset of the superfund project through the development of this TMDL. The most recent sample that exceeded the acute standard was collected on May 16, 2005.

During 2005 two steps in the cleanup process occurred that appear to have had lasting effects on the system. Discharge from HooDoo Gulch (a small drainage from the mine site) was eliminated. Also during 2005 the water treatment plant began full time operations. It is likely that the project has reduced the dissolved Cd to a point that acute violations will no longer occur.

Early sample data from Strawberry Creek utilized lab analysis method 200.7 from USEPA with a detection limit of 0.001 mg/L. This detection limit is too coarse to determine impairment of the chronic standard for dissolved cadmium (0.00009 mg/L to 0.00076 mg/L based on varying hardness). Much of the early (prior to 2002) sample data from Strawberry Creek easily exceeded the 0.001 mg/L level of detection as well as the acute standard. As a result, it provided a sufficient level of monitoring to list and track the condition of Strawberry Creek.

Progress made in the cleanup of the stream has steadily decreased the concentrations of dissolved cadmium, frequently yielding results at or below the detection limit. In 2007, lab results from CDM began reporting a lower detection limit of 0.0005 mg/L on some of the samples. This new detection limit coincides with the chronic standard at a hardness of 275 mg/L and the acute standard at a hardness of 25 mg/L. Over 80% of the samples collected from this site have a hardness of 275 mg/L or higher. This new lower limit allows for support determination at the chronic standard for a majority of the samples collected and at the acute standard for all of the samples collected.

The most recent data collected from 2007 through 2009 indicates that approximately 60% of the samples have a concentration between 0.0008 mg/L and 0.001 mg/L cadmium. In addition, only 14% of these samples were below the detection limits of either 0.001 mg/L or 0.0005 mg/L. This is important when determining how to deal with samples that were below the detection limit. EPA guidance (USEPA, 2000) suggests that in cases where fewer than 15% of the samples are below the detection limit, it is appropriate and acceptable to utilize one half the detection limits in calculations. This method was used and will have a minimal impact on the acute samples but will have a significant impact on the necessary reductions needed to attain the chronic water quality standard.

Figure 8 represents the hardness concentrations within the various flow zones. There appears to be two distinct trends. The low flow data exhibiting the hardness concentrations under 500 mg/L (data grouping in the lower right) were collected during times when the water treatment plant was not operating. There are 7 samples that were collected after the plant began full time operation within this group; they were collected on dates that the plant did not discharge.

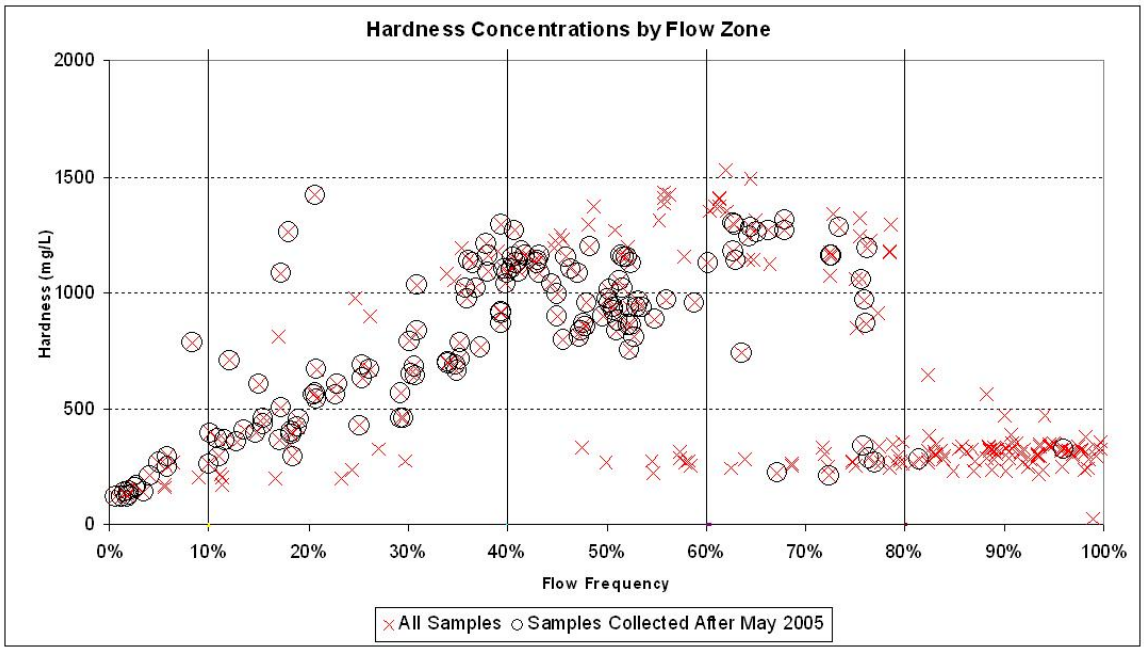

Figure 8. Hardness Concentrations by Flow Zone in Strawberry Creek

The flow zone break normally found at the 90th percentile was shifted to the 80th percentile because of these distinct data groups. Flows that are lower than the 80th

percentile are composed entirely of base flows within the stream and are unaffected by discharges from the water treatment plant.

The data grouping starting in the lower left in the high flow zone and stretching to the upper right represent samples collected while the treatment plant was discharging. The slope associated with this sample set may be best described by dilution occurring as a result of precipitation runoff events in the higher flows.

The importance of hardness on the toxicity of cadmium in relation to both the chronic and acute standards is discussed further in each section. The treatment plant appears to be playing an important role in both the hardness of the stream as well as the volume of base flow. While the plant is discharging, the stream flows at or above the 80th percentile of the long term flow record.

4.4 Load Duration Curve

Analyses of toxic metals, such as dissolved cadmium, with a load duration curve (LDC) require some special considerations. A typical LDC would incorporate a flow based limit above which a violation of the water quality standard occurs. The toxicity of metals such as cadmium is highly influenced by the hardness of the water. Higher concentrations of carbonates increase the hardness while decreasing the toxicity of the metal.

4.4.1 Evaluation of the Acute Standard

The load duration curve located in Figure 9 addresses the acute criteria and the effects of hardness on support of the water quality standard. Samples plotted below the lower limit "Acute Standard @ Hardness 25" would meet the water quality standard regardless of their measured hardness. Samples plotted above the upper limit "Acute Standard @ Hardness 400" exceed the water quality standard regardless of their measured hardness. The samples that fall between the two lines may or may not violate the standard depending on their hardness.

In Strawberry Creek, there are a total of six samples that exceed the acute standard based on the hardness measured at the time the sample was collected. All six of these samples were collected prior to the water treatment facility beginning full time operation in 2005. Based on the data used for the 2010 integrated report, Strawberry Creek met the acute water quality standard for cadmium.

Due to the large number of samples that were measured below the detection limit, special consideration was given to dealing with these values. The method which is most protective of the resource is to give the samples below the detection limit the next highest detected value. For Strawberry Creek, this value would be the detection limit itself. When this method was applied, the number of samples that exceed the acute standard remained six. Other methods result in values that are lower, which would also meet the acute water quality standard. The current detection limit was adequate for evaluating the acute water quality standard for cadmium.

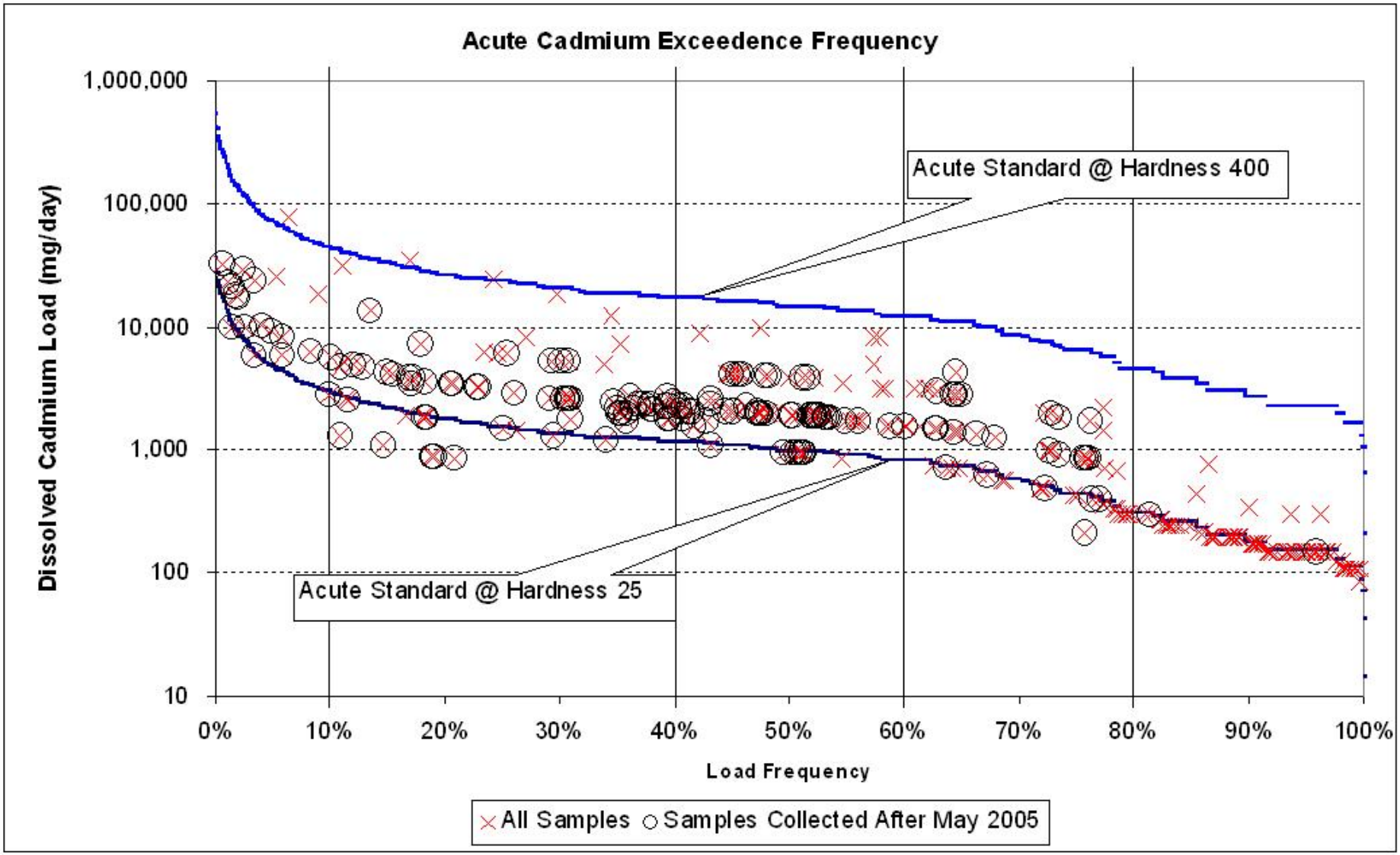

Figure 9. Dissolved Cadmium Load Duration Curve Based on Acute Criteria

4.4.2 Evaluation of the Chronic Standard

The 2010 Integrated Report for South Dakota defines how values used to determine support of chronic standards are calculated: "*Chronic standards, including geometric means and 30-day averages, are applied to a calendar month. For hardness-based metals, the hardness and metal concentrations were averaged for the calendar month*." This method is also used in permit development and was applied to the data set for Strawberry Creek.

The load duration curve located in Figure 10 addresses the chronic criteria and the effects of hardness on support of the water quality standard. Flow frequencies in Figure 10 were calculated based on average flow across the calendar months for the period of record. No data can be plotted below the lower limit "Chronic Standard @ Hardness 25" as a result of the fact that this limit is less than 50% of the lowest detection limit. Samples plotted above the upper limit "Chronic Standard @ Hardness 400" exceed the water quality standard regardless of their measured hardness. The samples that fall between the two lines may or may not violate the standard depending on their hardness.

Adequate data were available to plot 75 samples in Figure 10; 13 of these or 17% supported the water quality standard. These samples could be generalized in that they were collected from lower flows and that all of the individual samples that composed the monthly mean were below the detection limit. In each case, using the detection limit itself in place of 50% of the detection limit to calculate the average monthly concentration, each of these samples would exceed the water quality standard.

Reductions necessary to meet the water quality standards for this stream were based on the chronic standard. This is the result of nearly all of the sample concentrations falling between the chronic and acute thresholds. Due to the effects hardness has on the toxicity of cadmium, multiple reductions may be calculated depending on the hardness used in the calculations. Two other factors were given heavy consideration when determining the necessary reductions. Cadmium is a toxic and no violations are acceptable. Regardless of the calculated reductions, sample data indicating full attainment of the standard will dictate the success of the cleanup effort.

Each flow zone was evaluated based on the maximum average monthly cadmium concentration measured as well as the minimum monthly average hardness measured. This method provided assurance that the TMDL would meet the standard 100% of the time. Hardness concentrations are affected by flow making it appropriate to use different concentrations based on different flow zones.

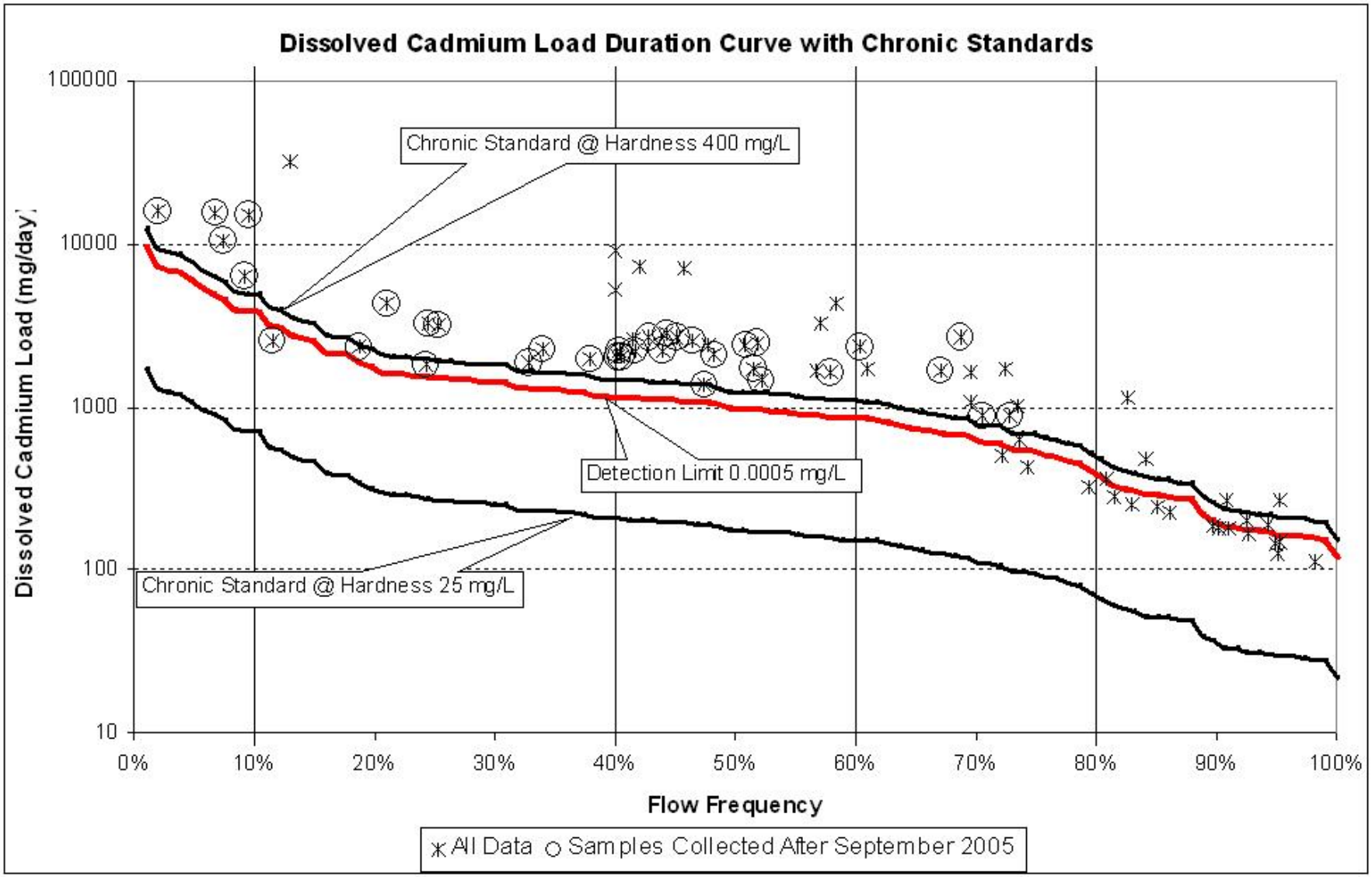

Figure 10. Dissolved Cadmium Load Duration Curve with Chronic Standards

5.0 TMDL and Allocations

Strawberry Creek has not experienced a single acute standard violation of the cadmium criteria since May, 2005. Chronic violations are common with over 80% of the months exceeding the standard. The TMDL will focus on reductions necessary to attain the chronic standards. Since all the values are already below the acute standards, any further reductions can be assumed to further protect the acute criteria.

TMDLs are typically based on a single concentration used in all flow zones. The dynamic relationship between hardness, flow frequency, and its impact on toxicity of cadmium in Strawberry Creek demand that a more complex approach be applied. Each flow zone will be analyzed independently taking into consideration the impacts the treatment plants operation has on hardness and cadmium concentrations. The intent of utilizing this approach is to strike a balance between protecting the stream while not requiring unnecessary reductions from the mine site. Hardness, cadmium concentrations, and flows were generated by taking the average of a minimum of three samples in a calendar month.

Each flow zone has multiple options for setting the hardness based concentration for the TMDL. Frequently, a percentile such as the 90^{th} or 95^{th} may be selected. As a result of the hardness concentrations being averaged across a calendar month and the fact that Cadmium is a toxic, the minimum hardness concentration will be used to generate assurance that the TMDL will fully attain the water quality standard. Taking the minimum hardness concentrations in each zone effectively means using the lowest monthly average concentration of hardness to generate the cadmium concentration that will be used as the standard in that flow zone. The flow used in each zone will utilize the 95^{th} percentile (high flow which exceeds 95% of the other flows within the zone) flow in each zone respectively.

5.0.1 Zone 1, Flow Frequencies Less than 10%

This zone is characterized by high flows which are related to rainfall and snowmelt events. These events occur infrequently and are minimally impacted by the water treatment plant. Hardness concentrations within this zone are typically the lowest measured with a minimum of 132 mg/L and a mean of 277 mg/L. All of the samples within this zone were collected after the treatment plant began full time operation in October, 2005.

The minimum average monthly hardness in this flow zone is 132 mg/L resulting in an allowable concentration of 0.0003 mg/L. An important consideration with this concentration is that it is less than the lowest detection limit used to date. The 95th percentile flow within this zone is 3,418 gpm, generating a total allowable load of 5,596 mg/day.

Table 2. Monthly Data for Flow Zone 1

Year	Month	Hardness (mg/L)	Cd (mg/L)	Standard (mg/L)	Chronic Violation
2006	4	365	0.00160	0.00060	Yes
2006	5	260	0.00120	0.00048	Yes
2007	6	324	0.00080	0.00056	Yes
2008	5	132	0.00090	0.00030	Yes
2008	6	305	0.00100	0.00053	Yes

The current load was calculated using the mean concentration for the flow zone (0.0011 mg/L) and the 95th percentile flow of 3,418 gpm yielding a load of 20,517 mg/day.

5.0.1 Zone 2, Flow Frequencies 10% to 40%

Flows in this zone are influenced by precipitation driven runoff events, but the impacts of the water treatment facility adding hardness to the stream begin to have a significant impact on the water quality. The minimum average monthly hardness measured in this zone prior to plant operation was 206 mg/L, however after full time operation began, this number increased to 320 mg/L. The average hardness since October, 2005 is 624 mg/L, which exceeds the maximum of 400 mg/L used to set the upper limits of the chronic standards.

The minimum average monthly hardness in this flow zone during plant operation is 320 mg/L, resulting in an allowable concentration of 0.00055 mg/L. The 95th percentile flow within this zone is 1,376 gpm, generating a total allowable load of 4,130 mg/day.

Table 3. Monthly Data for Flow Zone 2

Year	Month	Hardness (mg/L)	Cd (mg/L)	Standard (mg/L)	Chronic Violation
2003	5	206	0.00520	0.00041	Yes
2007	3	671	0.00070	0.00064	Yes
2007	4	353	0.00060	0.00059	Yes
2007	5	320	0.00031	0.00055	No
2007	7	627	0.00105	0.00064	Yes
2007	8	694	0.00093	0.00064	Yes
2008	3	1092	0.00084	0.00064	Yes
2008	4	650	0.00054	0.00064	No
2008	7	570	0.00125	0.00064	Yes
2008	8	649	0.00100	0.00064	Yes

The mean concentration for the flow zone is 0.0012 mg/L. Limiting the dataset to samples collected since October, 2005, this mean drops to 0.0008 mg/L. The lower concentration was used with the 95th percentile (high) flow to calculate the current load for this flow regime. The 95th percentile flow within this zone is 1,376 gpm, resulting in a load of 6,007 mg/day.

The cadmium reduction since October, 2005 in this flow zone is the product of successful mitigation activities associated with the Gilt Edge superfund cleanup. Reductions from 0.0012 to 0.0008 with a goal of 0.00055 suggest that at least 40% of the excess metal has already been removed from flows.

5.0.1 Zone 3, Flow Frequencies 40% to 60%

Flows in this zone are heavily impacted by the water treatment facility. Figure 8 shows two distinct groupings of hardness concentrations, with the defining difference coming from discharges from the treatment plant. Hardness concentrations within this flow zone have an average monthly minimum of 226 mg/L when no discharge from the treatment plant is present. The average monthly minimum increases to 367 mg/L after October, 2005. The mean concentration for all data is 844 mg/L, this also increases after October, 2005 to 941 mg/L.

Using the minimum hardness measured since October, 2005, a maximum allowable concentration of 0.00061 mg/L of cadmium may be calculated. The 95th percentile flow within this zone is 415 gpm, resulting in an allowable load of 1,381 mg/day.

Table 4. Monthly Data for Flow Zone 3

Year	Month	Hardness (mg/L)	Cd (mg/L)	Standard (mg/L)	Chronic Violation
2003	3	304	0.00186	0.00053	Yes
2003	4	281	0.00275	0.00050	Yes
2003	6	249	0.00333	0.00046	Yes
2004	3	936	0.00333	0.00064	Yes
2004	4	1113	0.00230	0.00064	Yes
2004	5	1260	0.00120	0.00064	Yes
2004	6	1405	0.00100	0.00064	Yes
2005	5	263	0.00250	0.00048	Yes
2005	6	226	0.00090	0.00043	Yes
2006	2	1288	0.00100	0.00064	Yes
2006	3	990	0.00125	0.00064	Yes
2006	6	367	0.00090	0.00061	Yes
2006	7	805	0.00125	0.00064	Yes
2006	8	888	0.00080	0.00064	Yes
2006	9	803	0.00110	0.00064	Yes
2006	10	731	0.00110	0.00064	Yes
2006	11	936	0.00125	0.00064	Yes
2006	12	1061	0.00125	0.00064	Yes
2007	1	1100	0.00130	0.00064	Yes
2007	9	709	0.00071	0.00064	Yes
2007	10	863	0.00094	0.00064	Yes
2007	11	1075	0.00100	0.00064	Yes
2007	12	1133	0.00105	0.00064	Yes
2008	1	1164	0.00090	0.00064	Yes
2008	2	1158	0.00090	0.00064	Yes

The mean concentration for the flow zone is 0.0014 mg/L. Limiting the dataset to samples collected since October, 2005, this mean drops to 0.0010 mg/L. The lower concentration was used with the 95th percentile (high) flow to calculate the current load for this flow regime. The 95th percentile flow within this zone is 415 gpm, resulting in a load of 2,265mg/day.

Similar to zone 2, it is apparent that significant reductions have already been achieved. The reductions from 0.0014 to 0.00010 with a goal of 0.00061 suggest that at least 50% of the source has already been mitigated.

5.0.1 Zone 4, Flow Frequencies 60% to 80%

Zone 4 is characterized by flows that are a combination of water treatment plant discharges and base flows within Strawberry Creek. When the plant is operating, flows do not appear to drop below the 80th percentile. Referring back to Figure 8, there are two distinct groups of data within this flow zone. Treatment plant influenced samples had a minimum hardness of 673 mg/L with a mean concentration of 1059 mg/L. Minimum hardness concentrations drop to 260 mg/L when no treatment plant discharges are present.

As in the other zones, the minimum hardness since October, 2005 was used to determine the maximum allowable monthly average concentration of 0.00064 mg/L of cadmium, which is equal to the maximum monthly average concentration allowed with the 400 mg/L hardness concentration. Using this concentration with the 95th percentile flow of 308 gpm a maximum allowable load of 1,076 mg/day was calculated.

Table 5. Monthly Data for Flow Zone 4

Year	Month	Hardness (mg/L)	Cd (mg/L)	Standard (mg/L)	Chronic Violation
2002	9	312	0.00060	0.00054	Yes
2003	7	260	0.00050	0.00048	Yes
2003	10	938	0.00050	0.00064	No
2003	11	1352	0.00108	0.00064	Yes
2004	1	1173	0.00100	0.00064	Yes
2004	2	1069	0.00138	0.00064	Yes
2004	7	1164	0.00100	0.00064	Yes
2005	4	332	0.00050	0.00057	No
2005	8	579	0.00167	0.00064	Yes
2005	10	959	0.00090	0.00064	Yes
2005	11	1234	0.00220	0.00064	Yes
2005	12	1210	0.00150	0.00064	Yes
2006	1	1220	0.00133	0.00064	Yes
2007	2	673	0.00075	0.00064	Yes

The mean concentration for the flow zone is 0.00062 mg/L. Limiting the dataset to samples collected since October, 2005, the mean increases to 0.0013 mg/L. This increase in cadmium does not fit with what was observed in the other flow zones where the concentration decreased. It is assumed that this is a product of transitioning from flows that are influenced by runoff from the mine site to flows that consist mainly of groundwater flows from seeps that are not influenced by the mine. This is further supported when zone 5 is evaluated where concentrations continue to decrease. It is important to note that the discharges from the water treatment plant are not causing the impairment. It is reducing concentrations in those flows; the lower concentrations are a result of dilution from clean groundwater flows.

Arbitrarily using the smaller number would suggest that this flow zone is meeting the standard; however, that is clearly not the case. In maintaining consistency with the other flow regimes, the concentration of 0.0013 mg/L was used with the 95th percentile flow of 308 gpm to generate a current load of 2,252 mg/day.

5.0.1 Zone 5, Flow Frequencies Greater than 80%

Flow zone 5 is characterized by baseflow conditions that only occur in the absence of precipitation driven runoff and/or water treatment plant discharges. Nearly all of the samples within this flow regime were at or below the detection limit. Average monthly flows within this regime have not occurred since the plant began full time operation in October, 2005.

Since no flows have occurred within this flow regime since October, 2005, the minimum hardness of 261 mg/L was used to calculate a maximum allowable concentration of 0.00048 mg/L dissolved cadmium. This concentration with the 95th percentile flow may be used to calculate a maximum allowable load of 322 mg/day.

Table 6. Monthly Data for Flow Zone 5

Year	Month	Hardness (mg/L)	Cd (mg/L)	Standard (mg/L)	Chronic Violation
2002	8	328	0.00067	0.00056	Yes
2002	10	274	0.00050	0.00050	Yes
2002	11	324	0.00050	0.00056	No
2002	12	316	0.00081	0.00055	Yes
2003	1	324	0.00050	0.00056	No
2003	2	311	0.00050	0.00054	No
2003	8	272	0.00050	0.00049	Yes
2003	9	397	0.00050	0.00064	No
2003	12	1197	0.00090	0.00064	Yes
2004	8	854	0.00080	0.00064	Yes
2004	9	350	0.00050	0.00059	No
2004	10	323	0.00050	0.00055	No
2004	11	327	0.00050	0.00056	No
2004	12	315	0.00050	0.00054	No
2005	1	312	0.00058	0.00054	Yes
2005	2	312	0.00050	0.00054	No
2005	3	533	0.00163	0.00064	Yes
2005	7	267	0.00063	0.00049	Yes
2005	9	261	0.00050	0.00048	Yes

The average cadmium concentration within this flow zone is 0.00063 mg/L. However, the lower half of the samples had a mean concentration of 0.00057 mg/L, suggesting that surface runoff of some type is necessary to elevate cadmium concentrations in the stream. Using the average concentration of 0.00063 mg/L with the 95th percentile flow of 123 gpm, a load of 423 mg/day is calculated.

As flow decreases within this zone, so does the cadmium concentration. This trend was also observed in the lower end of zone 4 and further supports the theory that these low concentrations at low flows are the product of clean groundwater flows in the drainage. As the flows decrease in magnitude, the clean groundwater has an increasing influence over the water quality in the stream.

Table 7 summarizes the TMDL allocations for each of the flow zones. Detailed information on how each of the waste load allocations (WLA), TMDLs, and current loads may be found throughout section 5.0. Margin of safety is described in further detail in section 6.1.

Table 7. TMDL Summary for Dissolved Cadmium in Strawberry Creek

TMDL Component	Flow Zone (expressed as mg/Day)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
WLA	4669	3758	1238	758	220
LA	0	0	0	0	0
MOS	927	372	143	318	102
TMDL	5596	4130	1381	1076	322
Current Load*	20517	6007	2265	2252	423
Load Reduction	73%	31%	39%	52%	24%
**Current Load is the flow zone mean concentration * 95th percentile flow in each regime*					

5.1 Load Allocations (LAs)

A load allocation of 0 was given to the watershed as there are no known sources of dissolved cadmium that are not related to the Gilt Edge Superfund site.

5.2 Wasteload Allocations (WLAs)

As an EPA Superfund site, the abandon mine is exempt from a permit and does not have a permit number. As the sole source of dissolved cadmium, for the purposes of this TMDL it will be considered a point source and included in the waste load allocation.

6.0 Margin of Safety (MOS) and Seasonality

6.1 Margin of Safety

An explicit MOS identified using a duration curve framework is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc). An explicit MOS was calculated as the difference between the loading capacity at the mid-point of each of the five flow zones and the loading capacity at the minimum flow in each zone. A substantial MOS is provided using this method, because the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point.

Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS. As new information becomes available and the TMDL is revisited, this unallocated capacity may be attributed to nonpoint sources and added to the load allocation, or the unallocated capacity may be attributed to point sources and become part of the waste load allocation.

6.2 Seasonality

Different seasons of the year can yield differences in water quality due to changes in precipitation. Some seasonality appeared in the concentrations of dissolved cadmium with spring and summer months occasionally carrying higher loads. These elevated samples all occurred prior to 2005. By addressing the TMDL in its individual flow zones, the seasonality was appropriately accounted for.

7.0 Public Participation

Public notice of this document was provided in the Black Hills Pioneer and the Rapid City Journal during March of 2010. It was also made available on the SD DENR website. Comments were received from the US EPA and the SD Department of Game Fish and Parks. These comments and the actions taken to address them may be found in Appendix B.

8.0 Monitoring Strategy

As part of an EPA superfund site, ongoing monitoring will be completed by both SD DENR as well as EPA.

The Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that are developed or come to light during the implementation of the TMDL and a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation. New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information and land use information. The Department will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity; the adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable water quality standards; and any adjusted WLA will be supported by a demonstration that load allocations are practicable. The Department will notify EPA of any adjustments to this TMDL within 30 days of their adoption.

9.0 Restoration Strategy

The restoration strategy for Strawberry Creek is contained within the Gilt Edge Superfund Site Record of Decision, which outlines the cleanup and implementation plans for Strawberry Creek. A copy of this document may be obtained from the South Dakota DENR or from the EPA superfund website: http://www.epa.gov/region8/superfund/.

10.0 Literature Sited

SD DENR, 2008. *The 2008 South Dakota Integrated Report for Surface Water Quality Assessment*

U.S. Environmental Protection Agency, 2000. *Guidance for Data Quality Assessment* EPA/600/R-96/084. Office of Environmental Information.

Appendix A. Sample data from Site 001

Date	Hardness	Dissolved Cd mg/L (Lab Result)	Dissolved Cd mg/L (Calculation Value)	Acute Standard	Acute Violation
08/13/2002	474	0.001	0.001	0.00774	No
08/19/2002	293	<0.001	0.0005	0.00572	No
08/26/2002	218	<0.001	0.0005	0.00429	No
09/04/2002	237	<0.001	0.0005	0.00466	No
09/09/2002	341	<0.001	0.0005	0.00663	No
09/16/2002	313	<0.001	0.0005	0.00610	No
09/23/2002	341	<0.001	0.0005	0.00663	No
09/30/2002	326	0.001	0.001	0.00634	No
10/07/2002	303	<0.001	0.0005	0.00591	No
10/14/2002	267	<0.001	0.0005	0.00523	No
10/21/2002	245	<0.001	0.0005	0.00481	No
10/28/2002	282	<0.001	0.0005	0.00551	No
11/04/2002	248	<0.001	0.0005	0.00487	No
11/12/2002	385	<0.001	0.0005	0.00745	No
11/18/2002	323	<0.001	0.0005	0.00629	No
11/25/2002	338	<0.001	0.0005	0.00657	No
12/02/2002	294	<0.001	0.0005	0.00574	No
12/09/2002	299	<0.001	0.0005	0.00583	No
12/09/2002	307	<0.001	0.0005	0.00599	No
12/16/2002	UnAvail	0.002	0.002		
12/23/2002	341	0.001	0.001	0.00663	No
12/23/2002	340	0.001	0.001	0.00661	No
12/30/2002	UnAvail	<0.001	0.0005		
12/30/2002	UnAvail	<0.001	0.0005		
01/06/2003	311	<0.001	0.0005	0.00606	No
01/13/2003	339	<0.001	0.0005	0.00659	No
01/13/2003	341	<0.001	0.0005	0.00663	No
01/20/2003	326	<0.001	0.0005	0.00634	No
01/27/2003	314	<0.001	0.0005	0.00612	No
01/27/2003	314	<0.001	0.0005	0.00612	No
02/03/2003	295	<0.001	0.0005	0.00576	No
02/10/2003	300	<0.001	0.0005	0.00585	No
02/10/2003	304	<0.001	0.0005	0.00593	No
02/17/2003	338	<0.001	0.0005	0.00657	No
02/24/2003	319	<0.001	0.0005	0.00621	No
03/03/2003	335	<0.001	0.0005	0.00651	No
03/10/2003	322	<0.001	0.0005	0.00627	No
03/10/2003	319	<0.001	0.0005	0.00621	No
03/17/2003	195	<0.001	0.0005	0.00385	No
03/24/2003	323	0.003	0.003	0.00629	No
03/24/2003	323	0.003	0.003	0.00629	No
03/31/2003	310	0.005	0.005	0.00604	No
04/07/2003	333	0.005	0.005	0.00648	No
04/14/2003	265	0.002	0.002	0.00519	No
04/21/2003	279	0.002	0.002	0.00545	No
04/28/2003	247	0.002	0.002	0.00485	No
05/05/2003	197	0.002	0.002	0.00389	No

05/12/2003	159	0.003	0.003	0.00316	No
05/12/2003	169	0.003	0.003	0.00335	No
05/19/2003	265	0.01	0.01	0.00519	**Yes**
05/26/2003	238	0.008	0.008	0.00468	**Yes**
06/02/2003	220	0.002	0.002	0.00433	No
06/09/2003	201	0.003	0.003	0.00397	No
06/16/2003	277	0.007	0.007	0.00542	**Yes**
06/16/2003	276	0.007	0.007	0.00540	**Yes**
06/23/2003	273	<0.001	0.0005	0.00534	No
06/30/2003	245	<0.001	0.0005	0.00481	No
07/07/2003	257	<0.001	0.0005	0.00504	No
07/14/2003	270	<0.001	0.0005	0.00528	No
07/14/2003	274	<0.001	0.0005	0.00536	No
07/21/2003	256	<0.001	0.0005	0.00502	No
07/28/2003	245	<0.001	0.0005	0.00481	No
08/04/2003	273	<0.001	0.0005	0.00534	No
08/11/2003	259	<0.001	0.0005	0.00508	No
08/18/2003	268	<0.001	0.0005	0.00525	No
08/25/2003	278	<0.001	0.0005	0.00544	No
08/25/2003	281	<0.001	0.0005	0.00549	No
09/02/2003	230	<0.001	0.0005	0.00452	No
09/08/2003	237	<0.001	0.0005	0.00466	No
09/16/2003	228	<0.001	0.0005	0.00448	No
09/22/2003	231	<0.001	0.0005	0.00454	No
09/29/2003	1060	<0.001	0.0005	0.00774	No
10/06/2003	1120	<0.001	0.0005	0.00774	No
10/13/2003	1140	<0.001	0.0005	0.00774	No
10/20/2003	646	<0.001	0.0005	0.00774	No
10/27/2003	844	<0.001	0.0005	0.00774	No
11/03/2003	1140	<0.001	0.0005	0.00774	No
11/07/2003	1370	0.002	0.002	0.00774	No
11/10/2003	1370	0.001	0.001	0.00774	No
11/10/2003	1400	0.001	0.001	0.00774	No
11/17/2003	1410	0.001	0.001	0.00774	No
11/24/2003	1420	0.001	0.001	0.00774	No
12/01/2003	1530	0.001	0.001	0.00774	No
12/09/2003	1300	0.001	0.001	0.00774	No
12/15/2003	1400	0.001	0.001	0.00774	No
12/22/2003	734	<0.001	0.0005	0.00774	No
12/29/2003	1020	0.001	0.001	0.00774	No
01/05/2004	1530	0.002	0.002	0.00774	No
01/12/2004	1290	<0.001	0.0005	0.00774	No
01/19/2004	1310	0.001	0.001	0.00774	No
01/26/2004	562	<0.001	0.0005	0.00774	No
02/02/2004	387	<0.001	0.0005	0.00749	No
02/09/2004	1200	0.002	0.002	0.00774	No
02/16/2004	1340	0.001	0.001	0.00774	No
02/23/2004	1350	0.002	0.002	0.00774	No
03/01/2004	909	0.002	0.002	0.00774	No
03/01/2004	908	0.003	0.003	0.00774	No

03/08/2004	UnAvail	0.002	0.002		
03/17/2004	1080	0.002	0.002	0.00774	No
03/22/2004	975	0.002	0.002	0.00774	No
03/29/2004	806	0.009	0.009	0.00774	**Yes**
04/05/2004	897	<0.001	0.0005	0.00774	No
04/12/2004	1110	0.004	0.004	0.00774	No
04/12/2004	1150	0.004	0.004	0.00774	No
04/20/2004	1190	0.002	0.002	0.00774	No
04/26/2004	1220	0.001	0.001	0.00774	No
05/03/2004	1250	0.002	0.002	0.00774	No
05/10/2004	1290	0.001	0.001	0.00774	No
05/17/2004	1270	0.001	0.001	0.00774	No
05/24/2004	1180	0.001	0.001	0.00774	No
05/31/2004	1310	0.001	0.001	0.00774	No
06/07/2004	1370	0.001	0.001	0.00774	No
06/14/2004	1430	0.001	0.001	0.00774	No
06/14/2004	1410	0.001	0.001	0.00774	No
06/18/2004	1380	0.001	0.001	0.00774	No
06/21/2004	1350	0.001	0.001	0.00774	No
06/28/2004	1490	0.001	0.001	0.00774	No
07/06/2004	1230	0.001	0.001	0.00774	No
07/12/2004	1070	0.001	0.001	0.00774	No
07/19/2004	1170	0.001	0.001	0.00774	No
07/26/2004	1170	0.001	0.001	0.00774	No
07/26/2004	1180	0.001	0.001	0.00774	No
08/02/2004	1240	0.001	0.001	0.00774	No
08/09/2004	1220	0.001	0.001	0.00774	No
08/16/2004	1320	0.001	0.001	0.00774	No
08/23/2004	469	<0.001	0.0005	0.00774	No
08/30/2004	23	<0.001	0.0005	0.00048	**Yes**
09/07/2004	345	<0.001	0.0005	0.00670	No
09/13/2004	359	<0.001	0.0005	0.00697	No
09/20/2004	375	<0.001	0.0005	0.00727	No
09/27/2004	322	<0.001	0.0005	0.00627	No
10/04/2004	327	<0.001	0.0005	0.00636	No
10/04/2004	319	<0.001	0.0005	0.00621	No
10/11/2004	333	<0.001	0.0005	0.00648	No
10/18/2004	351	<0.001	0.0005	0.00682	No
10/25/2004	283	<0.001	0.0005	0.00553	No
11/01/2004	285	<0.001	0.0005	0.00557	No
11/08/2004	328	<0.001	0.0005	0.00638	No
11/15/2004	338	<0.001	0.0005	0.00657	No
11/22/2004	333	<0.001	0.0005	0.00648	No
11/29/2004	350	<0.001	0.0005	0.00680	No
12/06/2004	317	<0.001	0.0005	0.00617	No
12/06/2004	323	<0.001	0.0005	0.00629	No
12/13/2004	312	<0.001	0.0005	0.00608	No
12/20/2004	309	<0.001	0.0005	0.00602	No
12/27/2004	312	<0.001	0.0005	0.00608	No
01/03/2005	314	0.001	0.001	0.00612	No

01/10/2005	306	<0.001	0.0005	0.00597	No
01/17/2005	311	<0.001	0.0005	0.00606	No
01/24/2005	291	<0.001	0.0005	0.00568	No
01/31/2005	332	<0.001	0.0005	0.00646	No
01/31/2005	318	<0.001	0.0005	0.00619	No
02/07/2005	303	<0.001	0.0005	0.00591	No
02/14/2005	304	<0.001	0.0005	0.00593	No
02/21/2005	319	<0.001	0.0005	0.00621	No
02/28/2005	323	<0.001	0.0005	0.00629	No
03/07/2005	336	<0.001	0.0005	0.00653	No
03/14/2005	353	<0.001	0.0005	0.00685	No
03/21/2005	1150	0.005	0.005	0.00774	No
03/28/2005	294	<0.001	0.0005	0.00574	No
04/04/2005	319	<0.001	0.0005	0.00621	No
04/11/2005	356	<0.001	0.0005	0.00691	No
04/18/2005	347	<0.001	0.0005	0.00674	No
04/25/2005	306	<0.001	0.0005	0.00597	No
05/02/2005	330	<0.001	0.0005	0.00642	No
05/09/2005	206	0.001	0.001	0.00406	No
05/16/2005	218	0.006	0.006	0.00429	**Yes**
05/23/2005	286	0.003	0.003	0.00559	No
05/30/2005	273	0.002	0.002	0.00534	No
06/06/2005	265	0.002	0.002	0.00519	No
06/13/2005	173	<0.001	0.0005	0.00343	No
06/13/2005	175	<0.001	0.0005	0.00347	No
06/20/2005	254	0.001	0.001	0.00498	No
06/27/2005	261	<0.001	0.0005	0.00511	No
07/05/2005	266	0.001	0.001	0.00521	No
07/11/2005	270	<0.001	0.0005	0.00528	No
07/18/2005	272	<0.001	0.0005	0.00532	No
07/25/2005	261	<0.001	0.0005	0.00511	No
08/02/2005	285	<0.001	0.0005	0.00557	No
08/08/2005	1050	0.005	0.005	0.00774	No
08/15/2005	1190	0.003	0.003	0.00774	No
08/22/2005	322	<0.001	0.0005	0.00627	No
08/22/2005	334	<0.001	0.0005	0.00650	No
08/29/2005	294	<0.001	0.0005	0.00574	No
09/06/2005	278	<0.001	0.0005	0.00544	No
09/12/2005	283	<0.001	0.0005	0.00553	No
09/19/2005	246	<0.001	0.0005	0.00483	No
09/26/2005	236	<0.001	0.0005	0.00464	No
10/04/2005	867	0.001	0.001	0.00774	No
10/10/2005	738	<0.001	0.0005	0.00774	No
10/17/2005	1060	0.001	0.001	0.00774	No
10/24/2005	971	0.001	0.001	0.00774	No
10/31/2005	1160	0.001	0.001	0.00774	No
11/07/2005	1160	0.002	0.002	0.00774	No
11/14/2005	1280	0.002	0.002	0.00774	No
11/14/2005	1280	0.003	0.003	0.00774	No
11/21/2005	1260	0.002	0.002	0.00774	No

11/28/2005	1190	0.002	0.002	0.00774	No
12/05/2005	1150	0.002	0.002	0.00774	No
12/12/2005	1140	0.002	0.002	0.00774	No
12/19/2005	1310	0.001	0.001	0.00774	No
12/27/2005	1240	0.001	0.001	0.00774	No
01/03/2006	1130	0.001	0.001	0.00774	No
01/09/2006	1240	0.002	0.002	0.00774	No
01/16/2006	1180	0.001	0.001	0.00774	No
01/23/2006	1280	0.001	0.001	0.00774	No
01/23/2006	UnAvail	0.002	0.002		
01/30/2006	1270	0.001	0.001	0.00774	No
02/06/2006	1270	0.001	0.001	0.00774	No
02/13/2006	1290	0.001	0.001	0.00774	No
02/20/2006	1300	0.001	0.001	0.00774	No
02/27/2006	1290	0.001	0.001	0.00774	No
03/06/2006	1260	0.002	0.002	0.00774	No
03/13/2006	955	0.001	0.001	0.00774	No
03/20/2006	934	0.001	0.001	0.00774	No
03/27/2006	811	0.001	0.001	0.00774	No
04/04/2006	456	0.002	0.002	0.00774	No
04/10/2006	266	0.001	0.001	0.00521	No
04/17/2006	785	0.001	0.001	0.00774	No
04/24/2006	159	0.002	0.002	0.00316	No
04/24/2006	160	0.002	0.002	0.00318	No
05/01/2006	123	0.001	0.001	0.00246	No
05/08/2006	139	0.002	0.002	0.00277	No
05/15/2006	210	0.001	0.001	0.00414	No
05/22/2006	395	0.001	0.001	0.00764	No
05/30/2006	433	0.001	0.001	0.00774	No
06/05/2006	563	0.001	0.001	0.00774	No
06/12/2006	629	0.002	0.002	0.00774	No
06/19/2006	224	<0.001	0.0005	0.00441	No
06/26/2006	208	<0.001	0.0005	0.00410	No
06/26/2006	209	<0.001	0.0005	0.00412	No
07/05/2006	793	0.002	0.002	0.00774	No
07/10/2006	753	0.001	0.001	0.00774	No
07/17/2006	863	0.001	0.001	0.00774	No
07/24/2006	811	0.001	0.001	0.00774	No
08/01/2006	863	0.001	0.001	0.00774	No
08/07/2006	832	<0.001	0.0005	0.00774	No
08/14/2006	885	0.001	0.001	0.00774	No
08/21/2006	962	0.001	0.001	0.00774	No
08/28/2006	900	<0.001	0.0005	0.00774	No
09/05/2006	882	<0.001	0.0005	0.00774	No
09/11/2006	922	<0.001	0.0005	0.00774	No
09/11/2006	935	<0.001	0.0005	0.00774	No
09/18/2006	868	0.001	0.001	0.00774	No
09/25/2006	409	0.003	0.003	0.00774	No
10/03/2006	765	0.001	0.001	0.00774	No
10/10/2006	789	0.002	0.002	0.00774	No

10/16/2006	977	0.001	0.001	0.00774	No
10/23/2006	288	<0.001	0.0005	0.00563	No
10/30/2006	837	0.001	0.001	0.00774	No
11/06/2006	852	0.002	0.002	0.00774	No
11/13/2006	899	0.001	0.001	0.00774	No
11/20/2006	953	0.001	0.001	0.00774	No
11/27/2006	1040	0.001	0.001	0.00774	No
12/04/2006	993	0.002	0.002	0.00774	No
12/11/2006	1420	0.001	0.001	0.00774	No
12/13/2006	1010	0.001	0.001	0.00774	No
12/13/2006	955	<0.001	0.0005	0.00774	No
12/18/2006	938	0.001	0.001	0.00774	No
12/26/2006	1050	0.002	0.002	0.00774	No
01/02/2007	970	0.001	0.001	0.00774	No
01/08/2007	1160	<0.001	0.0005	0.00774	No
01/15/2007	1200	0.002	0.002	0.00774	No
01/22/2007	1150	0.001	0.001	0.00774	No
01/29/2007	1020	0.002	0.002	0.00774	No
02/05/2007	1150	0.001	0.001	0.00774	No
02/12/2007	325	<0.001	0.0005	0.00633	No
02/19/2007	280	<0.001	0.0005	0.00547	No
02/26/2007	938	0.001	0.001	0.00774	No
03/04/2007	1130	0.001	0.001	0.00774	No
03/12/2007	693	<0.001	0.0005	0.00774	No
03/12/2007	703	<0.001	0.0005	0.00774	No
03/19/2007	400	0.001	0.001	0.00774	No
03/26/2007	428	<0.001	0.0005	0.00774	No
04/03/2007	262	<0.001	0.0005	0.00513	No
04/09/2007	460	<0.001	0.0005	0.00774	No
04/16/2007	388	<0.001	0.0005	0.00751	No
04/23/2007	291	<0.001	0.0005	0.00568	No
04/30/2007	362	0.001	0.001	0.00702	No
05/07/2007	138	<0.001	0.0005	0.00275	No
05/14/2007	292	<0.0005	0.00025	0.00570	No
05/21/2007	455	<0.0005	0.00025	0.00774	No
05/29/2007	394	<0.0005	0.00025	0.00762	No
06/05/2007	168	0.0007	0.0007	0.00333	No
06/11/2007	250	0.0007	0.0007	0.00490	No
06/18/2007	372	0.0009	0.0009	0.00721	No
06/25/2007	504	0.0009	0.0009	0.00774	No
07/02/2007	541	0.001	0.001	0.00774	No
07/09/2007	606	0.001	0.001	0.00774	No
07/16/2007	666	<0.0005	0.00025	0.00774	No
07/23/2007	642	0.002	0.002	0.00774	No
07/30/2007	679	0.001	0.001	0.00774	No
08/06/2007	686	0.001	0.001	0.00774	No
08/13/2007	665	0.0009	0.0009	0.00774	No
08/20/2007	642	0.001	0.001	0.00774	No
08/27/2007	782	0.0008	0.0008	0.00774	No
09/04/2007	335	<0.0005	0.00025	0.00651	No

09/10/2007	714	0.0008	0.0008	0.00774	No
09/17/2007	919	0.0008	0.0008	0.00774	No
09/25/2007	868	0.001	0.001	0.00774	No
10/01/2007	270	<0.001	0.0005	0.00528	No
10/08/2007	914	0.0012	0.0012	0.00774	No
10/15/2007	1020	0.001	0.001	0.00774	No
10/22/2007	1080	0.001	0.001	0.00774	No
10/29/2007	1030	0.001	0.001	0.00774	No
11/05/2007	1080	0.001	0.001	0.00774	No
11/12/2007	1100	0.0008	0.0008	0.00774	No
11/19/2007	1040	0.0011	0.0011	0.00774	No
11/26/2007	1080	0.0011	0.0011	0.00774	No
12/03/2007	1130	0.0008	0.0008	0.00774	No
12/10/2007	1140	0.0012	0.0012	0.00774	No
12/17/2007	1160	0.0011	0.0011	0.00774	No
12/26/2007	1100	0.0011	0.0011	0.00774	No
01/02/2008	1100	0.001	0.001	0.00774	No
01/07/2008	1090	0.0009	0.0009	0.00774	No
01/14/2008	1150	0.0009	0.0009	0.00774	No
01/21/2008	1210	0.0009	0.0009	0.00774	No
01/28/2008	1270	0.0008	0.0008	0.00774	No
02/04/2008	1130	0.001	0.001	0.00774	No
02/11/2008	1180	0.0009	0.0009	0.00774	No
02/18/2008	1160	0.001	0.001	0.00774	No
02/25/2008	1160	0.0007	0.0007	0.00774	No
03/04/2008	1130	0.0009	0.0009	0.00774	No
03/10/2008	1140	0.0011	0.0011	0.00774	No
03/17/2008	1080	0.0005	0.0005	0.00774	No
03/24/2008	1090	0.0009	0.0009	0.00774	No
03/31/2008	1020	0.0008	0.0008	0.00774	No
04/07/2008	977	0.0007	0.0007	0.00774	No
04/14/2008	836	0.0007	0.0007	0.00774	No
04/22/2008	366	0.0005	0.0005	0.00710	No
04/28/2008	422	<0.0005	0.00025	0.00774	No
05/06/2008	138	0.0011	0.0011	0.00275	No
05/12/2008	118	0.001	0.001	0.00237	No
05/19/2008	141	<0.001	0.0005	0.00281	No
05/27/2008	130	0.001	0.001	0.00260	No
06/02/2008	146	0.001	0.001	0.00291	No
06/09/2008	123	0.001	0.001	0.00246	No
06/16/2008	292	0.001	0.001	0.00570	No
06/23/2008	355	0.001	0.001	0.00689	No
06/30/2008	608	0.001	0.001	0.00774	No
07/07/2008	459	0.001	0.001	0.00774	No
07/14/2008	568	0.001	0.001	0.00774	No
07/21/2008	561	0.001	0.001	0.00774	No
07/28/2008	690	0.002	0.002	0.00774	No
08/04/2008	668	0.001	0.001	0.00774	No
08/11/2008	567	0.001	0.001	0.00774	No
08/18/2008	651	0.001	0.001	0.00774	No

08/25/2008	709	0.001	0.001	0.00774	No
09/02/2008	836	0.001	0.001	0.00774	No
09/08/2008	659	0.001	0.001	0.00774	No
09/15/2008	720	0.001	0.001	0.00774	No
09/22/2008	861	0.001	0.001	0.00774	No
09/29/2008	886	0.001	0.001	0.00774	No
10/06/2008	867	0.002	0.002	0.00774	No
10/13/2008	764	0.001	0.001	0.00774	No
10/20/2008	832	0.001	0.001	0.00774	No
10/27/2008	898	0.001	0.001	0.00774	No
11/03/2008	945	0.001	0.001	0.00774	No
11/11/2008	813	0.001	0.001	0.00774	No
11/17/2008	718	0.001	0.001	0.00774	No
11/24/2008	818	0.001	0.001	0.00774	No
12/01/2008	753	0.001	0.001	0.00774	No
12/08/2008	789	0.001	0.001	0.00774	No
12/15/2008	845	0.001	0.001	0.00774	No
12/22/2008	887	0.001	0.001	0.00774	No
01/05/2009	952	0.001	0.001	0.00774	No
01/13/2009	918	0.001	0.001	0.00774	No
01/19/2009	785	0.001	0.001	0.00774	No
01/26/2009	862	0.001	0.001	0.00774	No
02/02/2009	983	0.001	0.001	0.00774	No
02/09/2009	901	0.001	0.001	0.00774	No
02/17/2009	958	0.001	0.001	0.00774	No
02/23/2009	920	0.001	0.001	0.00774	No
03/02/2009	874	0.001	0.001	0.00774	No
03/09/2009	505	0.001	0.001	0.00774	No
03/16/2009	617	0.001	0.001	0.00774	No
03/23/2009	170	<0.001	0.0005	0.00337	No
04/01/2009	422	0.0007	0.0007	0.00774	No
04/06/2009	481	0.001	0.001	0.00774	No
04/14/2009	84	0.001	0.001	0.00170	No
04/20/2009	135	0.0012	0.0012	0.00270	No
04/27/2009	176	<0.0005	0.00025	0.00349	No
05/04/2009	189	<0.0005	0.00025	0.00374	No
05/11/2009	251	<0.0005	0.00025	0.00492	No

Appendix B . Comments Recieved During Public Notice

EPA Region VIII TMDL Review

TMDL Document Info:

Document Name:	**Dissolved Cadmium Total Maximum Daily Load Evaluation for Strawberry Creek, Lawrence County, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**February 23, 2010**
Review Date:	**March 24, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final review only):

- ☐ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   - 1.1. TMDL Document Submittal Letter
   - 1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   - 1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   - 4.1. Data Set Description
   - 4.2. Waste Load Allocations (WLA)
   - 4.3. Load Allocations (LA)
   - 4.4. Margin of Safety (MOS)
   - 4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum

allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's minimum submission requirements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in the minimum submission requirements denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review template is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal Letter

When a TMDL document is submitted to EPA requesting formal comments or a final review and approval, the submittal package should include a letter identifying the document being submitted and the purpose of the submission.

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern,

which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The public notice draft Strawberry Creek dissolved cadmium TMDL was submitted to EPA for review during the public notice period via an email from Cheryl Saunders, SD DENR on February 23, 2010. The email included the draft TMDL document and a public notice announcement requesting review and comment.

Comments: None**.**

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Minimum Submission Requirements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map

☐ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: Strawberry Creek is a small stream located in Lawrence County, South Dakota and is a tributary of Bear Butte Creek in the Lower Belle Fourche sub-basin (HUC 10120202). The drainage area of the listed segment of Strawberry Creek is 753 acres. The 303(d) listed segment of Strawberry Creek includes 2 miles of the Creek from the headwaters to the mouth at Bear

Butte Creek (SD-BF-R-STRAWBERRY_01). It receives runoff from a former 258-acre open pit, cyanide heap-leach gold mine (Gilt Edge Mine). Nearly a decade ago, the mine operator, Brohm Mining Company (BMC) went bankrupt, leaving 150 million gallons of acidic, heavy-metal-laden water in three open pits, as well as millions of cubic yards of acid-generating waste rock that requires cleanup and long-term treatment. Sulfide waste rock and exposed ore zones contain heavy metals, including arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc. Elevated nitrates and sulfates are also present in heap leach residues. It is listed as medium priority for TMDL development.

The designated uses for Strawberry Creek include coldwater marginal fish life propagation waters, limited-contract recreation waters, fish and wildlife propagation, recreation, and stock watering. The segment was included on the 2008 303(d) list for cadmium, copper, zinc and pH which are all impairing the coldwater marginal fish life use. The copper, zinc and pH impairments will be addressed in separate documents or delisting actions.

Comments: None**.**

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Minimum Submission Requirements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the significant sources. Therefore, all TMDL documents must be written to meet the existing water quality standards for that waterbody (CWA §303(d)(1)(C)).

Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek segment addressed by this TMDL is impaired based on dissolved cadmium concentrations for coldwater marginal fish life propagation. South Dakota has applicable numeric standards for dissolved cadmium that may be applied to this river segment. The numeric standards being implemented in this TMDL are expressed as equations which are based on the hardness of the water:

Cadmium acute criteria = CF x exp[1.0166(ln(hardness)) – 3.9240]
Cadmium chronic criteria = CF x exp[0.7409(ln(hardness)) – 4.7190]

CF acute = 1.136672-[(ln hardness)(0.041838)]
CF chronic = 1.101672-[(ln hardness)(0.041838)]

The criteria values increase as the hardness values increase, for example at a hardness of 100 mg/L as $CaCO_3$ the acute criteria is 2.01 ug/L and the chronic criteria is 0.25 ug/L. At a hardness of 250 mg/L as $CaCO_3$ the acute criteria is 4.90 ug/L and the chronic criteria is 0.46 ug/L. At a hardness of 400 mg/L as $CaCO_3$ the acute criteria is 7.74 ug/L and the chronic criteria is 0.64 ug/L.

Discussion of additional applicable water quality standards for Strawberry Creek can be found on pages 6 and 7 of the TMDL.

COMMENTS: The 30-day fecal coliform and E.coli standards shown in Table 1 should be expressed as "geometric mean" rather than "mean."

DENR Response: The changes were made as requested.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column

sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained.

Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.

☐ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water quality targets for this TMDL are based on the numeric water quality standards for dissolved cadmium based on the coldwater marginal fish life propagation beneficial use for Strawberry Creek.

The numeric targets/standards being implemented in this TMDL are expressed as equations which are based on the hardness of the water:

Cadmium acute criteria = CF x exp[1.0166(ln(hardness)) – 3.9240]
Cadmium chronic criteria = CF x exp[0.7409(ln(hardness)) – 4.7190]

CF acute = 1.136672-[(ln hardness)(0.041838)]
CF chronic = 1.101672-[(ln hardness)(0.041838)]

The criteria values increase as the hardness values increase, for example at a hardness of 100 mg/L as $CaCO_3$ the acute criteria is 2.01 ug/L and the chronic criteria is 0.25 ug/L. At a hardness of 250 mg/L as $CaCO_3$ the acute criteria is 4.90 ug/L and the chronic criteria is 0.46 ug/L. At a hardness of 400 mg/L as $CaCO_3$ the acute criteria is 7.74 ug/L and the chronic criteria is 0.64 ug/L.

Comments: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically

allocate quantifiable loads or load reductions to each significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: Strawberry Creek drains 753 acres of land in the Black Hills of western South Dakota and discharges into Bear Butte Creek that runs through Sturgis, South Dakota. Strawberry Creek is a cold-water marginal fishery, and is a headwater source for municipal water supplies for towns in the northern Black Hills. The Creek receives runoff from a former 258-acre open pit, cyanide heap-leach gold mine commonly referred to as the Gild Edge Mine. Mining activities began at the Site in 1876 when the Gilt Edge and Dakota Maid claims were located. Historical underground mining operations extracted sulfide-bearing gold ores from irregular deposits in veins and fracture zones in the igneous rocks. In 1984, Gilt Edge, Inc. applied for a permit to begin a heap leach operation. By that time, Gilt Edge, Inc. had acquired the claims of the Hoodoo-Union Hill and Anchor Hill Mining companies. Gilt Edge, Inc. was acquired by the Brohm Mining Company (BMC) before a mining permit was issued. In 1986, the South Dakota Board of Minerals and Environment issued a mining permit to BMC for the open pit/heap leach operations. BMC's parent company, Dakota Mining Corporation, filed for bankruptcy in Canada in July 1999. SD DENR assumed water treatment operations using the South Dakota Regulated Substance Response Fund in 1999 and sought inclusion on the National Priorities List (NPL) from EPA in February 2000. The Site was placed on the NPL in December 2000. EPA assumed responsibility for site wide operations in August 2000, which are ongoing. The abandoned mining operation is likely the only source of cadmium loading in the watershed.

The water treatment facility accounts for a majority of the flow in the stream, which discharges at the water treatment plant (WTP) site (i.e., marked "WTP End of Pipe" in Figure 4 of the TMDL document). Additional flow is added to the stream from a number of seeps between the WTP End of Pipe and site CP001 near the mouth of Strawberry Creek. These seeps are hydraulically

connected to the portions of the mine site that were not receiving treatment at the completion of this report. The Record of Decision (ROD) includes a significant amount of detail covering the hydraulic connections, on site sources of cadmium, and the plans for mitigating the site. As the only source of dissolved cadmium in the drainage, the Gilt Edge mine site was treated as a single waste load in this TMDL. The various hydraulic connections to the stream and their individual contributions and mitigation plans are addressed in the ROD.

Comments: None.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust data set and an appropriate level of technical analysis**.** This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum LAs + \sum WLAs + MOS$$

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Strawberry Creek TMDL describes how the dissolved cadmium loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segment.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach using data from site CP-001 located at the downstream end of the reach prior to Strawberry Creek entering Bear Butte Creek. The data from this site was used for the TMDL because it reflects the cumulative effects of the entire reach. Flow data for Strawberry Creek was available for over 3,200 days of record (see Figures 5 and 6 of the TMDL document), providing sufficient information for the development of an accurate load duration curve. The gap in the data represents the time period between the mine closing that sites placement on the national priorities list.

Analyses of toxic metals, such as dissolved cadmium, with a LDC require some special considerations. A typical LDC would incorporate a flow based limit above which a violation of the water quality standard occurs. The toxicity of metals such as cadmium is highly influenced by the hardness of the water. Higher concentrations of carbonates increase the hardness while decreasing the toxicity of the metal. The analysis of the data and the LDC using the acute standard for dissolved cadmium concluded Strawberry Creek has been meeting the acute standard from the date that the water treatment plant began full time operation in 2005. See Section 4.4.1 of the TMDL document for more detail on the results of the analysis of the acute standard.

Evaluation of the chronic standard for dissolved cadmium produced a different conclusion. Adequate data was available to plot 75, 30-day average values on the chronic LDC. Only thirteen of these, or 17 percent, were at or below the calculated chronic water quality standard. Because the acute standard has been met since the WTP began full time operations, the TMDL loads and load reductions needed to meet the water quality standards for this stream, were based on the chronic standard. Due to the effects hardness has on the toxicity of cadmium, multiple reductions may be calculated depending on the hardness used in the calculations. Two other factors were given heavy consideration when determining the necessary reductions. Cadmium is a toxic and no violations are acceptable. Regardless of the calculated reductions, sample data indicating full attainment of the standard will dictate the success of the cleanup effort. Each flow zone was evaluated based on the maximum average monthly cadmium concentration measured as well as the minimum monthly average hardness measured. This method provided assurance that the TMDL would meet the standard 100% of the time. See Section 4.4.2 of the TMDL document for more detail on the results of the analysis of the chronic standard.

The LDC was divided into 5 distinct flow regimes, or zones, based on the need to ensure that the chronic standard for dissolved cadmium is met (see Figure 10 of the TMDL document). The LDC is a dynamic expression of the allowable load for any given flow. Loading capacities were derived from this approach at the 95 percentile flow in each flow regime, and the results are expressed as the TMDL load in Table 7 of the TMDL document. See Section 5.0 of the TMDL document for details on how the loading capacities were calculated for each flow zone.

Comments: None.

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the

waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Minimum Submission Requirements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek TMDL data description and summary are included mostly in the Technical Analysis section of the document.

Data on Strawberry Creek was collected on a monthly basis from water quality monitoring site 460116 (marked as WQM-116 in Figure 4 of the TMDL document) by South Dakota Department of Environment and Natural Resources (SDDENR) Surface Water Quality Program staff. Data from this site was originally used to list the segment, and continues to be collected from this location. After the Gilt Edge mine site was placed on the Superfund clean-up list, Camp Dresser McGee (CDM) a consulting, engineering, construction, and operations firm facilitated the site from the initiation of the cleanup through the development of this TMDL. Data was collected from numerous sites throughout Strawberry Creek drainage as part of this clean-up effort. For purposes of TMDL development, data collected from WTP End of Pipe, and site CP-001 located at the downstream end of the reach prior to Strawberry Creek entering Bear Butte Creek, were the primary sites used for data analysis. For the purposes of the load duration curve development and analysis the site with the greatest importance is CP-001, which reflects the cumulative effects of the entire reach.

COMMENTS: None.

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water treatment facility accounts for a majority of the flow in the stream, which discharges at the water treatment plant (WTP) site. Additional flow is added to the stream from a number of seeps between the WTP End of Pipe and site CP001 near the mouth of Strawberry Creek. These seeps are hydraulically connected to the portions of the mine site that were not receiving treatment at the completion of this report. As the only source of dissolved cadmium in the drainage, the Gilt Edge mine site was treated as a single waste load in this TMDL.

Table 7, excerpted from the TMDL document, summarizes the wasteload allocations for each of the flow zones. Detailed information on how each of the waste load allocations, TMDL, and current loads may be found throughout Section 5.0 of the TMDL.

Table 7. TMDL Summary for Dissolved Cadmium in Strawberry Creek

TMDL Component	Flow Zone (expressed as mg/Day)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
WLA	4669	3758	1238	758	220
LA	0	0	0	0	0
MOS	927	372	143	318	102
TMDL	5596	4130	1381	1076	322
Current Load*	20517	6007	2265	2252	423
Load Reduction	73%	31%	39%	52%	24%
**Current Load is the flow zone mean concentration * 95th percentile flow in each regime*					

COMMENTS: None.

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural

load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Minimum Submission Requirements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: A load allocation of zero was given to the watershed as there are no known sources of dissolved cadmium that are not related to the Gilt Edge Superfund site.

COMMENTS: None.

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Minimum Submission Requirements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

- ☐ If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.
- ☒ If the MOS is explicit, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.
- ☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek TMDL includes an explicit MOS derived as the difference between the loading capacity at the mid-point of each flow zone and the loading capacity at the minimum flow in each zone. A significant MOS is provided using this method, because the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point.

COMMENTS: The text in the MOS section mentions 3 flow zones, but 5 zones are included in other parts of the document – correct or revise the MOS language.

DENR Response: The correction was made as requested.

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Minimum Submission Requirements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: By using the load duration curve approach to develop the TMDL loads and allocations, seasonal variability was taken into account. Highest steam flows typically occur during late spring and the lowest stream flows occur during late fall and winter.

Different seasons of the year can yield differences in water quality due to changes in precipitation.

COMMENTS: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Minimum Submission Requirements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:

☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process. The draft TMDL was also available for a 30-day public notice period prior to finalization.

COMMENTS: The Public Notice section of the TMDL document should summarize any public outreach efforts that have occurred for the TMDL prior to the public comment period. This should also include information on how the public notice was made available (i.e., names of newspapers, availability on DENR's website, etc.).

DENR Response: The additions were made as requested.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Minimum Submission Requirements:

☒ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☒ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: As part of an active EPA Superfund site, ongoing monitoring will be conducted by both SD DENR as well as EPA.

COMMENTS: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Minimum Submission Requirements:

☒ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Gilt Edge Superfund Site Record of Decision (ROD) explains the details of the cleanup and implementation plans for Strawberry Creek. The ROD and other supporting documents are available at: http://www.epa.gov/region8/superfund/sd/giltedge/

COMMENTS: Section 9.0, Restoration Strategy mentions that the ROD is attached to the TMDL document as Appendix B. There doesn't appear to be an Appendix B, or a placeholder for the ROD. This section should be revised or Appendix B should be added to the final document.

DENR Response: The RODs avaialability through DENR as well as the EPA superfund website were added in place of including the entire document as an appendix.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Minimum Submission Requirements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek dissolved cadmium TMDL includes daily loads expressed as milligrams per day. The daily TMDL loads are included in Table 7 of the TMDL document.

COMMENTS: None.

DEPARTMENT OF GAME, FISH AND PARKS REVIEW

Thank you for the opportunity to comment on the draft Dissolved Cadmium TMDL report for Strawberry Creek in Lawrence County. After reviewing the document, I have one suggested change. On page 6 under the heading of Water Quality Standards, I recommend **ASRD 74:51:01:12, Biological Integrity of Waters**, be added to the list of standards mentioned in the third paragraph.

The recommended change to text would be as follows:

"Additional "narrative" standards that may apply can be found in the "Administrative rules of South Dakota: Articles 74:51:01:05; 06; 08; 09 and 12. These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, or pollutants negatively impacting aquatic communities."

As for restrictions in ARSD 74:51:01 for visible pollutants, and materials causing pollutants, causing taste and odor issues or producing nuisance aquatic life, I believe restrictions for materials that adversely impact the structure and function of indigenous or intentionally introduced aquatic communities should be referenced in this section of the report. Thanks again for the opportunity to comment on this TMDL.

Sincerely,
John Lott
Aquatics Section Chief
South Dakota Game, Fish and Parks

DENR Response: The addition was made as requested.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
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http://www.epa.gov/region08

APR 19 2010

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APR 22 2010
DEPT. OF ENVIRONMENT AND NATURAL RESOURCES, SECRETARY'S OFFICE

Ref: 8EPR-EP

Steven M. Pirner
Secretary
South Dakota Department of Environment & Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Re: TMDL Approvals
Strawberry Creek; Cadmium; SD-BF-R-STRAWBERRY_01

Dear Mr. Pirner:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq.*), we approve all aspects of the TMDLs as developed for the water quality limited waterbodies as described in Section 303(d)(1). Based on our review, we feel the separate elements of the TMDLs listed in the enclosed table adequately address the pollutants of concern as given in the table, taking into consideration seasonal variation and a margin of safety.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Vern Berry and he may be reached at 303-312-6234.

Sincerely,

Eddie A. Sierra

Eddie A. Sierra
Acting Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures

ENCLOSURE 1: APPROVED TMDLs

Total Dissolved Cadmium Total Maximum Daily Load Evaluation for Strawberry Creek, Lawrence County, South Dakota, January 2010.

Submitted: 3/31/2010

1 Pollutant TMDLs completed.

1 Causes addressed from the 2008 303(d) list.

Determinations that no pollutant TMDL needed.

Segment: Strawberry Creek from the headwaters to the mouth at Bear Butte Creek

303(d) ID: SD-BF-R-STRAWBERRY

Parameter/Pollutant (303(d) list cause): CADMIUM - 15

Water Quality Targets: The Cd targets are hardness dependant and are expressed as equations. At a hardness of 250 mg/L as CaCO3 the acute criteria is 4.90 ug/L and the chronic criteria is 0.46 ug/L.

Allocation*	Value	Units	Permits
LA	0	MG/DAY	
WLA	4669	MG/DAY	
MOS	927	MG/DAY	

Notes: The loads shown represent the loads during the high flow regime as defined by the load duration curve for Strawberry Creek (see Figure 10 of the TMDL). The high flows are when the largest differences occur between the existing load and the target load, therefore the greatest load reduction is needed to meet the water quality standards.

* LA = Load Allocation, WLA = Wasteload Allocation, MOS = Margin of Safety, TMDL = sum(WLAs) + sum(LAs) + MOS

ENCLOSURE 2

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Dissolved Cadmium Total Maximum Daily Load Evaluation for Strawberry Creek, Lawrence County, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**March 31, 2010**
Review Date:	**April 14, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Final**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final review only):

- ☒ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   - 1.1. .TMDL Document Submittal Letter
   - 1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   - 1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   - 4.1. Data Set Description
   - 4.2. Waste Load Allocations (WLA)
   - 4.3. Load Allocations (LA)
   - 4.4. Margin of Safety (MOS)
   - 4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate.

A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant. A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's minimum submission requirements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in the minimum submission requirements denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review template is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal Letter

When a TMDL document is submitted to EPA requesting formal comments or a final review and approval, the submittal package should include a letter identifying the document being submitted and the purpose of the submission.

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☒ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The final Strawberry Creek dissolved cadmium TMDL was submitted to EPA for review and approval via an email from Cheryl Saunders, SD DENR on March 31, 2010. The email included the final TMDL document and a letter requesting final review and approval.

COMMENTS: None.

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Minimum Submission Requirements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map

☐ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: Strawberry Creek is a small stream located in Lawrence County, South Dakota and is a tributary of Bear Butte Creek in the Lower Belle Fourche sub-basin (HUC 10120202). The drainage area of the listed segment of Strawberry Creek is 753 acres. The 303(d) listed segment of Strawberry Creek includes 2 miles of the Creek from the headwaters to the mouth at Bear Butte Creek (SD-BF-R-STRAWBERRY_01). It receives runoff from a former 258-acre open pit, cyanide heap-leach gold mine (Gilt Edge Mine). Nearly a decade ago, the mine operator, Brohm Mining Company (BMC) went bankrupt, leaving 150 million gallons of acidic, heavy-metal-laden water in three open pits, as well as millions of cubic yards of acid-generating waste rock that requires cleanup and long-term treatment. Sulfide waste rock and exposed ore zones contain heavy metals, including arsenic, cadmium, chromium,

copper, lead, nickel, silver and zinc. Elevated nitrates and sulfates are also present in heap leach residues. It is listed as medium priority for TMDL development.

The designated uses for Strawberry Creek include coldwater marginal fish life propagation waters, limited-contract recreation waters, fish and wildlife propagation, recreation, and stock watering. The segment was included on the 2008 303(d) list for cadmium, copper, zinc and pH which are all impairing the coldwater marginal fish life use. The copper, zinc and pH impairments will be addressed in separate documents or delisting actions.

COMMENTS: None.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Minimum Submission Requirements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the significant sources. Therefore, all TMDL documents must be written to meet the existing water quality standards for that waterbody (CWA §303(d)(1)(C)).

Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek segment addressed by this TMDL is impaired based on dissolved cadmium concentrations for coldwater marginal fish life propagation. South Dakota has applicable numeric standards for dissolved cadmium that may be applied to this river segment. The numeric standards being implemented in this TMDL are expressed as equations which are based on the hardness of the water:

Cadmium acute criteria = CF x exp[1.0166(ln(hardness)) – 3.9240]
Cadmium chronic criteria = CF x exp[0.7409(ln(hardness)) – 4.7190]

CF acute = 1.136672-[(ln hardness)(0.041838)]
CF chronic = 1.101672-[(ln hardness)(0.041838)]

The criteria values increase as the hardness values increase, for example at a hardness of 100 mg/L as $CaCO_3$ the acute criteria is 2.01 ug/L and the chronic criteria is 0.25 ug/L. At a hardness of 250 mg/L as $CaCO_3$ the acute criteria is 4.90 ug/L and the chronic criteria is 0.46 ug/L. At a hardness of 400 mg/L as $CaCO_3$ the acute criteria is 7.74 ug/L and the chronic criteria is 0.64 ug/L.

Discussion of additional applicable water quality standards for Strawberry Creek can be found on pages 6 and 7 of the TMDL.

COMMENTS: None.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained.

Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.

☐ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water quality targets for this TMDL are based on the numeric water quality standards for dissolved cadmium based on the coldwater marginal fish life propagation beneficial use for Strawberry Creek.

The numeric targets/standards being implemented in this TMDL are expressed as equations which are based on the hardness of the water:

Cadmium acute criteria = CF x exp[1.0166(ln(hardness)) – 3.9240]
Cadmium chronic criteria = CF x exp[0.7409(ln(hardness)) – 4.7190]

CF acute = 1.136672-[(ln hardness)(0.041838)]
CF chronic = 1.101672-[(ln hardness)(0.041838)]

The criteria values increase as the hardness values increase, for example at a hardness of 100 mg/L as $CaCO_3$ the acute criteria is 2.01 ug/L and the chronic criteria is 0.25 ug/L. At a hardness of 250 mg/L as $CaCO_3$ the acute criteria is 4.90 ug/L and the chronic criteria is 0.46 ug/L. At a hardness of 400 mg/L as $CaCO_3$ the acute criteria is 7.74 ug/L and the chronic criteria is 0.64 ug/L.

COMMENTS: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: Strawberry Creek drains 753 acres of land in the Black Hills of western South Dakota and discharges into Bear Butte Creek that runs through Sturgis, South Dakota. Strawberry Creek is a cold-water marginal fishery, and is a headwater source for municipal water supplies for towns in the northern Black Hills. The Creek receives runoff from a former 258-acre open pit, cyanide heap-leach gold mine commonly referred to as the Gild Edge Mine. Mining activities began at the Site in 1876 when the Gilt Edge and Dakota Maid claims were located. Historical underground mining operations extracted sulfide-bearing gold ores from irregular deposits in veins and fracture zones in the igneous rocks. In 1984, Gilt Edge, Inc. applied for a permit to begin a heap leach operation. By that time, Gilt Edge, Inc. had acquired the claims of the Hoodoo-Union Hill and Anchor Hill Mining companies. Gilt Edge, Inc. was acquired by the Brohm Mining Company (BMC) before a mining permit was issued. In 1986, the South Dakota Board of Minerals and Environment issued a mining permit to BMC for the open pit/heap leach operations. BMC's parent company, Dakota Mining Corporation, filed for bankruptcy in Canada in July 1999. SD DENR assumed water treatment operations using the South Dakota Regulated Substance Response Fund in 1999 and sought inclusion on the National Priorities List (NPL) from EPA in February 2000. The Site was placed on the NPL in December 2000. EPA assumed responsibility for site wide operations in August 2000, which are ongoing. The abandoned mining operation is likely the only source of cadmium loading in the watershed.

The water treatment facility accounts for a majority of the flow in the stream, which discharges at the water treatment plant (WTP) site (i.e., marked "WTP End of Pipe" in Figure 4 of the TMDL document). Additional flow is added to the stream from a number of seeps between the WTP End of Pipe and site CP001 near the mouth of Strawberry Creek. These seeps are hydraulically connected to the portions of the mine site that were not receiving treatment at the completion of this report. The Record of Decision (ROD) includes a significant amount of detail covering the hydraulic connections, on site sources of cadmium, and the plans for mitigating the site. As the only source of dissolved cadmium in the drainage, the Gilt Edge mine site was treated as a single waste load in this TMDL. The various hydraulic connections to the stream and their individual contributions and mitigation plans are addressed in the ROD.

COMMENTS: None.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust data set and an appropriate level of technical analysis. This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the

relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum LAs + \sum WLAs + MOS$$

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments;

chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc...) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Strawberry Creek TMDL describes how the dissolved cadmium loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segment.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach using data from site CP-001 located at the downstream end of the reach prior to Strawberry Creek entering Bear Butte Creek. The data from this site was used for the TMDL because it reflects the cumulative effects of the entire reach. Flow data for Strawberry Creek was available for over 3,200 days of record (see Figures 5 and 6 of the TMDL document), providing sufficient information for the development of an accurate load duration curve. The gap in the data represents the time period between the mine closing that sites placement on the national priorities list.

Analyses of toxic metals, such as dissolved cadmium, with a LDC require some special considerations. A typical LDC would incorporate a flow based limit above which a violation of the water quality standard occurs. The toxicity of metals such as cadmium is highly influenced by the hardness of the water. Higher concentrations of carbonates increase the hardness while decreasing the toxicity of the metal. The analysis of the data and the LDC using the acute standard for dissolved cadmium concluded Strawberry Creek has been meeting the acute standard from the date that the water treatment plant began full time operation in 2005. See Section 4.4.1 of the TMDL document for more detail on the results of the analysis of the acute standard.

Evaluation of the chronic standard for dissolved cadmium produced a different conclusion. Adequate data was available to plot 75, 30-day average values on the chronic LDC. Only thirteen of these, or 17 percent, were at or below the calculated chronic water quality standard. Because the acute standard has been met since the WTP began full time operations, the TMDL loads and load reductions needed to meet the water quality standards for this stream, were based on the chronic standard. Due to the effects hardness has on the toxicity of cadmium, multiple reductions may be calculated depending on the hardness used in the calculations. Two other factors were given heavy consideration when determining the necessary reductions. Cadmium is a toxic and no violations are acceptable. Regardless of the calculated reductions,

sample data indicating full attainment of the standard will dictate the success of the cleanup effort. Each flow zone was evaluated based on the maximum average monthly cadmium concentration measured as well as the minimum monthly average hardness measured. This method provided assurance that the TMDL would meet the standard 100% of the time. See Section 4.4.2 of the TMDL document for more detail on the results of the analysis of the chronic standard.

The LDC was divided into 5 distinct flow regimes, or zones, based on the need to ensure that the chronic standard for dissolved cadmium is met (see Figure 10 of the TMDL document). The LDC is a dynamic expression of the allowable load for any given flow. Loading capacities were derived from this approach at the 95 percentile flow in each flow regime, and the results are expressed as the TMDL load in Table 7 of the TMDL document. See Section 5.0 of the TMDL document for details on how the loading capacities were calculated for each flow zone.

COMMENTS: None.

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc...).

Minimum Submission Requirements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek TMDL data description and summary are included mostly in the Technical Analysis section of the document.

Data on Strawberry Creek was collected on a monthly basis from water quality monitoring site 460116 (marked as WQM-116 in Figure 4 of the TMDL document) by South Dakota Department of Environment and Natural Resources (SDDENR) Surface Water Quality Program staff. Data from this site was originally used to list the segment, and continues to be collected from this location. After the Gilt Edge mine site was placed on the Superfund clean-up list, Camp Dresser McGee (CDM) a consulting, engineering, construction, and operations firm facilitated the site from the initiation of the cleanup through the development of this TMDL. Data was collected from numerous sites throughout Strawberry Creek drainage as part of this clean-up effort. For purposes of TMDL development, data collected from WTP End of Pipe, and site CP-001 located at the downstream end of the reach prior to Strawberry Creek entering Bear Butte Creek, were the primary sites used for data analysis. For the purposes of the load duration curve

development and analysis the site with the greatest importance is CP-001, which reflects the cumulative effects of the entire reach.

COMMENTS: None.

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water treatment facility accounts for a majority of the flow in the stream, which discharges at the water treatment plant (WTP) site. Additional flow is added to the stream from a number of seeps between the WTP End of Pipe and site CP001 near the mouth of Strawberry Creek. These seeps are hydraulically connected to the portions of the mine site that were not receiving treatment at the completion of this report. As the only source of dissolved cadmium in the drainage, the Gilt Edge mine site was treated as a single waste load in this TMDL.

Table 7, excerpted from the TMDL document, summarizes the wasteload allocations for each of the flow zones. Detailed information on how each of the waste load allocations, TMDL, and current loads may be found throughout Section 5.0 of the TMDL.

Table 7. TMDL Summary for Dissolved Cadmium in Strawberry Creek

TMDL Component	Flow Zone (expressed as mg/Day)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
WLA	4669	3758	1238	758	220
LA	0	0	0	0	0
MOS	927	372	143	318	102
TMDL	5596	4130	1381	1076	322
Current Load*	20517	6007	2265	2252	423
Load Reduction	73%	31%	39%	52%	24%
**Current Load is the flow zone mean concentration * 95th percentile flow in each regime*					

COMMENTS: None.

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Minimum Submission Requirements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: A load allocation of zero was given to the watershed as there are no known sources of dissolved cadmium that are not related to the Gilt Edge Superfund site.

COMMENTS: None.

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Minimum Submission Requirements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

- ☐ If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.
- ☒ If the MOS is explicit, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.
- ☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek TMDL includes an explicit MOS derived as the difference between the loading capacity at the mid-point of each flow zone and the loading capacity at the minimum flow in each zone. A significant MOS is provided using this method, because the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point.

COMMENTS: None.

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider

seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Minimum Submission Requirements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: By using the load duration curve approach to develop the TMDL loads and allocations, seasonal variability was taken into account. Highest steam flows typically occur during late spring and the lowest stream flows occur during late fall and winter. Different seasons of the year can yield differences in water quality due to changes in precipitation.

COMMENTS: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Minimum Submission Requirements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☒ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process. The draft TMDL was also available for a 30-day public notice period prior to finalization.

COMMENTS: None.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Minimum Submission Requirements:

☒ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☒ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: As part of an active EPA Superfund site, ongoing monitoring will be conducted by both SD DENR as well as EPA.

COMMENTS: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Minimum Submission Requirements:

☒ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement

the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Gilt Edge Superfund Site Record of Decision (ROD) explains the details of the cleanup and implementation plans for Strawberry Creek. The ROD and other supporting documents are available at: http://www.epa.gov/region8/superfund/sd/giltedge/

COMMENTS: None.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Minimum Submission Requirements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Strawberry Creek dissolved cadmium TMDL includes daily loads expressed as milligrams per day. The daily TMDL loads are included in Table 7 of the TMDL document.

COMMENTS: None.