SELENIUM TOTAL MAXIMUM DAILY LOAD FOR CROW CREEK, LARAMIE COUNTY, WYOMING

Topical Report RSI-2225

prepared for

Wyoming Department of Environmental Quality
122 West 25th Street
Herschler Building
Cheyenne, Wyoming 82002

March 2013

RESPEC
CONSULTING & SERVICES

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by

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Total Maximum Daily Load Summary	
Waterbody Name/Description	Crow Creek (from 0.5 mile below Morrie Avenue in Cheyenne downstream to Hereford Reservoir #1)
Assessment Unit I.D.	WYSP101900090107_02
Size of Impaired Waterbody	3.2 miles (5.1 kilometers)
Size of Watershed	448 square miles (1,160 square kilometers)
Size of Watershed (Project Area)	256 square miles (663 square kilometers)
Size of Watershed (Impairment)	24.7 square miles (64 square kilometers)
Location	12-digit Hydrologic Unit Code: 101900090107
Impaired Designated Use(s)	Aquatic life
Cause(s) of Impairment	Selenium—Petroleum Production
Cycle Most Recently Listed	2010
Total Maximum Daily Load Endpoints	Indicator Name: Selenium Threshold Values: Acute concentration of ≤20 micrograms per liter (µg/L) and a chronic concentration of ≤5 µg/L. The chronic threshold value is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922 to convert this to a value that is expressed in terms of dissolved metal. Using this conversion, the chronic aquatic-life value for selenium is 4.61 µg/L as dissolved metal.
Analytical Approach	Load Duration Curves and Mass Balance

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1.0 INTRODUCTION

The intent of this document is to clearly identify the components of a Total Maximum Daily Load (TMDL), support adequate public participation, and facilitate the U.S. Environmental Protection Agency (EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidelines developed by the EPA. This TMDL document addresses selenium impairments in the Crow Creek Watershed. The impaired waterbody was assigned Class 2C (supports nongame fish, does not support drinking water) in the Wyoming Water Quality Assessment and Impaired Waters List [Wyoming Department of Environmental Quality, 2010]

1.1 CLEAN WATER ACT SECTION 303(d) LISTING INFORMATION

The 2012 Integrated Report was not complete at the initiation of this project, and therefore this TMDL is written for segments in the 2010 Integrated Report [Wyoming Department of Environmental Quality, 2010]. There are three impaired stream segments on Crow Creek downstream of the confluence of North Fork and South Fork Crow Creek [Wyoming Department of Environmental Quality, 2010]. These segments are classified as 2AB, 2AB/2C, and 2C streams. Streams classified as 2AB are protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, scenic value uses, game fish, and drinking water. Streams classified as 2C are protected for all of these uses except game fish and drinking water. Crow Creek is listed as nonsupportive of recreational use because of elevated fecal coliform concentrations and nonsupportive of the aquatic-life use because of excessive sediment and high selenium concentrations. The designated uses of impaired streams in the project area are listed in Table 1-1. This TMDL document addresses the selenium impairment, which is shown in bold font in Table 1-1. The sediment and fecal coliform impairments are addressed in separate documents.

Table 1-1. 2010 303(d) Impaired Waterbodies Summary

Name	Class	Location	Miles	Uses	Cause(s)	Source	List Date
Crow Creek	2AB	From Missile Road (Hwy 207) upstream to Roundtop Road	41.1	Recreation	Fecal coliform	Stormwater	1996
Crow Creek	2AB/2C	From Happy Jack Road downstream to Hereford Reservoir #1	9.0	Aquatic life	Sediment	Stormwater	2010
Crow Creek	**2C**	**From 0.5 mile below Morrie Avenue downstream to Hereford Reservoir #1**	**3.2**	**Aquatic life**	**Selenium**	**Petroleum production**	**2010**

The Wyoming Department of Environmental Quality (WDEQ) set the acute and chronic aquatic-life numeric criteria for selenium impairment at 20 micrograms per liter (µg/L) and 5 µg/L, respectively. The threshold values are expressed in terms of total recoverable metal in the water column; however, it is scientifically acceptable to use the conversion factor of 0.922 to convert this to a value that is expressed in terms of dissolved metal. Using this conversion, the chronic aquatic-life value for selenium is 4.61 µg/L as dissolved metal [Wyoming Department of Environmental Quality, 2007]. Table 1-2 shows the total and dissolved selenium criteria for the selenium-impaired reach of Crow Creek. The total recoverable metal criteria, shown in bold font, are used for this TMDL; unless specifically identified as dissolved selenium, all references to selenium concentration and load refers to total recoverable selenium.

Table 1-2. State Surface Water-Quality Standards for Crow Creek

Parameter	Aquatic Life Acute Value[(a)]	Aquatic Life Chronic Value[(a)]	Units
Selenium, total recoverable	**20**	**5**	**µg/L**
Selenium, dissolved	N/A	4.61	µg/L

(a) Acute value = 1-hour average concentration; chronic value = 4-day average concentration [Wyoming Department of Environmental Quality, 2007].

The WDEQ defines “acute” as the 1-hour average concentration and “chronic” as the 4-day average concentration [Wyoming Department of Environmental Quality, 2007]. Based on Load Duration Curve (LDC) analysis presented later in this document and known point-source discharges of selenium, it is evident that selenium loads in Crow Creek are not driven by the rainfall-runoff process and that both the 1-hour average and 4-day-average loadings can be represented with discrete grab samples. Furthermore, since the needed data are not available to evaluate 4-day-average selenium concentrations, the WDEQ currently evaluates discrete selenium samples against the chronic criterion for determining impairment. Thus, for the TMDL assessment, the TMDL target was based on 5 µg/L, making this assessment protective of both the acute and chronic criteria.

Section 303(d) of the Clean Water Act and the EPA Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] 130) require states to develop TMDLs for waterbodies not meeting applicable water-quality standards or guidelines for the protection of designated uses under technology-based controls. TMDLs specify the maximum pollutant amount a waterbody can receive and still meet water-quality standards. Based on a calculation of the total allowable load, TMDLs allocate pollutant loads to sources incorporating a margin of safety (MOS). TMDL pollutant load reduction goals for significant sources provide a scientific basis for restoring surface water quality, linking the development and implementation of control actions to the attainment and maintenance of water-quality standards and designated uses.

1.2 WATERSHED CHARACTERISTICS

The Crow Creek Watershed (Hydrologic Unit Code [HUC] 10190009) is located in Laramie County in the southeastern part of Wyoming. Crow Creek originates in Albany County, beginning at the confluence of North Fork Crow Creek and South Fork Crow Creek approximately 8.5 miles west of Cheyenne, Wyoming. Crow Creek flows east to southeast to its confluence with the South Platte River in Colorado, draining approximately 256 square miles. The Crow Creek Watershed project encompasses a selenium TMDL, a *E. coli* TMDL, and a sediment TMDL. The Crow Creek Watershed project area, shown as the black boundary in Figure 1-1, begins at the confluence of North Fork and South Fork Crow Creek and ends where Crow Creek meets the Colorado state line. The assessment area for this selenium TMDL project is in the Crow Creek Watershed near Cheyenne and is described as the area 0.5 mile downstream of the Morrie Avenue Bridge in Cheyenne to Wyoming Hereford Ranch Reservoir #1 on Burlington Trail Road east of Cheyenne. The selenium-improved reach consists of approximately 24 square miles, including ephemeral tributaries, as shown in Figure 1-2. There are no major perennial tributaries in the assessment area.

The assessment area is represented by suburban, urban, industrial, and grazing areas in and around the city of Cheyenne. Water quality is suspected to be influenced by urban stormwater runoff, water-treatment facilities, housing development, and industrial facilities. Above and below the assessment area, land use is primarily characterized by dryland farming, recreation, industry, irrigation, livestock grazing, and small housing development with nationally and state-owned forested lands. Water-quality influences in the watershed are presumed to be grazing, irrigation, small housing development, industry, water-treatment facilities, forest management, and stormwater carryover [Laramie County Conservation District, 2008]. The assessment area also contains Frontier Refinery, which is a known selenium source through direct effluent discharges to Crow Creek and indirect discharges to the Crow Creek Wastewater Treatment Plant (WWTP).

1.2.1 Land Cover/Land Use

A summary of land cover/land use was completed using the 2001 National Land Cover Dataset (NLCD). The NLCD is a 21-category multilayer land cover classification dataset derived from Landsat imagery and ancillary data that provides consistent land cover data for all 50 states [Multi-Resolution Land Characteristics Consortium, 2001]. Approximately 81 percent of the land cover/land use of the Crow Creek Watershed project area consists of herbaceous grasslands, with the remaining areas consisting of cultivated crops, developed land, and other small land uses, as shown on Figure 1-3. Cheyenne is the only large urban area in the watershed, with a population of about 60,000 and incorporated area of approximately 45 square miles. Land use for the Crow Creek Watershed project area is shown in Table 1-3.

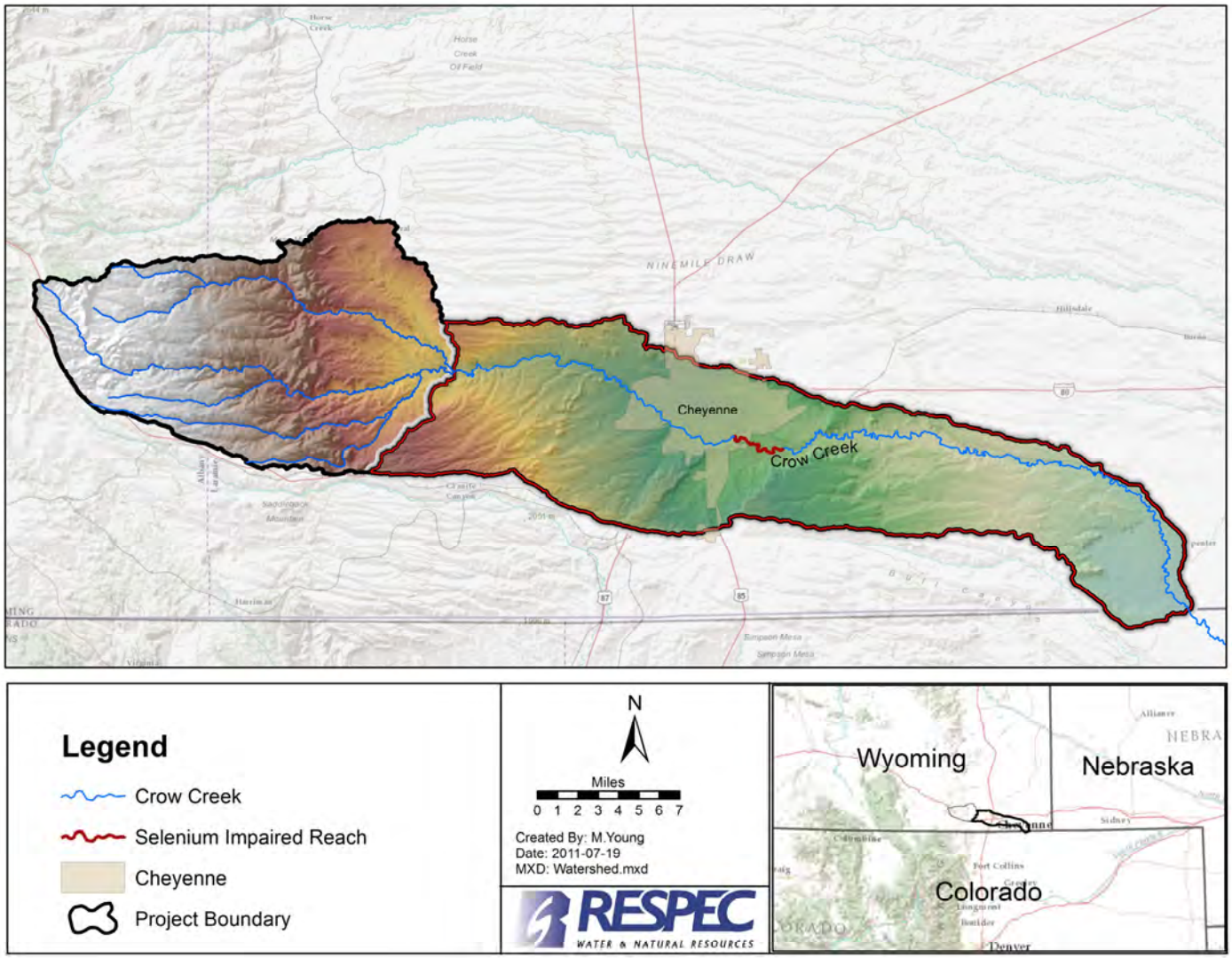


Figure 1-1. Crow Creek Watershed and Project Area.

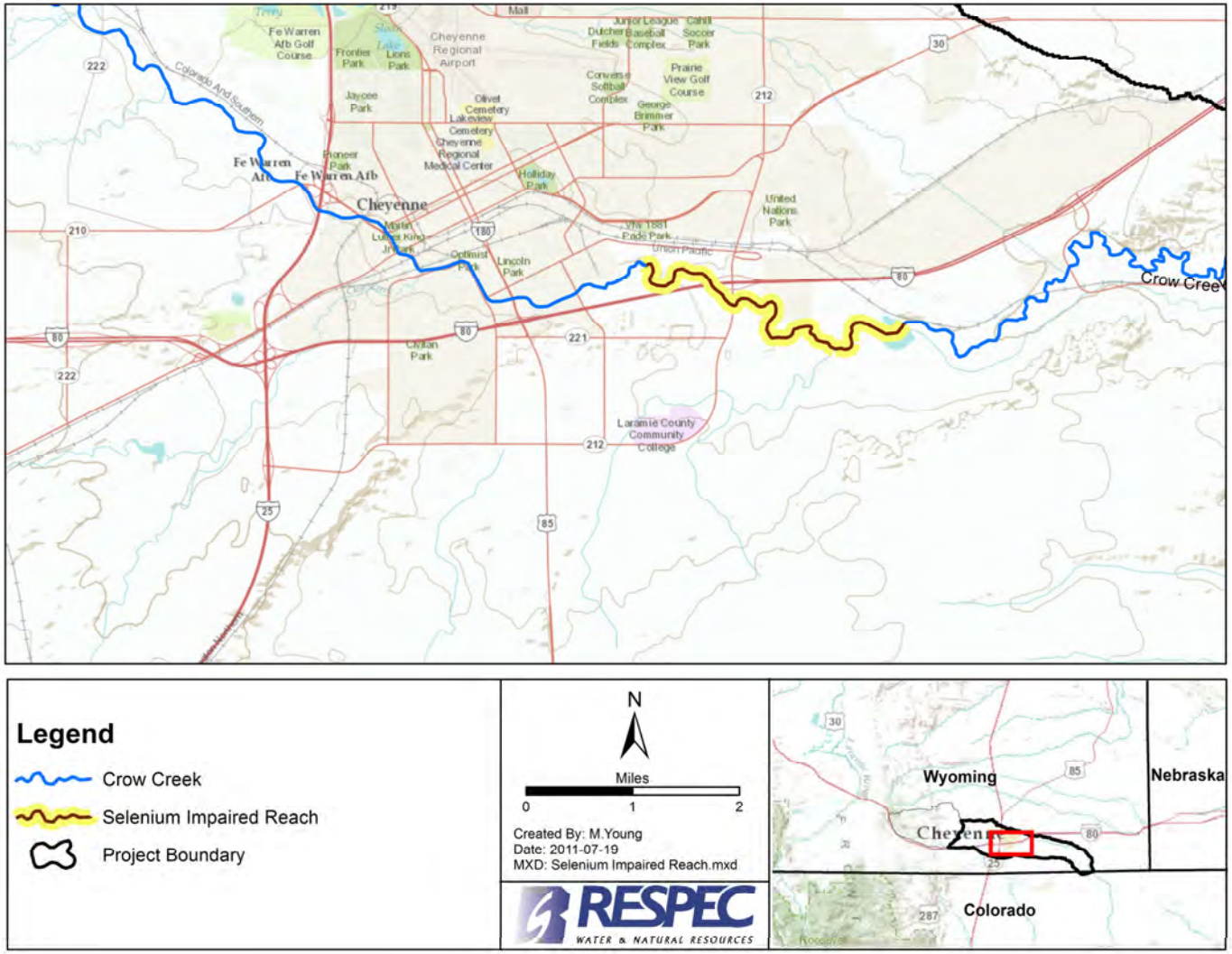


Figure 1-2. Crow Creek Selenium-Impaired Reach.

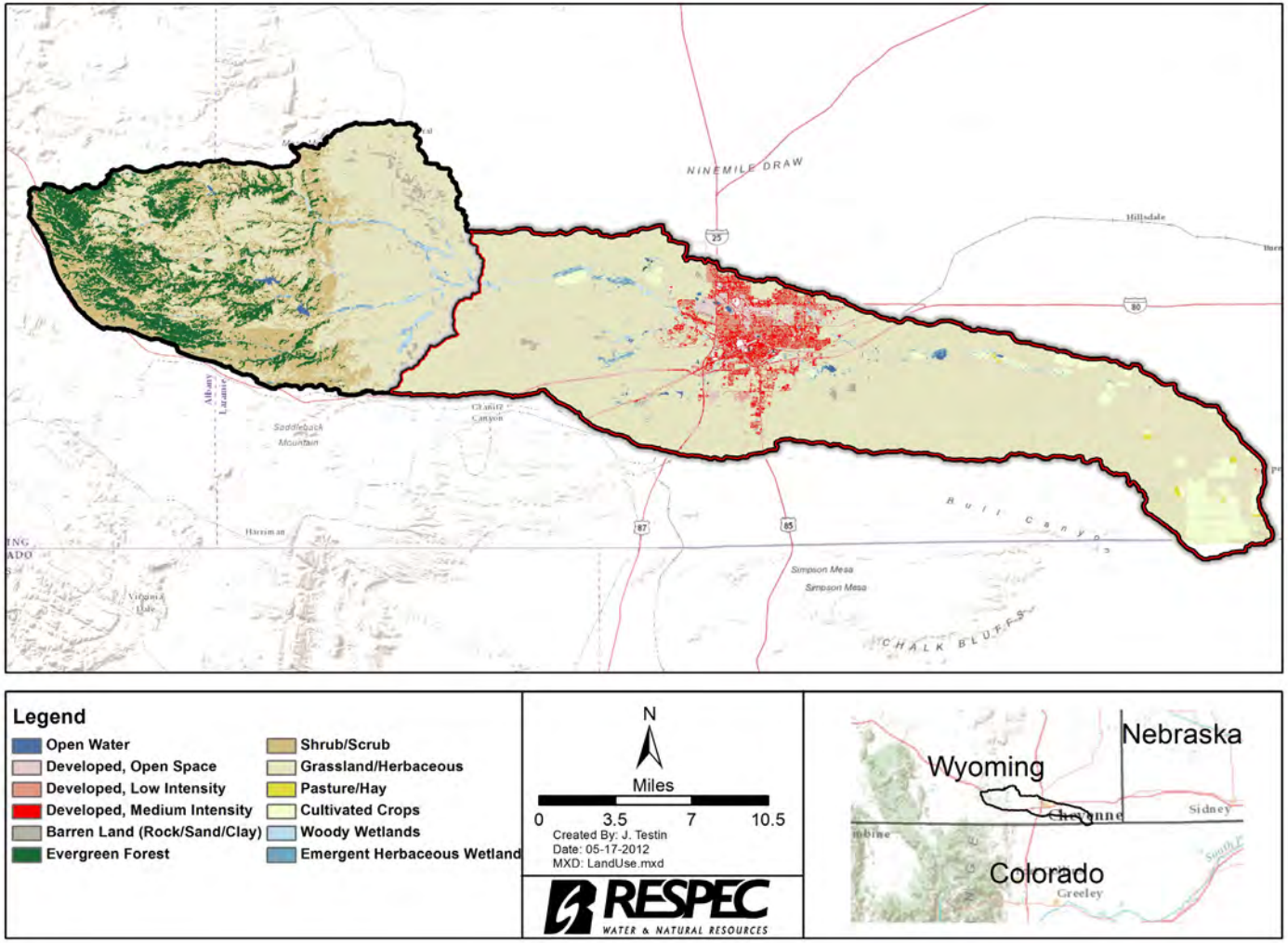


Figure 1-3. Predominant Land Cover/Land Use.

Table 1-3. Land Use by National Land Cover Dataset Category

NLCD Land Use Category	Acres	Percent of Total
Grassland, Herbaceous	132,597	80.9
Cultivated Crops	7,974	4.9
Developed, Low Intensity	7,311	4.5
Developed, Open Space	6,147	3.8
Developed, Medium Intensity	4,410	2.7
Other	5,364	3.3
Total	**163,802**	**100**

Note: To avoid rounding errors, the sum of percent values may not always total to 100.

1.2.2 Precipitation

Precipitation varies throughout the state of Wyoming but is generally consistent throughout the Crow Creek Watershed project area, with typical annual precipitation between 13 and 17 inches per year, as shown in Figure 1-4. Maximum precipitation generally occurs in the spring and early summer months.

The largest consumptive use of water (approximately 80 to 85 percent) in Wyoming is from agricultural irrigation, of which the primary source is surface water. Irrigation waters from surface sources in the watershed come mainly from South Crow Creek via the Gilchrist #4 Diversion, 14 miles west of Cheyenne, which has a permitted conveyance of 37.5 cubic feet per second (cfs). A number of smaller irrigation diversions also exist in the watershed [Wyoming State Water Plan Platte River Basin Water Atlas, 2010].

1.2.3 Geology and Soils

The study area is in the Denver Basin immediately east of the Laramie Mountains. In general, this area consists almost entirely of Tertiary- and Quaternary-age deposits. These deposits were derived from sediment that was eroded off the Laramie Mountains beginning after the mountains were uplifted as part of the Laramide orogeny about 60 million years ago. The bedrock geology is shown in Figure 1-5.

Approximately 90 percent of the watershed is underlain by the Ogallala Formation (Tmu) deposited in the Upper Miocene. These rocks primarily consist of light-colored claystone, sandstone, and gravel conglomerate. Additionally, several volcanic ash deposits can be found in the upper sequences of the Ogallala Formation. The formation was deposited in a complex alluvial sequence with inherent heterogeneity, although most clasts are locally derived.

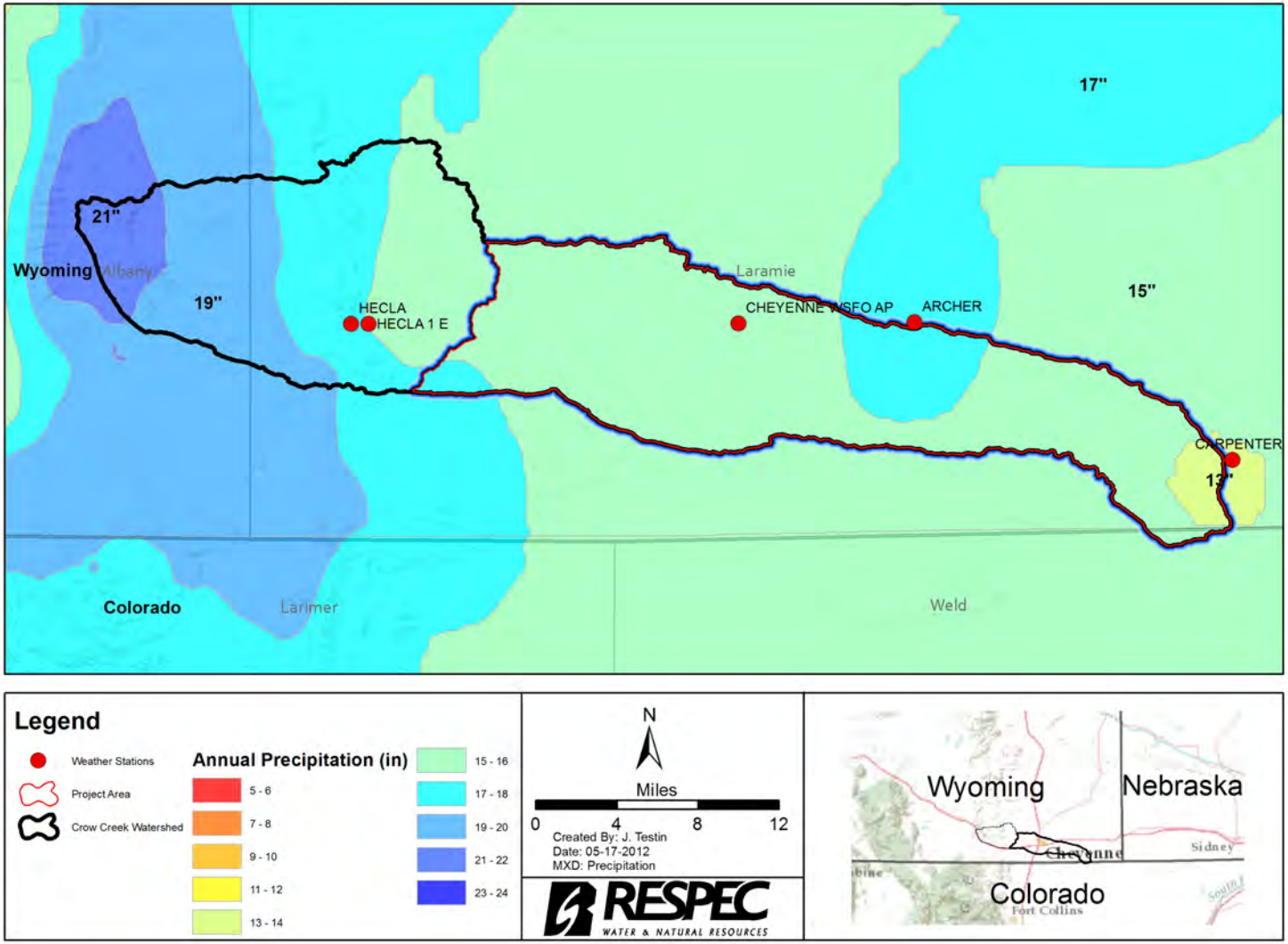


Figure 1-4. Average Annual Precipitation in the Project Area.

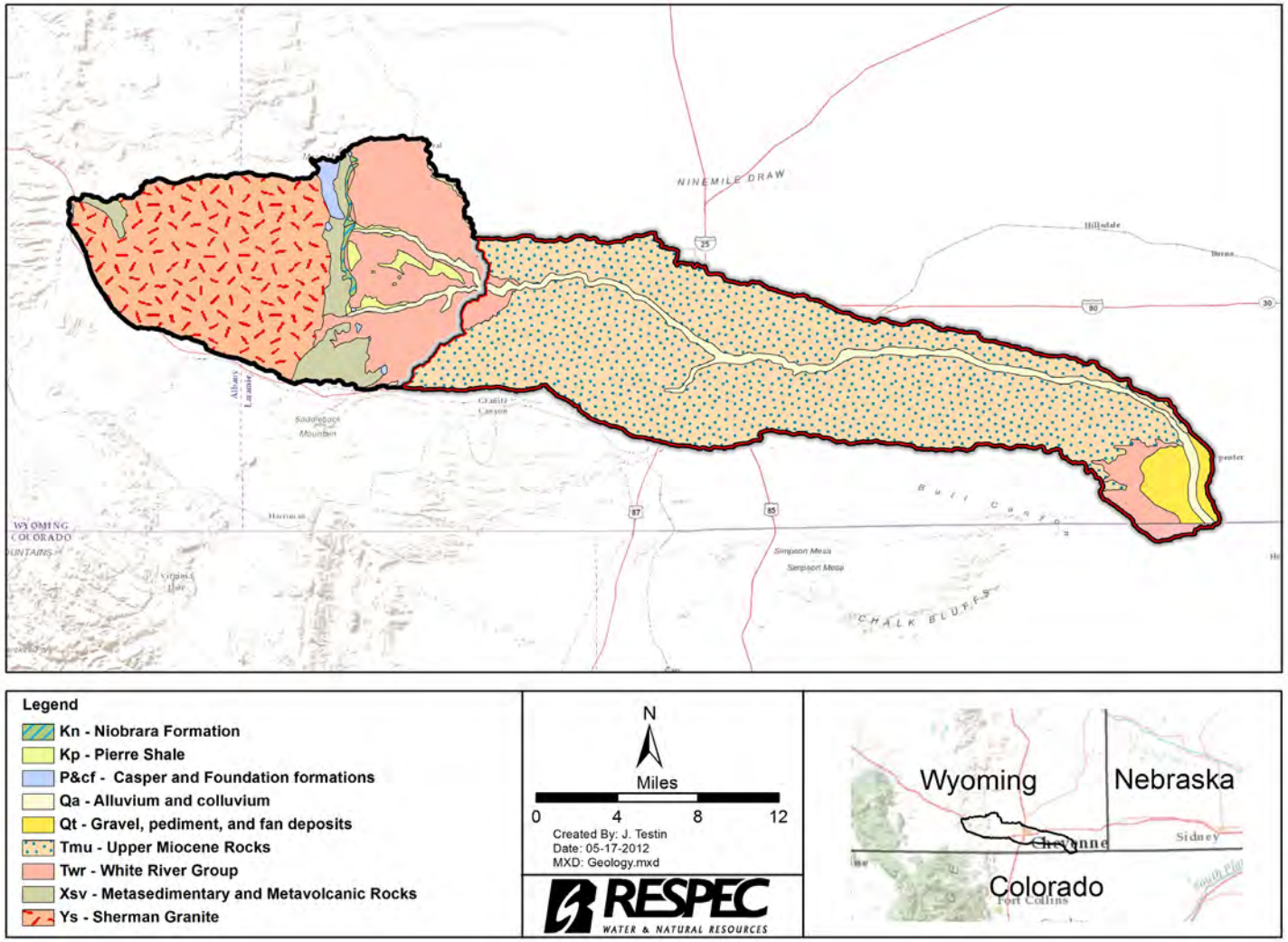


Figure 1-5. Bedrock Geology Distribution in the Crow Creek Watershed.

Two small areas of exposed Tertiary White River Formation (Twr) are found at the head and toe of the watershed. The White River Formation is dominantly composed of pale to white tuffaceous claystone and sandstone. Thin Quaternary alluvial and gravel deposits (Qt) are also present at the easternmost edge of the watershed.

There have been no studies that identified a specific geologic source of selenium in the Crow Creek Watershed. The Ogallala Formation and other rocks in the Crow Creek Watershed are not known to have high concentrations of selenium or other heavy metals.

1.3 SUMMARY OF AVAILABLE SELENIUM AND DISCHARGE DATA

Data used in the calculation of this TMDL include stream discharge and selenium concentration data collected by U.S. Geological Survey (USGS), WDEQ, RESPEC, and the Wyoming Pollutant Discharge Elimination System- (WYPDES-) permitted facilities of Frontier Refinery and Crow Creek WWTP. Selenium monitoring locations with ten or more samples are shown in Figure 1-6.

USGS currently has one active and several historical streamflow gauging stations from which discharge data can be obtained as well as several sites where dissolved selenium samples were collected. Historical USGS streamflow and water-quality data are available for retrieval through the USGS National Water Information System (NWIS) web pages. A USGS discharge data summary is shown in Table 1-4 and a dissolved selenium sampling summary is shown in Table 1-5.

Figure 1-7 shows dissolved selenium concentrations from quarterly samples collected by USGS at two Crow Creek sites, CRC300 and CRC705. Data at CRC300 were collected from May 1986 to August 1994, and data at CRC705 were collected from October 1987 to July 1990. Samples reported at or below the detection limit were set to 1 µg/L for the boxplot in Figure 1-7.

WDEQ collected chemical, biological, and physical water-quality data at numerous sites along Crow Creek in 2007 and 2008, including a discharge measurement and a total recoverable selenium sample at ten sites each year. The purpose of the WDEQ monitoring was to evaluate the water-quality condition of Crow Creek to determine whether its designated uses were being supported. Analysis of data collected in this assessment resulted in the listing of the reach as “impaired” on the 2010 303(d) list.

As part of the TMDL monitoring, RESPEC collected 76 total recoverable selenium water-quality samples (base flow and event flow) from two Crow Creek sites (CRC600 and CRC700) and one stormwater outfall (STW500) in 2010. These samples include instantaneous grab samples, individual aliquots from automatic water-quality samplers, and flow-weighted composite samples collected during storm events using automatic samplers. A summary of total recoverable selenium data is shown in Table 1-6, which includes the number of samples

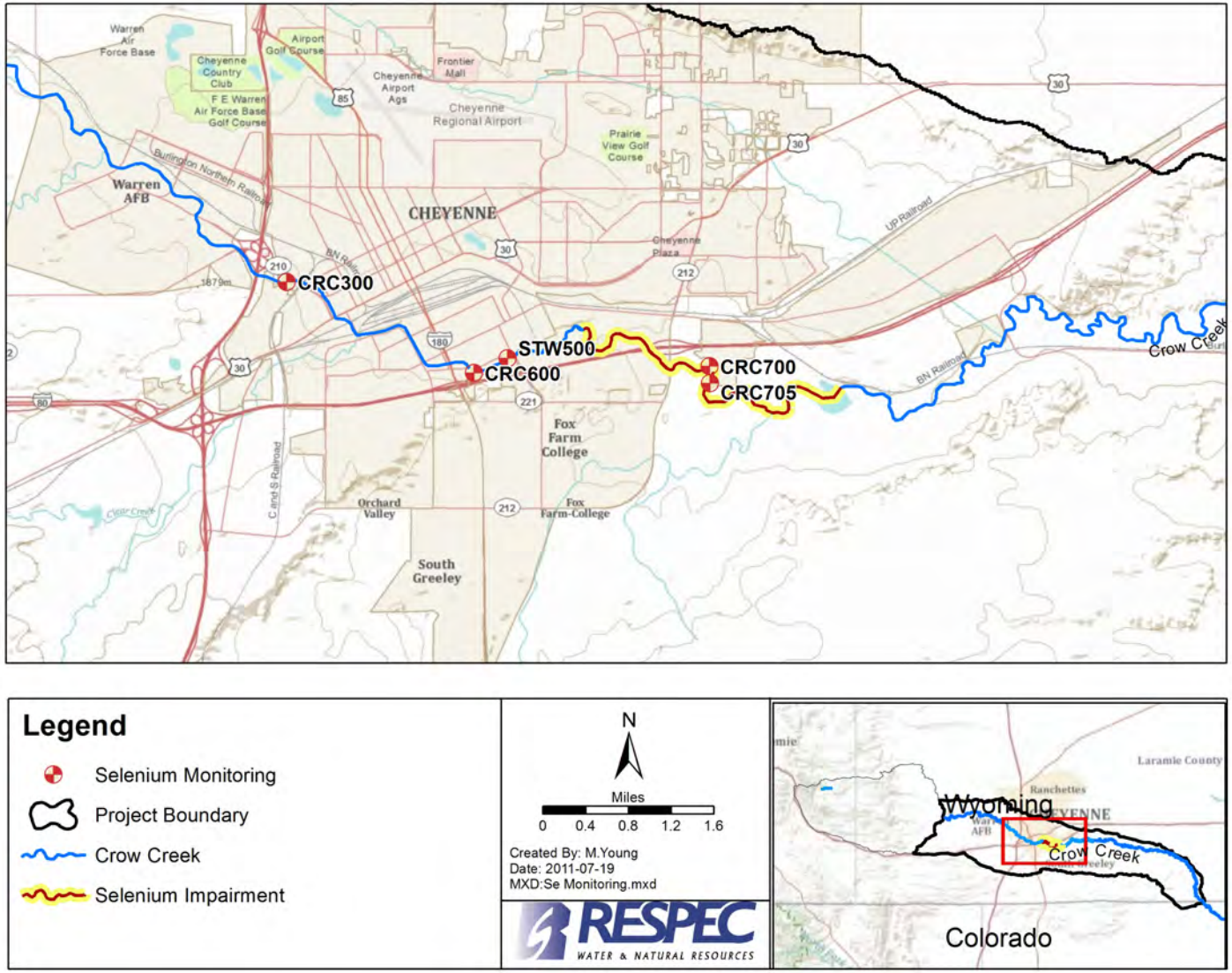


Figure 1-6. Monitoring Locations With Ten or More Selenium Samples In and Near the Selenium-Impaired Reach of Crow Creek.

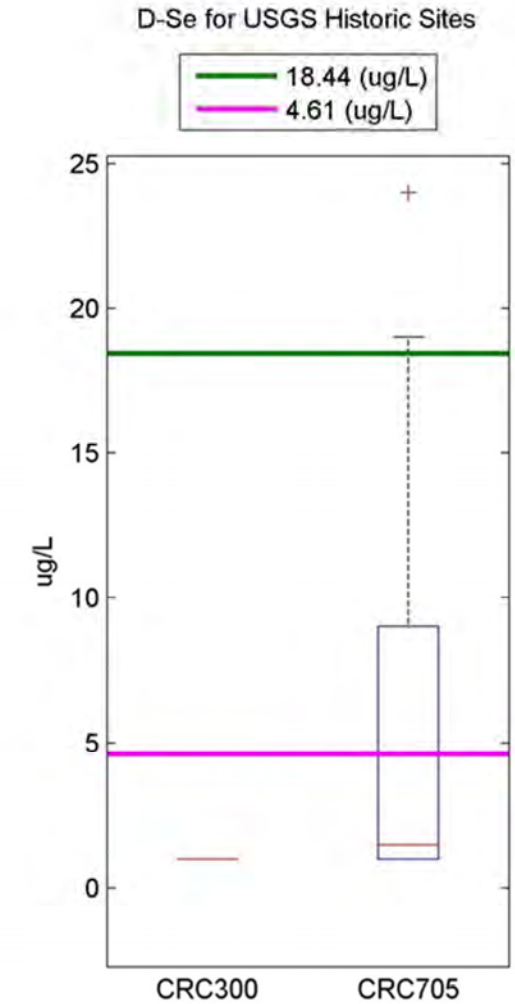
collected, the number of detections, and the maximum detected concentration. A boxplot of selenium data at CRC600, STW500, and CRC700 is shown in Figure 1-8. The plot shows the negligible upstream contribution of selenium to the impaired reach at CRC600 and STW500 and the high selenium concentration in the reach at CRC700. The mean and median total recoverable selenium concentrations in Crow Creek at CRC600 were 1.33 µg/L and 1 µg/L, respectively, while the mean and median concentrations at CRC700 were 13.7 µg/L and 12.5 µg/L, respectively. None of the 30 samples at CRC600 (the upstream site) and none of the 20 samples at STW 500 (the last major Cheyenne stormwater outfall before the impaired reach) exceeded chronic state water-quality criterion for selenium. At CRC700 (the downstream site), 7 of 26 samples (27 percent) exceeded the acute total recoverable selenium criterion of 20 µg/L, whereas 20 samples (77 percent) exceeded the chronic total recoverable selenium criterion. Although the chronic criterion is defined as the 4-day average, single samples were used for this exceedance evaluation, as described in Section 1.1.

Table 1-4. U.S. Geological Survey Streamflow Gauge Sites in the Crow Creek Watershed

Site Number	Station Name	Flow Data Start Date	Flow Data End Date
06755800	Crow Creek at Roundtop Road, near Cheyenne, Wyoming	03/21/1994	09/30/1996
06755840	Diamond Creek below Roundtop Road, at F. E. Warren Air Force Base, Wyoming	03/21/1994	09/30/1996
06755860	Diamond Creek at F. E. Warren Air Force Base, Wyoming	05/16/1992	09/30/1996
06755880	Diamond Creek at mouth at F. E. Warren Air Force Base, Wyoming	05/18/1992	09/30/1996
06755950	Crow Creek at F. E. Warren Air Force Base, Wyoming	03/21/1994	09/30/1996
06755960	Crow Creek at 19th Street at Cheyenne, Wyoming	10/01/1993	Present
06756000	Crow Creek near Cheyenne, Wyoming	10/01/1922	09/30/1957
06756100	Crow Creek near Carpenter, Wyoming	05/01/1990	09/30/1996

Table 1-5. U.S. Geological Survey Dissolved Selenium Data Summary by Site for the Total Maximum Daily Load Project Area

Station I.D.	Station Name	Number of Samples Analyzed	Number of Detections	Mean Value (µg/L)	Maximum Value (µg/L)	Date Range
CRC300	USGS 06755950	30	9	<1	1	1986–1994
CRC705	USGS 06756000	18	14	5.94	24	1987–1990



	CRC300	CRC705
n	30	18
Min	1	1
Max	1	24
q1	1	1
Median	1	1.5
q3	1	9
Mean	1	5.94

Figure 1-7. Boxplot of Historical U.S. Geological Survey Dissolved Selenium Data at CRC300 and CRC705 With Acute and Chronic Criteria.

Table 1-6. Total Selenium Data Summary by Site for the Total Maximum Daily Load Project Area

Station I.D.	Station Name	Number of Samples Analyzed	Number of Detections	Maximum Value (µg/L)	Reporting Limit (µg/L)	Date
CRC600	Crow Creek at First Street	30	4	5	1	2010
STW500	Morrie Avenue Storm Outfall	20	11	4	1	2010
CRC700	Crow Creek at Crow Creek WWTP	26	24	30	1	2010

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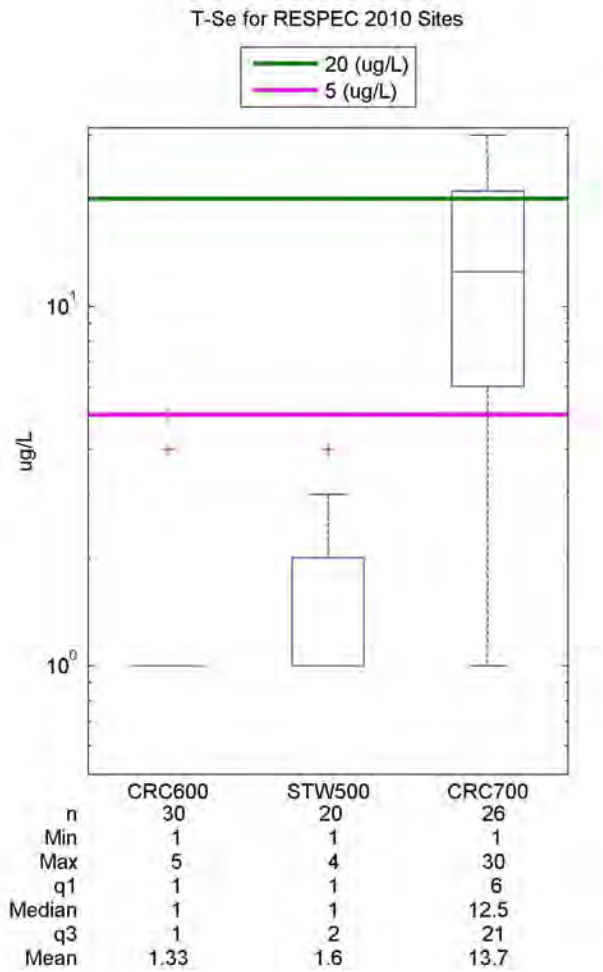

Figure 1-8. Boxplot of Total Selenium Concentration at CRC600, STW500, and CRC700.

RESPEC also collected continuous discharge data at CRC600, STW500, and CRC700 in 2010. Discharge data and total recoverable selenium data collected in 2010 at CRC700 were coupled to develop an LDC. The LDC is a dynamic expression of the allowable load as a function of the measured flow for any given day. Figure 1-9 shows observed data plotted on an LDC using the chronic criterion. The LDC method involves developing a flow duration curve or a representation of the percentage of days when a given stream flow occurs. A lower-percentile rank of flow exceedance indicates periods of high flows that rarely occur (runoff events); a high-percentile rank of flow exceedance indicates periods when a given flow value is often exceeded (low-flow periods). The allowable pollutant load curve (solid line in Figure 1-9) was calculated using the flow duration curve by multiplying the flow values by the chronic criterion (5 µg/L). In Figure 1-9, observed selenium loads were plotted along with the chronic LDC, which was set using the 5 µg/L chronic criterion. The points that fall above an LDC indicate exceedance of the applicable criterion, while the points that fall below an LDC indicate loads within the acceptable range. The observed selenium loads consistently exceeded the chronic standard and commonly exceeded the acute standard in the flow regimes sampled at CRC700.

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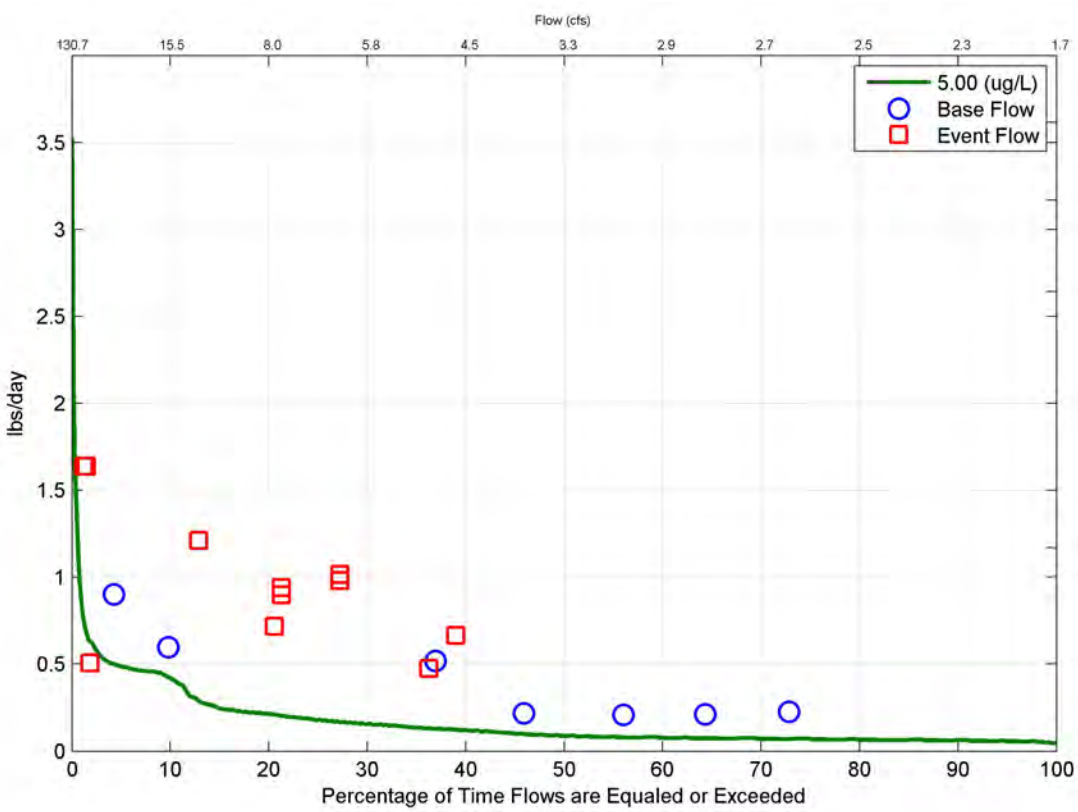


Figure 1-9. Load Duration Curve Using the Chronic Criterion Concentration of 5 µg/L for Total Recoverable Selenium (Created Using 2010 Data at CRC700).

1.4 QUALITY ASSURANCE REPORTING

Quality assurance procedures for field sampling were followed for all data collection for this project. The following basic handling procedures were required:

- Sample bottles were rinsed with the stream water to be sampled.
- Containers were appropriate to parameters sampled and the required cleaning procedures were followed.
- All equipment was examined for maintenance recommendations and checked for proper operation, and the required maintenance was performed immediately to ensure acceptable operation before the next use.

Quality assurance/quality control (QA/QC) sample sets were collected as part of the selenium monitoring effort. QA/QC samples consisted of a field replicates and blanks. Field replicate samples were independent samples representative of the parameters of interest, for which a second sample was collected in the same way with the same equipment as close in time and space to the previous sample as practicable. No marks were used that would indicate that the sample was anything other than a regular sample from the station identified on the label. The location and date of the replicate sample along with the regular or routine sample were recorded. Relative percent difference (RPD) was calculated for each replicate sample pair as follows:

$$\mathrm{RPD} = \left(\left|\mathrm{S} - \mathrm{R}\right|\right) \Big/ \left(\left(\mathrm{S} + \mathrm{R}\right)/2\right) \times 100 \qquad (1\text{-}1)$$

where:

$$\mathrm{S} = \text{sample}$$

$$\mathrm{R} = \text{replicate.}$$

Field blanks were collected using deionized water obtained from the laboratory during regular sampling activities at random sites during the base flow sample collection and during storm events. Field blanks were collected in a manner consistent with normal sampling activities and were used to determine whether the sample collection equipment or the activities of sample collection, handling, or transport were influencing sample results. Field blanks were collected, stored, and shipped with other samples.

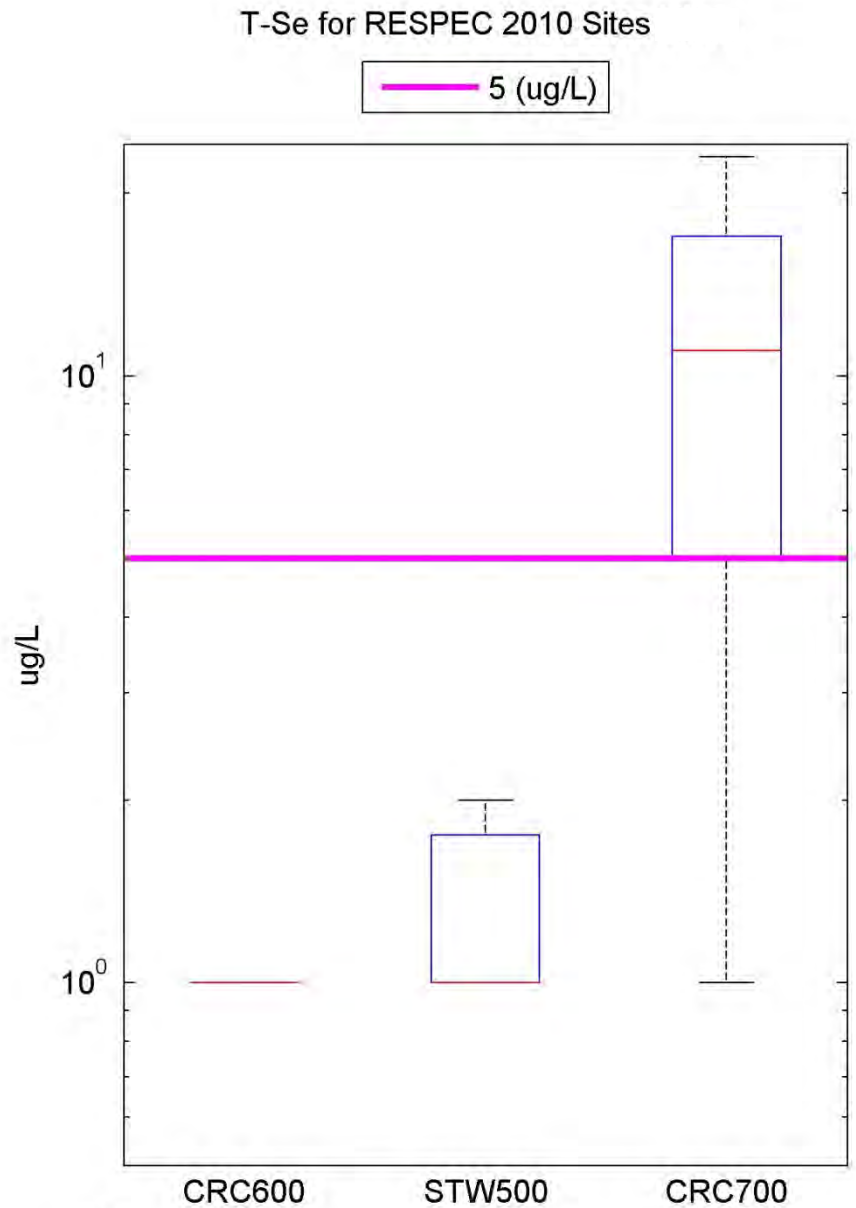
All field blanks (n = 16) were reported as below the detection limit of 1 µg/L for selenium concentration. Three replicate samples were collected at the upstream site (CRC600); all of these had nondetects reported for selenium concentration. One sample replicate was collected at the downstream site (CRC700). The selenium concentration values for this replicate sample set were reported as 11 µg/L and 12 µg/L; the RPD for this sample set is 9 percent.

The commercial laboratory used for selenium analysis for this project also performed internal QA/QC measures and reported their results for each sample batch analyzed. The laboratory analyses returned results for four internal QA/QC samples: a method blank, a laboratory control sample, a sample matrix spike, and a sample matrix spike duplicate.

For this project, all method blanks were reported as nondetects with the exception of the first two sample dates (collected on May 10 and 12, 2010). For both of these sample sets, laboratory method blank values were 0.8 µg/L (reporting limit of 0.3 µg/L). The values for all the laboratory control samples were reported within advisory limits. Laboratory control samples were run with known concentrations of 500 µg/L, with advisory limits of 90 to 110 percent recovery of the known concentration. Three sets of sample matrix spikes were returned with values outside the advisory limits of 85 to 115 percent recovery of known concentrations (grab samples collected on May 12, 2010, and September 1, 2010, and a set of storm event samples collected on August 3, 4, and 5, 2010). All sample matrix spike duplicates were within the RPD limit of 15 percent.

Statistics were run on the selenium dataset with samples removed from the dates where laboratory QA/QC samples were outside advisory limits and/or had detections above the reporting limit on method blanks. The boxplot with statistics of the remaining dataset is shown in Figure 1-10. The samples that were removed generally had higher selenium concentrations, which resulted in lower mean selenium concentration at each of the sites. The most notable impact to the statistics for water-quality data was for CRC600. All selenium samples at CRC600 were reported as nondetects, with the exception of the samples collected on May 10 and 12, 2010, and September 1, 2010; during which time, the laboratory reported QA/QC values outside the acceptable range. No other samples collected from Crow Creek upstream of the Frontier Refinery Outfall, including all historic samples, have had a selenium concentration greater than 1 µg/L.

When analyzing the current load and reductions needed to meet the TMDL, the full dataset was evaluated. While the results of some of the values seem to have some questions associated with them, there is no clear reason to believe these results are invalid. Including these values in the current load and reduction analysis ensures a more conservative TMDL.



	CRC600	STW500	CRC700
n	21	15	18
Min	1	1	1
Max	1	2	23
q1	1	1	5
Median	1	1	11
q3	1	1.75	17
Mean	1	1.27	11.2

Figure 1-10. Boxplot of Total Selenium Concentration at CRC600, STW500, and CRC700 With Samples That Met All Quality Assurance/Quality Control Limits.

2.0 SIGNIFICANT SOURCES

The primary sources of selenium in Crow Creek are the point-source discharges at Frontier Refinery Outfall 003 and Crow Creek WWTP. However, data suggest a nonpoint source of selenium exists in the project area as well. These nonpoint sources are quantified in Section 2.2.

2.1 POINT SOURCES

Two known point-source discharge streams containing selenium are in the Crow Creek Watershed project area. The WYPDES facilities in the Crow Creek Watershed are shown in Figure 2-1. The project area includes Frontier Refining Inc. (Frontier), a WYPDES-permitted 52,000-barrel-per-day crude-oil refinery owned by Frontier Oil Corporation that primarily produces gasoline and diesel fuel. Frontier has a WYPDES discharge permit (WY0000442) for effluent to receiving waters (Crow Creek and Porter Draw) that limits the amount of pollutants the facility may discharge, including stormwater effluent limits, range limits for temperature and pH, and acute and chronic whole effluent toxicity (WET) testing requirements. Frontier's WYPDES discharge permit expired on July 31, 2008, was resubmitted in draft form in February 2011, and has since been approved. The current permit limits the amount of selenium that Frontier may release to receiving waters via Outfall 003 to 6.21 µg/L total recoverable selenium and typical discharge volume at Outfall 003 to 0.8 million gallons per day (mgd) starting September 1, 2015. This value is a dilution-based value derived from the mixing equation using the lowest 7-day average flow that occurs on average once every 10 years (7Q10 flow) of 0.3 cfs at Martin Luther King Park in Cheyenne (USGS 06755960), an initial value of 0.0 µg/L total recoverable selenium in Crow Creek upstream of the Frontier Refinery discharge, a typical discharge of 0.8 mgd, and Wyoming's chronic water-quality standard for total recoverable selenium of 5 µg/L.

The second point source contributing to the impaired reach is the Crow Creek WWTP. The Crow Creek WWTP is a permitted facility that discharges treatment plant effluent directly to Crow Creek. The design flow for the Crow Creek WWTP is 6.5 mgd. There appears to be no selenium coming to the WWTP plant from the city of Cheyenne; however, Frontier does divert some of their effluent to the WWTP. Because of this fact, the WWTP effluent contains selenium that exceeds the in-stream selenium criterion. The Cheyenne Board of Public Utilities assumes that the only source of selenium into the WWTP is from Frontier Refinery [Dunn, 2011]. This assumption was validated by evaluating the available data; concentrations in the WWTP at times when Frontier is not discharging to the WWTP are at or below detection limits for selenium. For both point sources, Frontier is the source of selenium being discharged to Crow Creek.

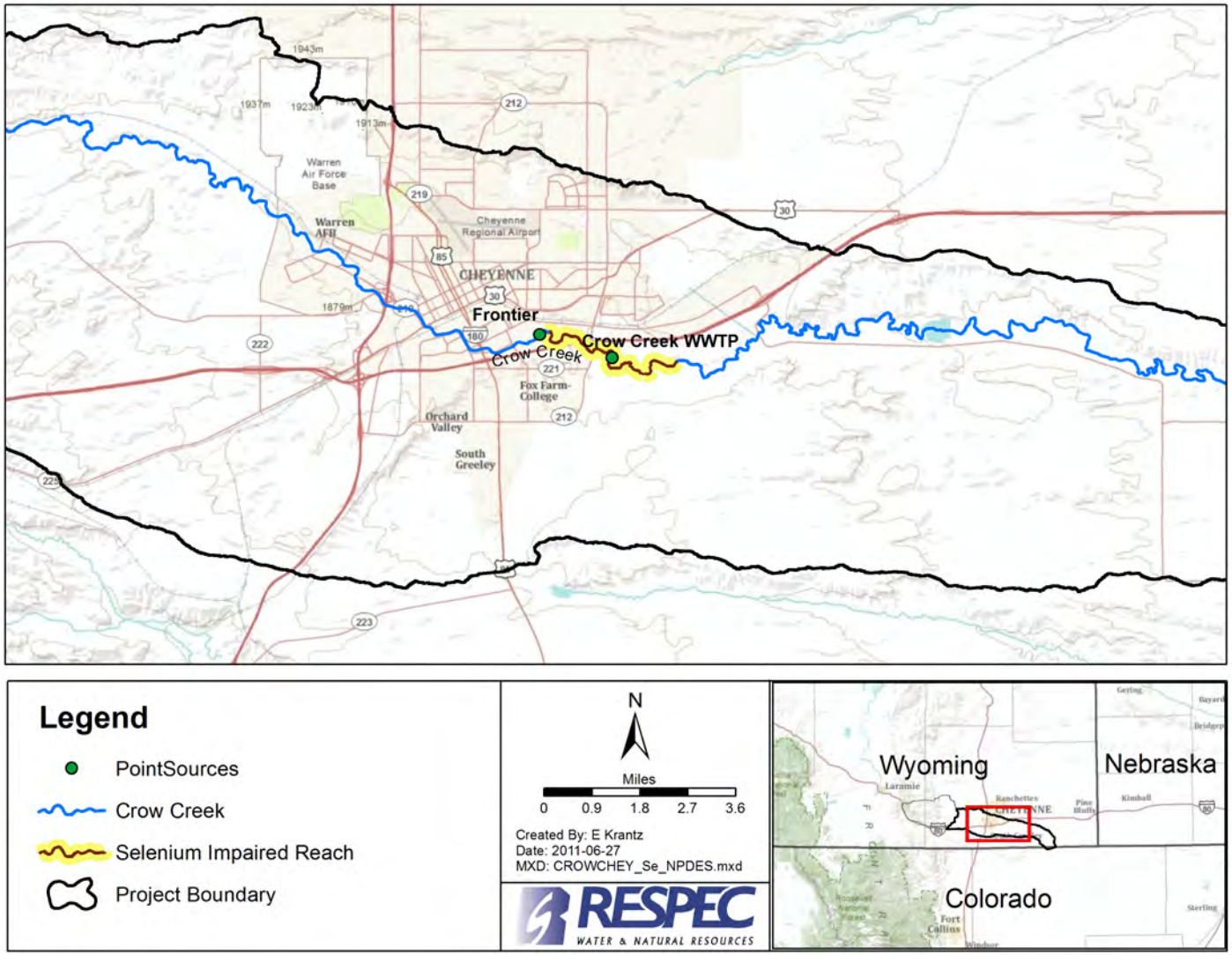


Figure 2-1. Wyoming Pollutant Discharge Elimination System Facilities Discharging to the Impaired Reach.

Frontier's previous permit did not require sampling selenium in the discharge stream to Crow Creek. For their current permit, Frontier began collecting daily maximum data for Crow Creek discharges in November 2011; however, the WWTP has collected monthly samples of the influent stream from Frontier to the Crow Creek WWTP since 2006. For the purposes of this TMDL, it was assumed that the two Frontier waste streams contain the same selenium concentration where data were unavailable for the discharge to Crow Creek. Figure 2-2 shows a conceptual diagram of the discharge locations and data available from Frontier Refinery and Crow Creek WWTP.

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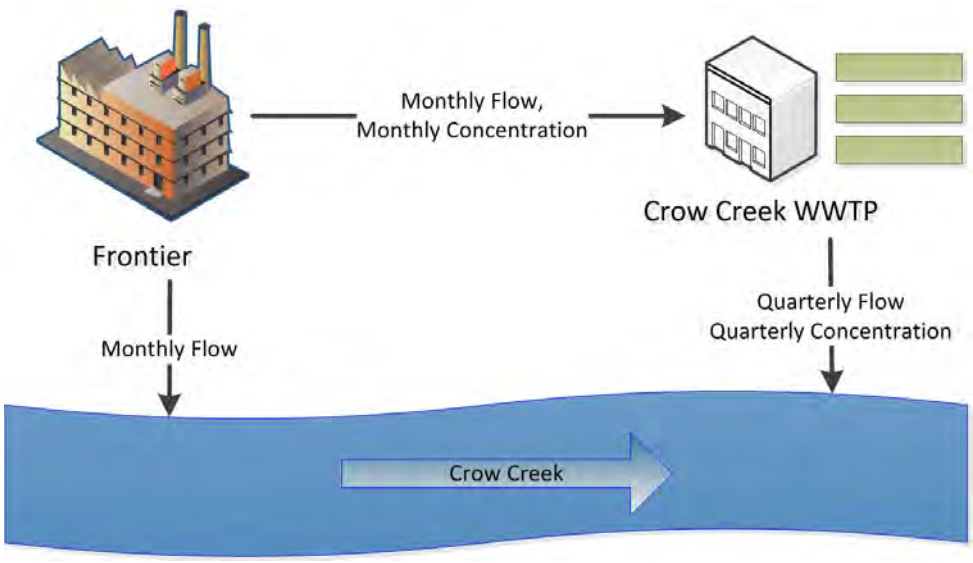

Figure 2-2. Diagram of Discharge Locations and Data Available From Frontier Refinery and the Crow Creek Wastewater Treatment Plant.

WYPDES data were acquired from the Frontier Refinery and the city of Cheyenne Board of Public Utilities. At the time of this document's writing, Frontier Refinery was not required to, and did not; collect selenium data as part of their WYPDES permit for discharges to Crow Creek via Outfall 003. However, Frontier has collected monthly flow data for Outfall 003 since 2006. Monthly selenium samples and flow data are also available since 2006 from the waste stream being discharged to Crow Creek WWTP, and Crow Creek WWTP collects quarterly selenium samples and flow data from the effluent stream discharged to Crow Creek. From November 2011 through March 2012, daily maximum concentration data were available for Outfall 003. These recent data were incorporated into this TMDL analysis.

Selenium load in the Crow Creek WWTP effluent to Crow Creek is shown in Figure 2-3, and selenium concentration in the same discharge stream is shown in Figure 2-4. Effluent discharge data for Crow Creek WWTP begin in January 2006 while selenium concentration data are available beginning in 2001. Estimated loads were calculated by multiplying concurrent concentration data and discharge data.

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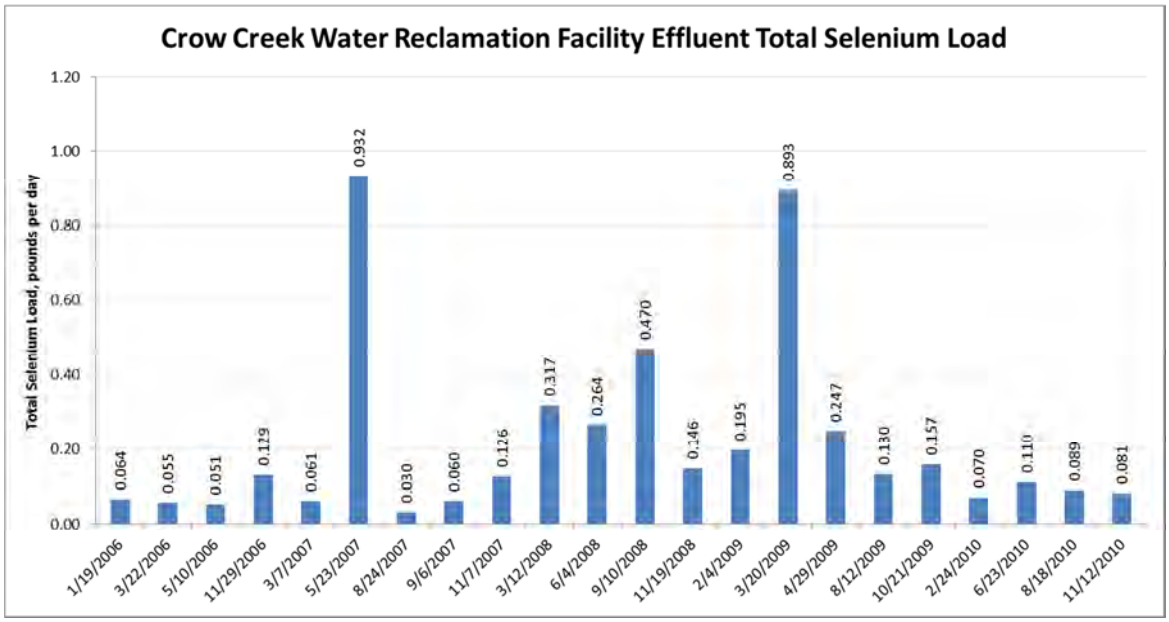

Figure 2-3. Total Selenium Loads in Crow Creek Wastewater Treatment Plant Effluent Discharged to Crow Creek in Pounds per Day.

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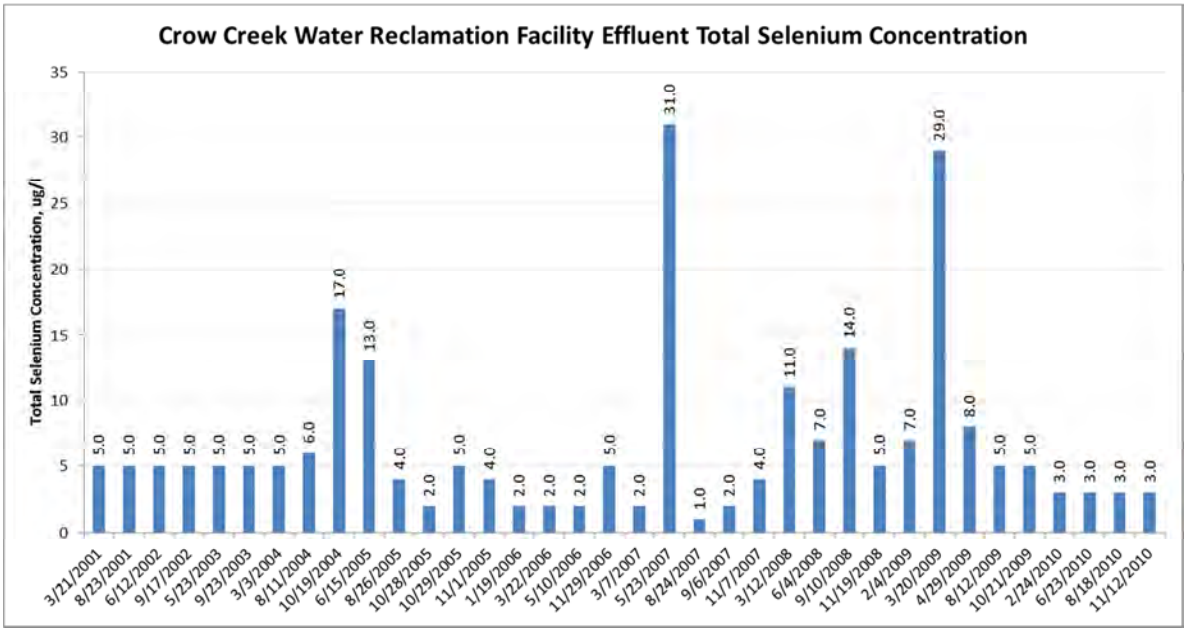

Figure 2-4. Total Recoverable Selenium Concentration in Crow Creek Wastewater Treatment Plant Effluent Discharged to Crow Creek in Micrograms per Liter (µg/L).

Frontier's previous permit did not require collection of selenium data from the WYPDES-permitted discharge to Crow Creek at Outfall 003 until November 2011. Because of the lack of data, it was assumed that the discharge contains the same concentration as the sampled stream being discharged to the Crow Creek WWTP. Frontier provided monthly selenium data in pounds per day and monthly discharge data in gallons per minute for the discharge to the Crow Creek WWTP. In addition, Frontier provided monthly discharge data to Crow Creek at Outfall 003 in gallons per day. Concentrations delivered to Crow Creek WWTP were calculated from load data which were then applied to the monthly discharge from Outfall 003 to calculate loads. Calculated selenium loads in Crow Creek at Outfall 003 are shown in Figure 2-5 and concentrations are shown in Figure 2-6. Flow data were available with four of the five recent daily maximum concentration samples supplied from Outfall 003 (December 2011–March 2012), and the paired samples were used to calculate loads for these 4 months. Load and concentration from these new data are shown in Figures 2-7 and 2-8, respectively.

Besides Frontier and the Crow Creek WWTP, multiple other point sources, including the Cheyenne Board of Public Utilities Water Treatment Plant (WY0031721), the Cheyenne Parks and Recreation Department (WY0094617), and the Cheyenne Rail Yard Union Pacific Railroad (WY0000647), Pilot Travel Centers LLC (WY0033944), and the Wyoming Air National Guard (WY0028576 and WY0056731) are located in the watershed upstream of the endpoint of the impaired reach.

The Municipal Separate Storm Sewer System (MS4) permit is a municipal stormwater discharge permit which authorizes the discharge of stormwater from municipal separate storm sewer systems. The permit area covered by the MS4 includes the Cheyenne, Wyoming, urbanized area as defined by the 2000 Census [Wyoming Department of Environmental Quality, 2008]. The current MS4 permit was issued on December 1, 2008, and will expire on September 30, 2013 [Sahl, 2012a]. Its boundary includes the city of Cheyenne MS4, the Laramie County MS4 (portions within the urbanized area), the Warren Air Force Base MS4, and the Wyoming Department of Transportation—Cheyenne MS4. Stormwater management programs are required to meet the applicable requirements of any TMDL on waters that will receive discharges from the MS4 [Sahl, 2012a].

In addition to the point sources and the general MS4 permit, there is also a Large Construction General Permit (LCGP), a Small Construction General Permit (SCGP), a Mineral Mining General Permit (MMGP), and an Industrial General Permit (IGP) [Sahl, 2012a]. In Laramie County, there are 57 construction permits, 16 mining permits, and 26 industrial permits. Temporary permits also exist in Laramie County, and mainly consist of construction site dewatering. Temporary permits also cover release of hydrostatic test water, swimming pool discharges, potable water line flushing, and a few other things [Sahl, 2012b]. Some permits that have coverage under these general permits in the project area include Emerald Foam Control, Simon Contractors, and Rubens Metals [Coleman, 2012]. Based on best engineering judgment as well as the WDEQ watershed study [Hargett, 2009], there is no reason to believe nor is there evidence that any permitted facilities or areas contribute selenium to the impaired reach except Frontier and the Crow Creek WWTP.

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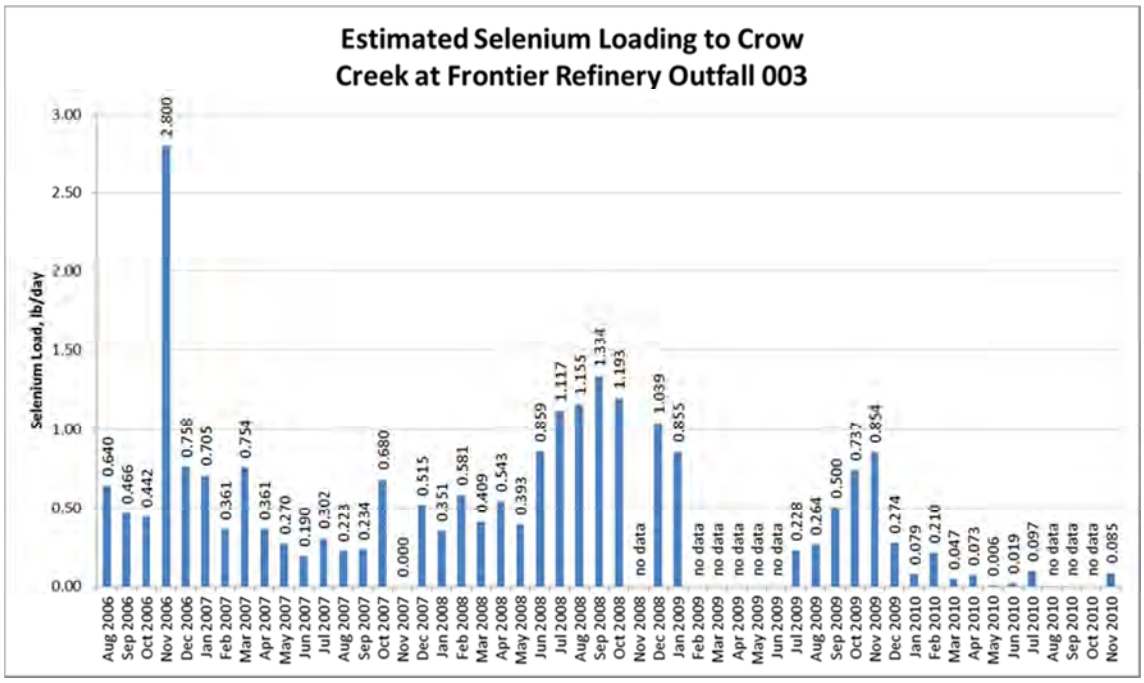

Figure 2-5. Estimated Total Selenium Loading Discharged to Crow Creek at Frontier Outfall 003.

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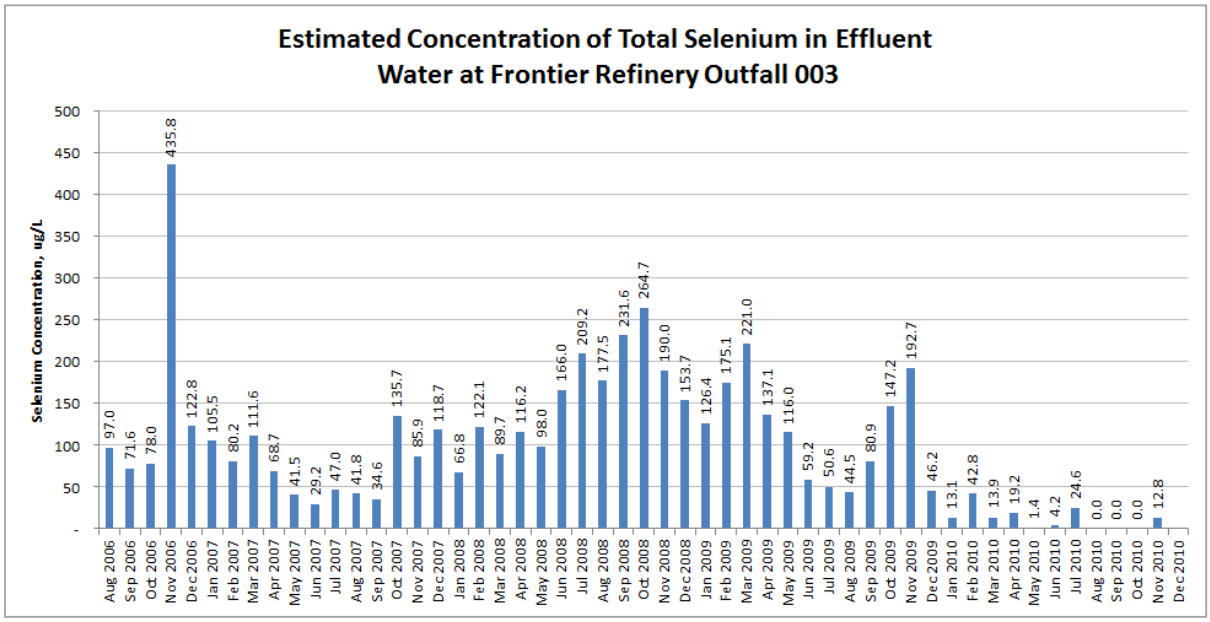

Figure 2-6. Estimated Total Recoverable Selenium Concentration Discharged to Crow Creek at Frontier Outfall 003.

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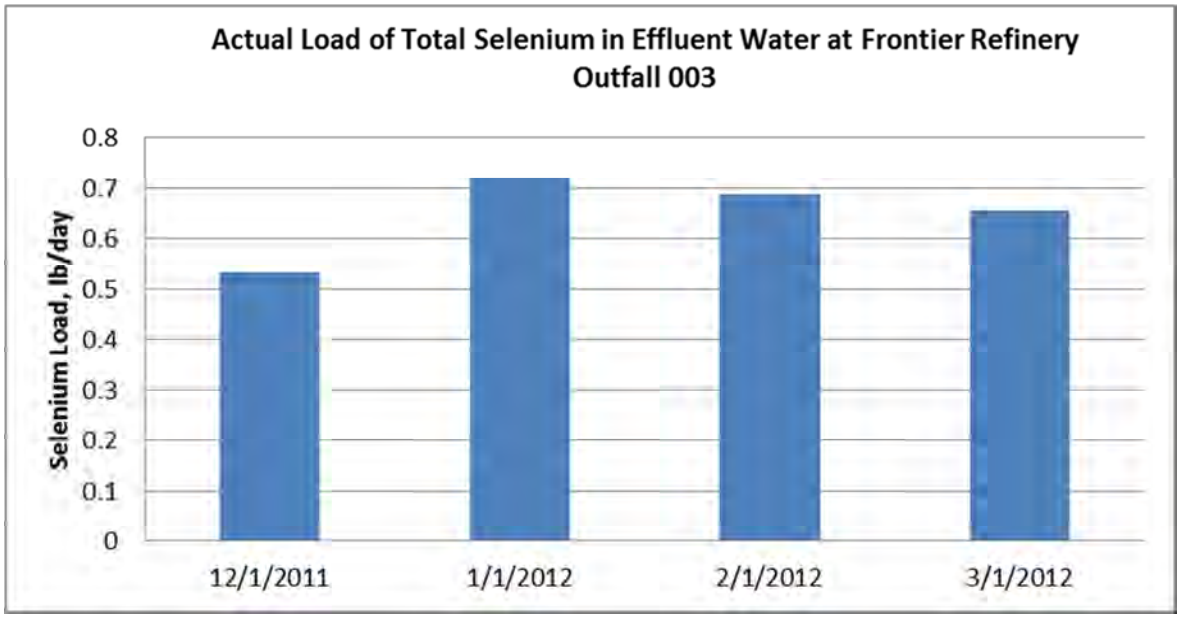

Figure 2-7. Actual Total Selenium Loading Discharged to Crow Creek at Frontier Outfall 003 (December 2011–March 2012).

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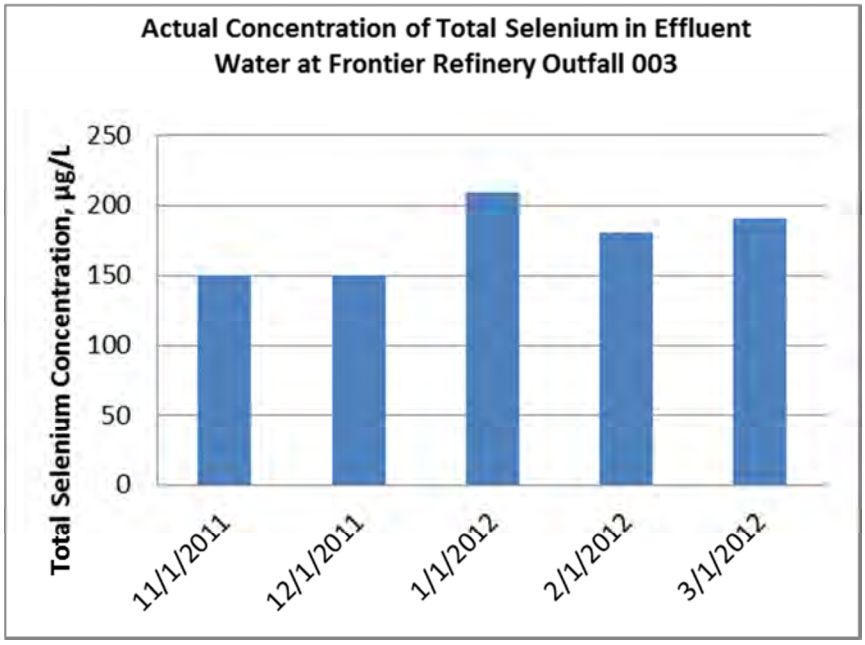

Figure 2-8. Actual Total Recoverable Selenium Concentration Discharged to Crow Creek at Frontier Outfall 003 (November 2011–March 2012).

2.2 NONPOINT SOURCES

Because there are no known natural geologic sources of selenium in the project area and selenium concentrations upstream of the impaired reach are below the chronic criterion, it is assumed that historical or legacy contamination from the Frontier Refinery in the form of alluvial groundwater contamination, stormwater runoff, and erosion of contaminated soils is the primary nonpoint source of selenium in the assessment area. Further assessment may be required to identify the mechanism of delivery of the historical or legacy contamination to Crow Creek.

3.0 SOURCE ALLOCATION ANALYSES

For this assessment, the analyses included constructing LDCs and calculating a mass balance. Source allocations were then based on analyses of LDCs and evaluation of the mass balance.

3.1 LOAD DURATION CURVE ANALYSIS

The TMDL was developed using the LDC approach, resulting in flow-variable targets across the entire flow regime. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10 percent), moist conditions (10–40 percent), midrange flows (40–60 percent), dry conditions (60–90 percent), and low flows (90–100 percent), congruent with the approach outlined by the U.S. Environmental Protection Agency [2007].

Background selenium concentrations upstream of the point sources are consistently at or below method reporting limits. The only known sources of selenium in the impaired reach of Crow Creek are point sources and possibly legacy contamination associated with Frontier Refinery. The selenium impairment is primarily a chronic problem not related to storm discharge or rainfall-runoff dynamics. The problem is exacerbated when stream flows are relatively low, as they typically are in late summer and fall months. Discharges from Frontier Refinery average between 0.7 and 0.8 mgd (~500 gallons per minute, or 1 cfs) and are relatively constant. Because discharge is relatively constant, causing the selenium exposure of aquatic life to be fairly constant, the LDC analysis based on the chronic criterion is used to determine load reductions necessary to bring Crow Creek into compliance with the chronic selenium aquatic-life criterion.

A selenium LDC, based on the chronic criterion of 5 µg/L, shown in Figure 3-1, was constructed for the selenium-impaired reach of Crow Creek. A wasteload allocation (WLA) was calculated for total recoverable selenium (shaded area in Figure 3-1). The methods used to calculate the WLA are discussed in detail in Chapter 4.0. Continuous discharge data from CRC700 were collected from July 7, 2010, to September 6, 2010; these data were paired with sample concentrations to determine loads, which are plotted as triangles in Figure 3-1. Average daily time-series discharge results were generated using **HSPF** and calibrated to all observed discharge data available during the modeling period (1995 through 2010). This time series of simulated discharges was used to develop the loading capacity, which is represented by the green curve, for the period of 1995 through 2010. The discharge time series was also used to pair with concentration data when no observed data were available to generate loads (squares in Figure 3-1). Both the triangles and squares on Figure 3-1 represent observed selenium data; only the associated flow was simulated, with the samples represented as squares.

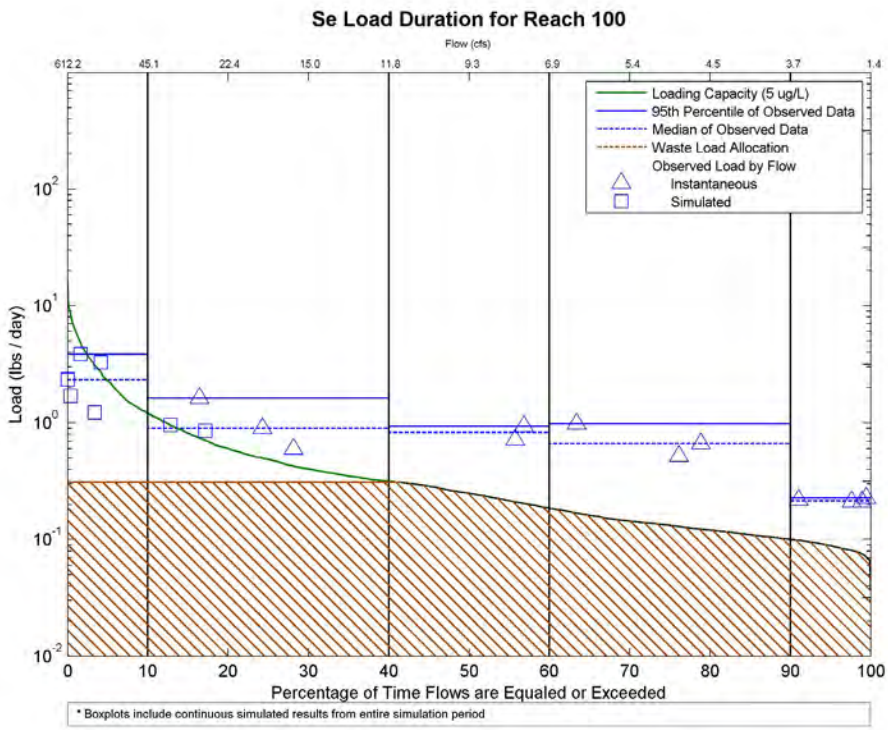

Figure 3-1. Load Duration Curve Representing Allowable Total Recoverable Selenium Loads.

When the loads are plotted on the LDC, characteristics of the water-quality impairment are shown. Loads that plot above the loading capacity curve are exceeding the chronic water-quality criterion, while loads below the curve are in compliance. As shown in Figure 3-1, all samples collected in the low, dry, midrange, and moist (10–100 percent) flow regimes are exceeding the criterion, while one in five of those in the high flow regime exceeded the criterion.

Loads that are within the same order of magnitude across flow regimes are typical of nonevent-driven point-source discharges. Figure 3-2 shows concentrations of selenium with respect to flow for samples collected in 2010 at CRC700. Again, all symbols on the figure represent observed selenium data; only the associated flow was simulated with the samples represented in Figure 3-2 as blue diamonds. The plot shows that concentrations decrease at higher flows, which is typical of point sources that are diluted during high flows. Loads generally decrease as flows decrease in Figure 3-1, while loads would be expected to be constant across flow regimes because of the relatively constant nature of point-source discharges and loads. This decrease likely occurs because more streamflow losses to the substrate and groundwater occur during lower flows, carrying selenium into the soils and groundwater, and because lateral inflow and overland flow during higher flows add selenium from legacy contamination and subsurface selenium stored during low flows.

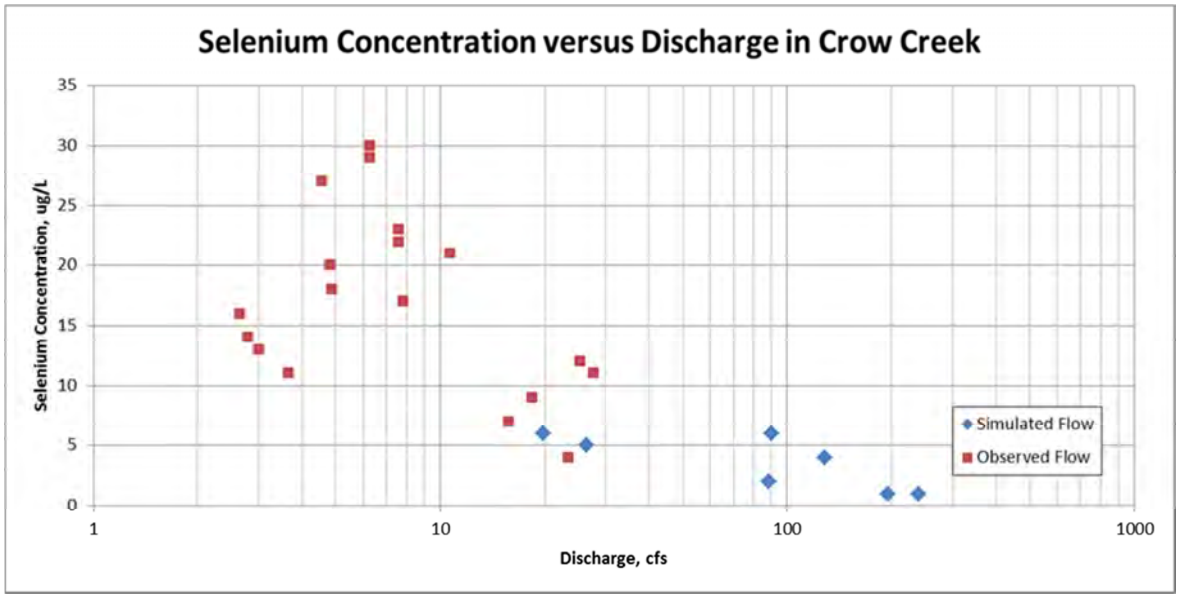

Figure 3-2. Total Recoverable Selenium Concentration in 2010 CRC700 Samples Plotted With Respect to Streamflow.

3.2 MASS BALANCE ANALYSIS

Selenium loading to the impaired segment of Crow Creek is, for the most part, a combination of point-source loads and nonpoint-source loads from the Frontier Refinery. To calculate current loads in Crow Creek, sample concentrations were multiplied by simulated flow values to estimate current daily loading (in pounds per day [lb/day]) in each flow zone. The 95th percentile of the range of these estimates in each flow zone was defined as the current total load. Current loads are shown in Table 3-1. The 95th percentile point-source selenium load to Crow Creek currently coming from the Frontier Refinery effluent is estimated to be 2.05 lb/day for the high-flow zone. Although the 95th percentile loads from the Frontier Refinery vary daily, they remain fairly constant over longer periods. However, selenium loads in the stream are more variable because streamflow losses to the substrate and groundwater occur during lower flows, carrying selenium into the soils and groundwater, and because lateral inflow and overland flow during higher flows add selenium from legacy contamination and subsurface selenium stored during low flows. Selenium in the stream can also be lost through various uptake processes. Therefore, the point-source load from Frontier Refinery in the moist, midrange, dry, and low-flow zones does not encompass the entire 2.05 lb/day because the total current load was less than 2.05 lb/day in these flow zones. Thus, the point-source load in the moist, midrange, dry, and low flow zones was set to the applicable total current load. The remainder of the load for each flow zone (the difference between the current total load and the current point-source load) is assumed to be from Frontier Refinery-related nonpoint sources, such as legacy contamination, overland flow, and interflow during runoff events. Figure 3-3 shows the estimated current total load from point and nonpoint sources.

Table 3-1. Current Total Recoverable Selenium Loads

Type of Source	Current Loads per Flow Zone (lb/day)				
	High	Moist	Midrange	Dry	Low
Total	2.99	1.64	0.98	0.67	0.23
Point Source	2.05	1.64	0.98	0.67	0.23
Nonpoint Source	0.94	0.00	0	0	0

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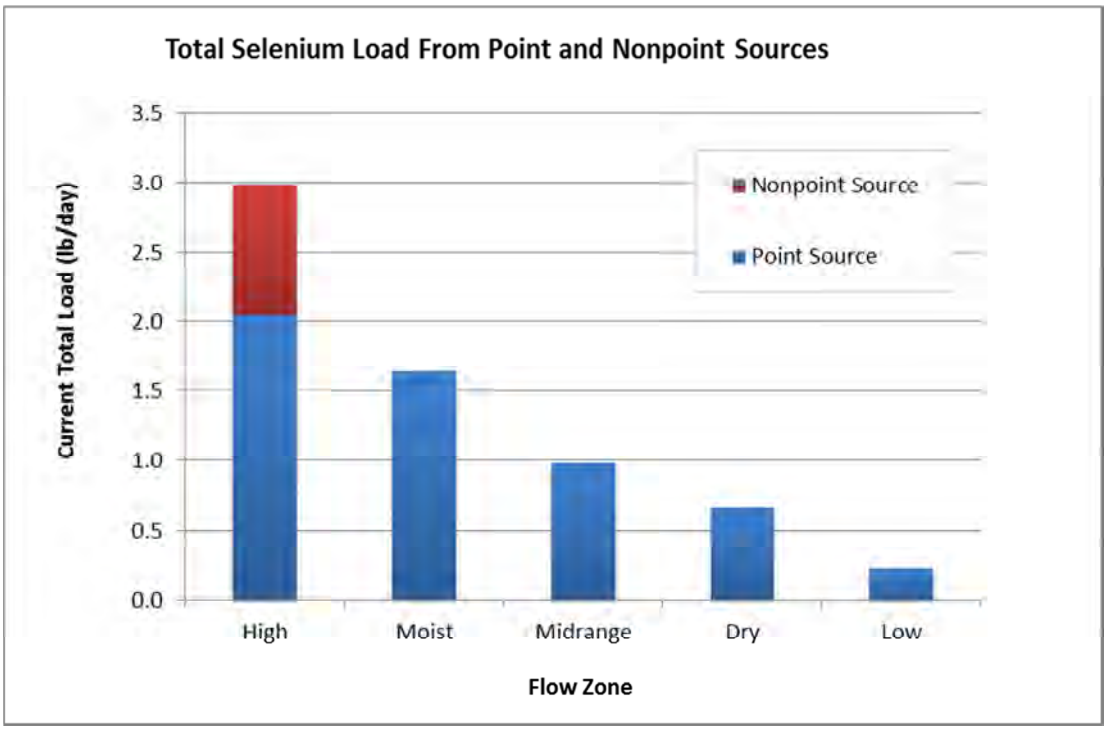
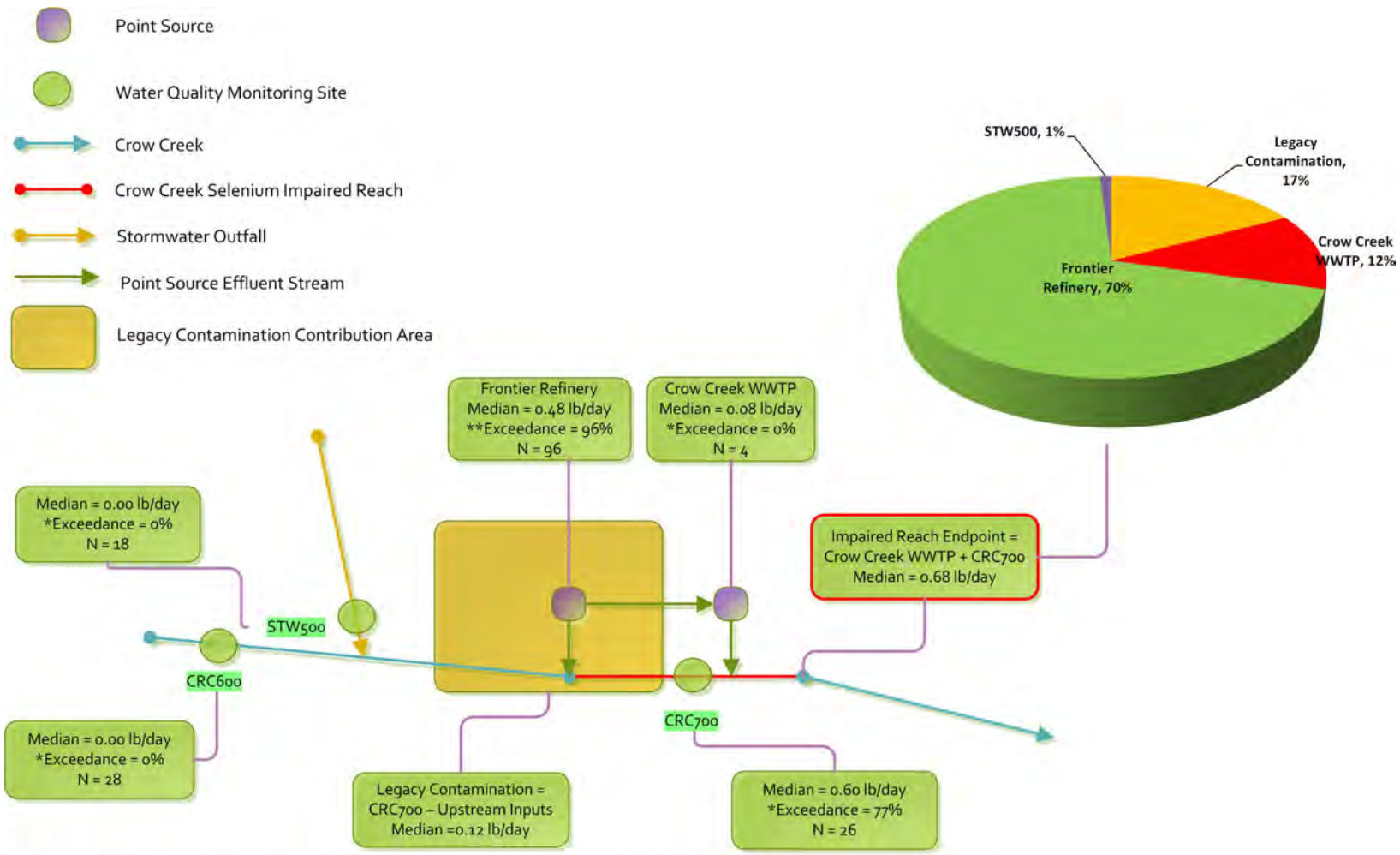


Figure 3-3. Total Selenium Load in 2010 Samples Plotted With Respect to Flow Zone.

A mass balance was completed to determine 2010 median load contributions from CRC600, STW500, Frontier Refinery, Frontier Refinery Legacy Contamination, and Crow Creek WWTP to the endpoint of the selenium-impaired reach. Figure 3-4 is a schematic showing the location of each contribution, the median load, the percent exceedance of the chronic criterion, and the number of samples used in the calculation. CRC700 is included in the figure; however, it was not individually accounted for in the mass balance because contributions were accounted for with upstream monitoring sites. Data from CRC700 were used to calculate the legacy contamination from Frontier Refinery. Legacy contamination was calculated as the difference between the median CRC700 load and the sum of the upstream input loads. The historical Frontier Refinery data included monthly selenium concentration data for the effluent that is



*Exceedance was calculated as the percent of 2010 samples above the chronic selenium criteria (5 µg/L)
**Exceedance was calculated as the percent of calculated historic concentration (2004 through 2010) above the chronic selenium criteria (5 µg/L) in the waste stream from Frontier Refinery to the Crow Creek WWTP.

Figure 3-4. Mass Balance of Sources to Endpoint of Impaired Reach.

discharged to the Crow Creek WWTP, and this analysis assumes that the effluent stream to Crow Creek at Outfall 003 contained the same selenium concentrations historically as the effluent stream to Crow Creek WWTP. It should be noted that the median load from Frontier Refinery was estimated using the median of all available estimated loads (historical included) from their waste stream to the Crow Creek WWTP and four newly collected calculated loads from the actual Frontier Outfall 003 stream from December 2011 through March 2012 to capture variability.

The mass balance analysis shows that approximately 0.68 lb/day of selenium is reaching the endpoint of the impaired reach. Less than 1 percent of this amount can be considered background (load at CRC600), 70 percent is attributable to Frontier Outfall 003, 4 percent is attributable to legacy contamination, and 12 percent comes indirectly from Frontier via the Crow Creek WWTP.

4.0 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

The TMDL (loading capacity) is the flow at any given time (flow duration curve) multiplied by the water-quality standard. The TMDL is further broken down into the load allocation (LA), WLA, and MOS, and these, when summed, add up to the TMDL. For each of the five flow zones, the 95th percentile of the range of loading capacities in each flow zone (i.e., the product of the 95th percentile flow in that zone and the water-quality criterion) was set as the TMDL. As mentioned earlier, the critical criterion for this TMDL is the chronic 4-day average concentration (5 µg/L) because selenium loads in the impaired reach of Crow Creek are fairly constant and primarily nonstormwater-related. Since not enough data are available to compute a true 4-day average load, the TMDL was evaluated using the chronic criterion.

The selenium TMDL table was constructed for the endpoint of the impaired reach (Hereford Reservoir #1) using simulated flows and 2010 selenium concentration data from the water-quality monitoring station in the reach. Methods used to calculate the TMDL allocations are discussed in more detail in this chapter.

4.1 WASTE LOAD ALLOCATION

Two point sources of selenium discharge directly to the impaired segment of Crow Creek. These facilities are the primary source of selenium in the impaired reach and are causing the impairment of Crow Creek. The origin of selenium in both discharges is Frontier Refinery, which splits its selenium-rich effluent stream between Crow Creek (via Frontier Outfall 003) and the Crow Creek WWTP, as shown in Figure 2-1. Possible selenium load from both effluent streams were accounted for in the WLA calculation.

The WLA for the impaired reach is the sum of the load from contributing point-source facilities. The Frontier Refinery WYPDES permit sets the selenium effluent concentration limit at 6.21 µg/L and the discharge limit at 0.8 mgd (typical flow) when it flows to Crow Creek through Outfall 003. Although the concentration limit (6.21 µg/L) is higher than the current chronic criterion of 5 µg/L, Crow Creek has the capacity to assimilate this load unless flows upstream of the refinery drop below the 7Q10, assuming that the upstream load is negligible. This discharge limit is appropriate because very few samples (<10 percent) upstream of the refinery have had detections of selenium. Furthermore, the 5 µg/L criterion is a chronic criterion; if there is a source of selenium upstream of Frontier, there is no evidence that it is a constant source that would cause a chronic impairment. An inherent MOS is also included in this calculation because the discharge location for Frontier is downstream of the point where the 7Q10 was calculated for the WYPDES permit (USGS 06755960). The median flow at the discharge location is nearly 50 percent higher than the median flow at the USGS gauge.

The Crow Creek WWTP also allows Frontier Refinery to divert part of their effluent stream to the WWTP. An allowable load was added to the WLA to account for discharge to Crow Creek from the WWTP. For the WLA calculation, it was assumed the concentration of the effluent from the WWTP will not exceed the in-stream chronic criterion (5 µg/L). The WLA was calculated using the design flows of 6.5 mgd from the Crow Creek WWTP and 0.8 mgd from Frontier Refinery Outfall 003. The WLA for the WWTP and Frontier combined was calculated to be 0.31 lb/day (shown in Figure 3-1 as the solid tan line). Table 4-1 shows a breakdown of the WLAs between facilities. All flows below 11.8 cfs, the point where the WLA line meets the loading capacity in Figure 3-1, are below the potential discharge of the two point-source facilities. Because the WLA meets the loading capacity at the high end of the midrange flow zone, all loading capacity in the midrange, dry, and low flow zones is allocated to the WLA. At these low flows, the point-source discharges are the only known source of selenium. The permit for Frontier includes both Outfall 003 and stormwater runoff sources, and therefore, a separate allocation was not given for the stormwater contribution from STW500. Similarly, based on best engineering judgment as well as the Crow Creek watershed study [Hargett, 2009] there is no reason to believe that any stormwater permits contribute selenium within the project area besides Frontier.

Table 4-1. Breakdowns of Waste Load Allocations For Crow Creek Wastewater Treatment Plant and Frontier

Point Source	WLA (lb/day)				
	High	Moist	Midrange	Dry	Low
Crow Creek WWTP	0.27	0.27	0.21	0.12	0.08
Frontier	0.04	0.04	0.03	0.02	0.01

4.2 LOAD ALLOCATION

To develop the selenium LA for the impaired reach, the loading capacity was first determined using the data sources and methods specified above, and point sources were allocated to the WLA based on the Frontier Refinery WYPDES permit (a typical flow of 0.8 mgd) and a design flow of 6.5 mgd from the Crow Creek WWTP. Portions of the loading capacity were then allocated to the MOS to account for uncertainty. The LA was calculated as the loading capacity minus the sum of the WLA and the MOS. The LA takes into account any legacy contamination from the Frontier site and selenium-rich lateral inflows resulting from legacy contamination and overland flow. It should be noted that when using this method for calculating the LA, loading capacity is unavailable for the LA in the three lowest flow regimes. This is appropriate because the only source of selenium during dry conditions is from point sources (i.e., no runoff is occurring from storm events and lateral inflow from subsurface flow is at a minimum); therefore, the WLA was set at the allowable load minus the MOS. If the flow from the point sources combined is at their design flow of 7.3 mgd, the flow in Crow Creek would be higher

than the low and dry flow zones and would not exceed the WLA for the flow condition in the stream.

4.3 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, and variability in point-source concentrations and discharge). An explicit MOS was calculated as 10 percent of the allowable load (TMDL) in each flow zone.

4.4 BASELINE CONDITIONS

Sample concentrations were multiplied by flow values to estimate current daily loading (in pounds per day). The 95th percentile of the range of these estimates in each flow zone was defined as the baseline daily load, shown in Table 4-2 as the "Current Load." Table 4-1 also presents the loading capacity (TMDL), LA, WLA, and MOS for each flow zone. Load reductions necessary for Crow Creek to meet the chronic selenium water-quality standard are also shown in Table 4-1 and are given in pounds per day and as a percentage of current load. Load reductions are required in all flow zones except the high flow zone (>29 cfs). Load reductions necessary to meet the criterion of 5 µg/L are 57 percent in the moist zone, 73 percent in the midrange-flow zone, 76 percent in the dry zone, and 56 percent in the low-flow zone, for an overall reduction of 60 percent of the total load. A majority of these load reductions will come from Frontier Refinery's reductions, because reducing the load from the refinery should reduce the in-stream loading in Crow Creek by approximately 61 percent in the low flow zone up to 83 percent in the moist and high flow zones, just by meeting their current permit.

Table 4-2. Crow Creek Selenium Total Maximum Daily Load

TMDL Component	Load per Flow Zone (lb/day)				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	>29 cfs	**29–10 cfs**	**10–6 cfs**	**6–4 cfs**	**<4 cfs**
LA	4.48	0.33	0.00	0.00	0.00
WLA	0.31	0.31	0.24	0.14	0.09
MOS	0.53	0.07	0.03	0.02	0.01
TMDL	**5.32**	**0.71**	**0.27**	**0.16**	**0.10**
Current Load[(a)]	2.99	1.64	0.98	0.67	0.23
Load Reduction	0.00	0.93	0.71	0.51	0.13
% Load Reduction	0%	57%	73%	76%	56%
Overall Reduction = 60%					

Note: TMDL for selenium is based on the chronic aquatic-life criterion (5 µg/L) and the recommended WYPDES selenium discharge limit (6.21 µg/L).

(a) The current load is the 95th percentile of the daily average selenium load for each flow zone.

5.0 SEASONALITY

Stream flows in Crow Creek display seasonal variation. Although selenium loads in the impaired reach do not vary seasonally because of the nature of the point-source discharge, selenium concentrations do vary seasonally because of the seasonal variation of stream flow. The USGS statistics for real-time monitoring Site 06755960 (upstream of the impaired reach) were summarized to determine streamflow seasonality. This site was chosen because of data availability and it was assumed that flow in the impaired reach (downstream of USGS Gauge 06755960) will follow similar seasonal trends, although peak flows will be higher because of urban runoff input from impervious areas between the USGS gauge and the impaired reach. The monthly average flow data from October 1993 to September 2010 were used to calculate the mean value for each month of monthly average flow data, which are shown in Figure 5-1. This figure shows that the highest flows occur during the late spring and early summer months of April, May, and June, with flows from July to March lower and relatively equal. The lowest average monthly flow occurred during September. Selenium concentrations vary inversely with flow because of dilution. Selenium concentration data, available from May through September, appear to follow the expected trend, as shown in Figure 5-2.

RSI-1939-11-021

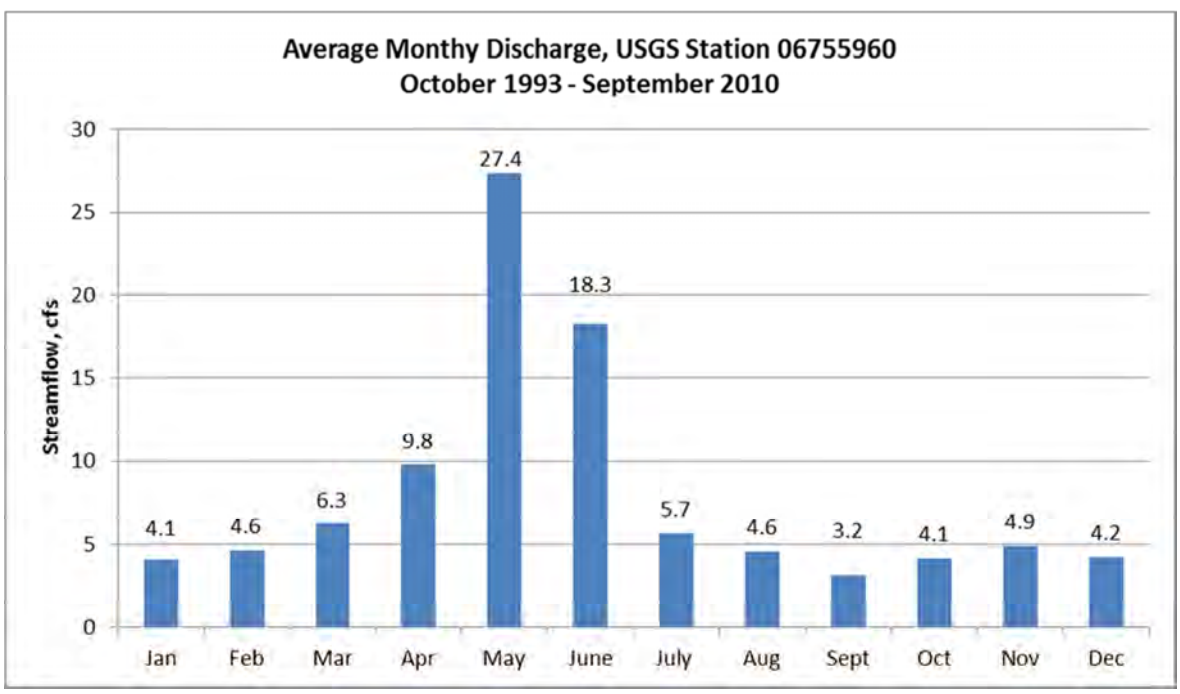
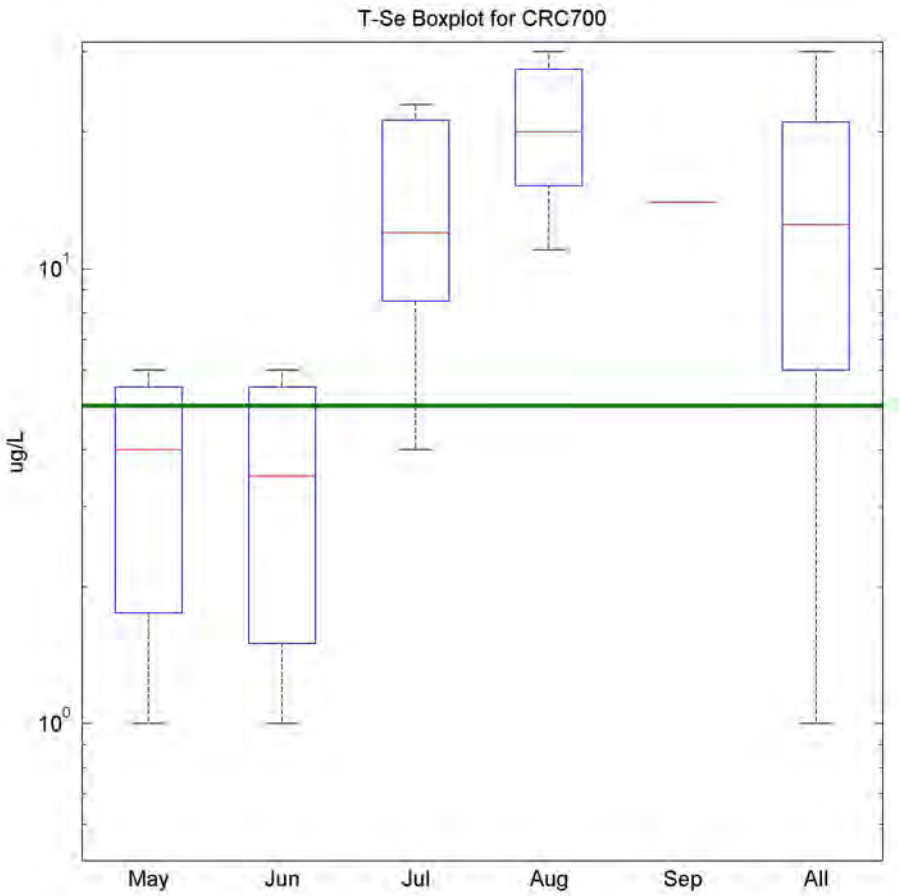


Figure 5-1. Monthly Mean Discharge at U.S. Geological Survey Gauge 06755960 From October 1993 to September 2010.



	May	Jun	Jul	Aug	Sep	All
n	3	4	9	9	1	26
Min	1	1	4	11	14	1
Max	6	6	23	30	14	30
q1	1.75	1.5	8.5	15.3	14	6
Median	4	3.5	12	20	14	12.5
q3	5.5	5.5	21.3	27.5	14	21
Mean	3.67	3.5	14	21.2	14	13.7
% Exceeded	33	25	89	100	100	77

Figure 5-2. Selenium Data at CRC700 by Month From May 2010 to September 2010 With the Chronic Standard Line Shown in Green.

6.0 PUBLIC PARTICIPATION

Efforts taken to facilitate public education, review, and comment during development of the Crow Creek selenium TMDL include presentations to local groups in the watershed on the findings of the assessment, a feature photograph in a local media publication, and a 30-day public notice period for public review of and comment on the draft TMDL document. TMDL findings have been communicated to Frontier Refinery, and a meeting between WDEQ, Frontier Refinery, and RESPEC was held May 14, 2012. All input, comments, responses, and suggestions from public meetings and the public notice period have been addressed or were taken into consideration in the development of the TMDL. The public notice was published in the *Casper Star Tribune* on August 19 and in the *Wyoming Tribune Eagle* on August 20. The public noticed document was available from August 17 to September 19 on the WDEQ website and at the Laramie County Public Library. Copies of the document were also sent to the Board of Public Utilities (Crow Creek WWTP) and to Frontier. The document was also made available through the WDEQ website. Throughout the project, monthly meetings took place between the WDEQ, the city of Cheyenne, the Laramie County Conservation District, and the TMDL consultants. Table 6-1 lists specific announcements and events. A photograph of a sampling site and field crew and a brief project description was published on the front page of the *Wyoming Tribune Eagle* on August 12, 2010.

Table 6-1. Crow Creek Public Outreach Announcements and Events

Date	Outreach Name	Description
08/19/2009	Crow Creek Watershed meeting/tour	Transition from watershed planning to TMDL development
09/08/2009	WDEQ press release on TMDLs	Reviewed and provided comments to Eric Hargett, WDEQ
10/20/2009	Wyoming Game and Fish projects for Crow Creek	Coordinated with Wyoming Game and Fish for delaying fish projects until after TMDL
02/2010	Newspaper insert on water quality	*Wyoming Tribune Eagle* and *Pine Bluffs Post*
02/2010	*Crow Creek Connection* (Winter 2010)	TMDL and water-quality update to Crow Creek Watershed Committee
04/29/2010	Open house announcement on website	Announcement provided by RESPEC
05/11/2010	Newspaper insert on water quality	Delivered supply of extra newspaper inserts to Laramie County Planning Office
06/15/2010	Public meeting hosted by RESPEC	Direct mailing to landowners on or near Crow Creek; meeting held at Laramie County Library
08/12/2010	*Wyoming Tribune Eagle* article	A photograph of a sampling site and field crew and a brief project description was published on the front page
09/21/2010	Crow Creek Watershed meeting/tour	Update on TMDL and projects with watershed committee members
01/18/2011	Stakeholder meeting hosted by RESPEC	Meeting held at Laramie County Library
02/2011	Newspaper insert on water quality	*Wyoming Tribune Eagle* and *Pine Bluffs Post*
05/14/2012	WDEQ, Frontier, RESPEC meeting	TMDL findings discussion
08/17/2012	TMDL Public Notice	Public notice of TMDL was published in the *Casper Star Tribune* and the *Wyoming Tribune Eagle*

7.0 MONITORING STRATEGY

During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDL. Stream water-quality monitoring will need to be performed upstream of the reach (Morrie Avenue Bridge) and at the endpoint of the reach (Hereford Reservoir #1). Selenium samples and flow data should be collected monthly at both points to determine required and achieved load reductions. Selenium concentration and discharge data for their respective effluent discharges should be collected by both Frontier Refinery and the Crow Creek WWTP and reported to WDEQ. These samples are being collected by both the Frontier Refinery and the Crow Creek WWTP and will be evaluated in the future during any TMDL reevaluations.

WDEQ may adjust the LAs and/or WLAs in this TMDL to account for new information or circumstances that develop during the implementation phase of the TMDL. WDEQ 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 the 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 LAs are practicable. WDEQ will notify EPA of any adjustments to this TMDL within 30 days of their adoption. Adjustment of the LAs and WLAs will only be made following an opportunity for public participation.

8.0 RESTORATION STRATEGY

Because of the point-source nature of the Crow Creek selenium impairment, reduction of Frontier Refinery's effluent selenium load is the primary restoration strategy that must be employed for compliance with the aquatic-life-designated use standards. A total point-source discharge from all sources combined of 0.31 lb/day in the highest two flow regimes, 0.24 in the midrange regime, 0.14 lb/day in the dry regime, and 0.09 lb/day in the low regime, will protect aquatic life by maintaining selenium concentrations below the 5 µg/L chronic criterion for the protection of aquatic life. Frontier Refinery will need to comply with their WYPDES permit, which allows 0.04 lb/day at Outfall 003. The remaining allowable point-source load (0.27 lb/day in the highest two regimes) is the potential point-source load from the Crow Creek WWTP, if the plant discharges at the design flow and the in-stream chronic criterion. However, Crow Creek WWTP currently has no WYPDES selenium discharge permit in place. In the future, a selenium limit will be implemented for the Crow Creek WWTP.

The load reductions needed to achieve the designated use standard are shown in Table 8-1. The point-source load reductions should reduce loads in all flow zones to meet the TMDL allowance. Furthermore, the required point-source reductions include an inherent MOS such that if the reductions were met, in-stream selenium concentrations would be less than the 5 µg/L chronic standard. Crow Creek would also benefit from reduction of nonpoint sources from Frontier Refinery with continued implementation of load reduction measures in and near the refinery area. Figure 8-1 breaks down the load reductions in Table 8-1 for the moist flow zone in terms of the TMDL allocations and the current point- and nonpoint-source contributions in the moist flow zone. Figure 8-2 shows the required TMDL reductions, including the MOS as well as the reductions that will result in Crow Creek selenium compliance for the purpose of protecting the aquatic life designated use.

Information is limited to determine exactly where the nonpoint-source loadings are originating, although it is possible that the long-term point-source discharge has contaminated much of the surrounding land and the shallow groundwater in the area, which could contribute to nonpoint-source discharges during times of stream recharge or shallow lateral flow. Reductions in point-source concentrations should reduce the nonpoint-source contributions over time. If the point-source loads are reduced to meet the concentration limits used to calculate the WLA, the TMDL will be met.

Table 8-1. Load Reductions Necessary to Meet the Total Maximum Daily Load

TMDL Component	Load per Flow Zone (lb/day)				
	High	**Moist**	**Midrange**	**Dry**	**Low**
Current Load	2.99	1.64	0.98	0.67	0.23
Allowable Load (TMDL)	5.32	0.71	0.27	0.16	0.10
MOS	0.53	0.07	0.03	0.02	0.01
Allowable Load (with MOS)	4.79	0.64	0.24	0.14	0.09
Needed TMDL Reductions	0	0.93	0.71	0.51	0.13
Needed TMDL Reductions, Including MOS	**0**	**1.00**	**0.74**	**0.53**	**0.14**
Current Point-Source Load	2.05	1.64	0.98	0.67	0.23
Point-Source Load Allowed	0.31	0.31	0.24	0.14	0.09
Needed Point-Source Load Reduction	**1.74**	**1.33**	**0.74**	**0.53**	**0.14**
Current Nonpoint-Source Load	0.94	0	0	0	0
Nonpoint-Source Load Allowed	4.48	0.33	0	0	0
Needed Nonpoint-Source Load Reduction	**0**	**0**	**0**	**0**	**0**

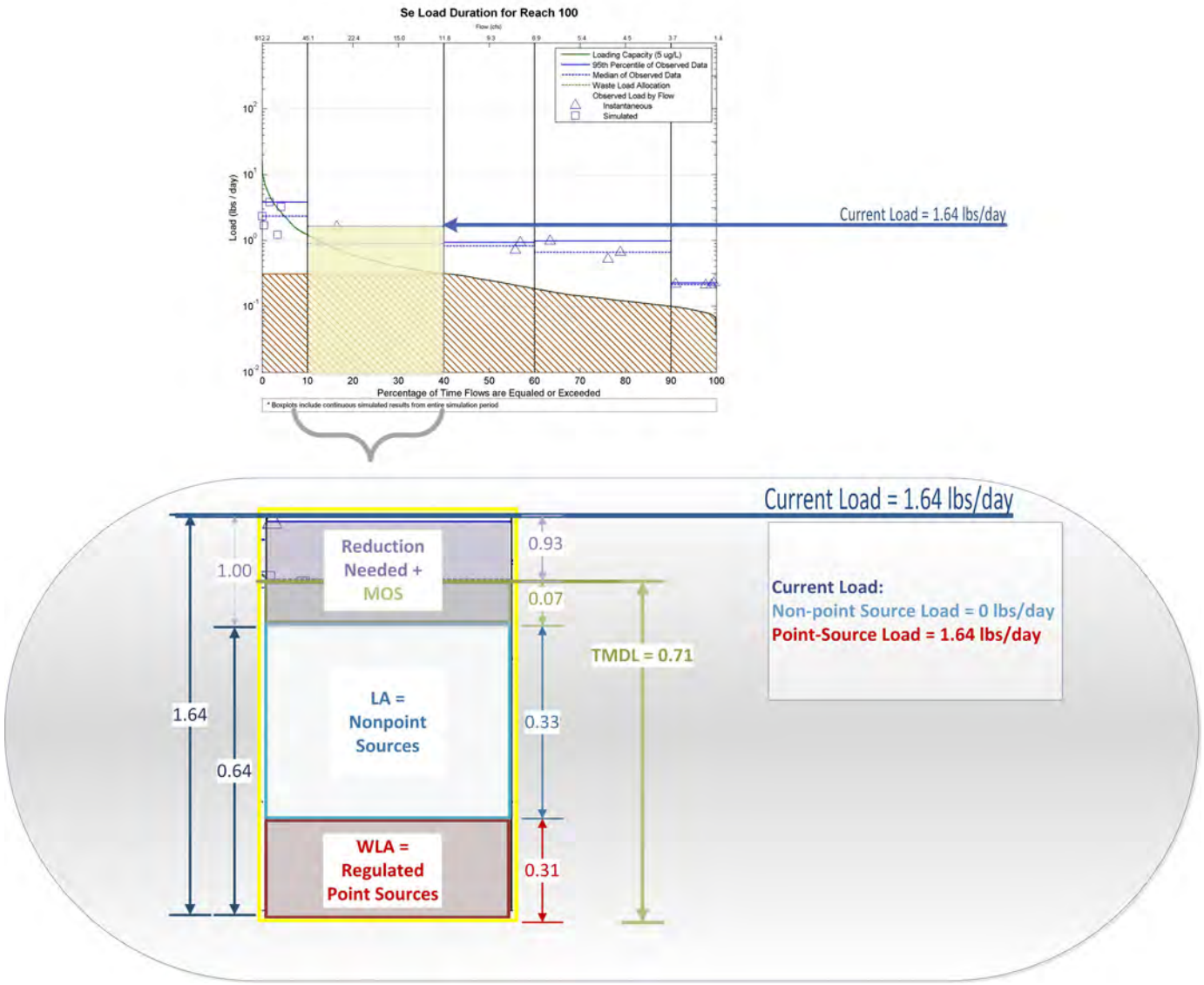


Figure 8-1. Current Load Definitions and Required Reductions for Moist Flow Zone.

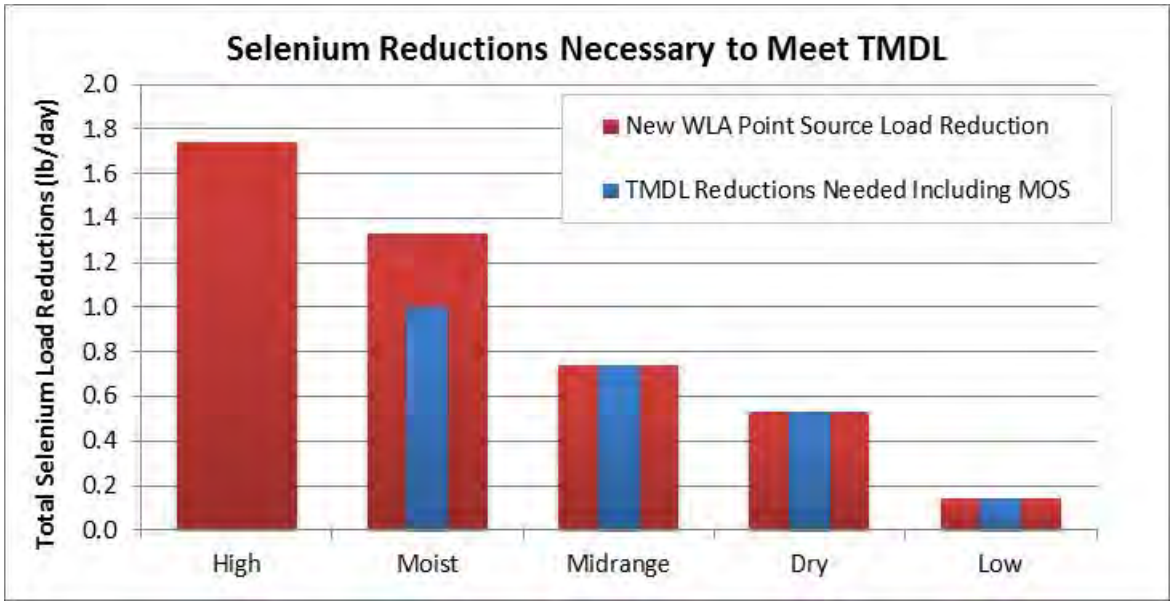


Figure 8-2. Necessary Selenium Total Maximum Daily Load Reductions Plotted With the New Wasteload Allocation Reductions and Nonpoint-Source Reductions Required to Bring Crow Creek Into Compliance.

9.0 REFERENCES

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APPENDIX A

DATA USED IN TOTAL MAXIMUM DAILY LOAD

Table A-1. Ambient Water Quality Sampling (Page 1 of 4)

Site	Sample Type	Characteristic	Date/Time	Result	Units	Comments	Base Versus Event	Detection Limit	Meets QA/QC Requirements
CRC600	g	Total Selenium	05/10/2010 12:40:00	4	ug/L	N/A	E	1	No
CRC600	g	Total Selenium	05/12/2010 13:16:00	4	ug/L	N/A	E	1	No
CRC600	g	Total Selenium	05/18/2010 20:28:00	ND	ug/L	Replicate	E	1	Yes
CRC600	g	Total Selenium	05/18/2010 20:33:00	ND	ug/L	Replicate	E	1	Yes
CRC600	g	Total Selenium	06/14/2010 14:30:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	06/21/2010 12:09:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	06/26/2010 16:48:00	ND	ug/L	N/A	E	1	Yes
CRC600	g	Total Selenium	06/28/2010 11:40:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	07/07/2010 11:25:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	07/09/2010 18:20:00	ND	ug/L	N/A	E	1	Yes
CRC600	c	Total Selenium	07/10/2010 10:35:00	ND	ug/L	N/A	E	1	Yes
CRC600	g	Total Selenium	07/12/2010 11:40:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	07/19/2010 16:45:00	ND	ug/L	N/A	E	1	Yes
CRC600	a	Total Selenium	07/19/2010 16:45:00	ND	ug/L	N/A	E	1	Yes
CRC600	c	Total Selenium	07/19/2010 23:47:00	ND	ug/L	N/A	E	1	Yes
CRC600	g	Total Selenium	07/21/2010 17:15:00	ND	ug/L	Replicate	E	1	Yes
CRC600	a	Total Selenium	07/21/2010 17:15:00	ND	ug/L	N/A	E	1	Yes
CRC600	g	Total Selenium	07/21/2010 17:20:00	ND	ug/L	Replicate	E	1	Yes
CRC600	c	Total Selenium	07/21/2010 22:37:00	ND	ug/L	N/A	E	1	Yes
CRC600	g	Total Selenium	08/03/2010 22:50:00	ND	ug/L	N/A	E	1	No
CRC600	a	Total Selenium	08/03/2010 22:50:00	ND	ug/L	N/A	E	1	No
CRC600	g	Total Selenium	08/04/2010 17:40:00	ND	ug/L	Replicate	E	1	No

Table A-1. Ambient Water Quality Sampling (Page 2 of 4)

Site	Sample Type	Characteristic	Date/Time	Result	Units	Comments	Base Versus Event	Detection Limit	Meets QA/QC Requirements
CRC600	a	Total Selenium	08/04/2010 17:40:00	ND	ug/L	N/A	E	1	No
CRC600	g	Total Selenium	08/04/2010 17:45:00	ND	ug/L	Replicate	E	1	No
CRC600	c	Total Selenium	08/05/2010 15:00:00	ND	ug/L	N/A	E	1	No
CRC600	g	Total Selenium	08/09/2010 11:05:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	08/16/2010 11:35:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	08/23/2010 11:50:00	ND	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	08/30/2010 11:35:00	1	ug/L	N/A	B	1	Yes
CRC600	g	Total Selenium	09/01/2010 11:21:00	5	ug/L	N/A	B	1	No
CRC700	g	Total Selenium	05/10/2010 01:02:00	6	ug/L	N/A	E	1	No
CRC700	g	Total Selenium	05/12/2010 14:30:00	4	ug/L	N/A	E	1	No
CRC700	g	Total Selenium	05/18/2010 21:03:00	ND	ug/L	N/A	E	1	Yes
CRC700	g	Total Selenium	06/14/2010 14:08:00	ND	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	06/21/2010 11:26:00	2	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	06/26/2010 17:05:00	5	ug/L	N/A	E	1	Yes
CRC700	g	Total Selenium	06/28/2010 10:55:00	6	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	07/07/2010 11:06:00	7	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	07/09/2010 18:35:00	12	ug/L	Replicate	E	1	Yes
CRC700	g	Total Selenium	07/09/2010 18:40:00	11	ug/L	Replicate	E	1	Yes
CRC700	c	Total Selenium	07/10/2010 10:55:00	4	ug/L	N/A	E	1	Yes
CRC700	g	Total Selenium	07/12/2010 11:04:00	9	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	07/19/2010 17:25:00	17	ug/L	N/A	E	1	Yes
CRC700	a	Total Selenium	07/21/2010 17:55:00	22	ug/L	N/A	E	1	Yes
CRC700	g	Total Selenium	07/21/2010 17:55:00	23	ug/L	N/A	E	1	Yes

Table A-1. Ambient Water Quality Sampling (Page 3 of 4)

Site	Sample Type	Characteristic	Date/Time	Result	Units	Comments	Base Versus Event	Detection Limit	Meets QA/QC Requirements
CRC700	c	Total Selenium	07/21/2010 23:21:00	21	ug/L	N/A	E	1	Yes
CRC700	g	Total Selenium	08/03/2010 23:20:00	27	ug/L	N/A	E	1	No
CRC700	a	Total Selenium	08/03/2010 23:20:00	27	ug/L	N/A	E	1	No
CRC700	g	Total Selenium	08/04/2010 18:25:00	29	ug/L	N/A	E	1	No
CRC700	a	Total Selenium	08/04/2010 18:25:00	30	ug/L	N/A	E	1	No
CRC700	c	Total Selenium	08/05/2010 15:00:00	18	ug/L	N/A	E	1	No
CRC700	g	Total Selenium	08/09/2010 10:40:00	20	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	08/16/2010 10:50:00	11	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	08/23/2010 10:50:00	13	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	08/30/2010 11:00:00	16	ug/L	N/A	B	1	Yes
CRC700	g	Total Selenium	09/01/2010 10:35:00	14	ug/L	N/A	B	1	No
STW500	g	Total Selenium	05/10/2010 12:49:00	4	ug/L	N/A	E	1	No
STW500	g	Total Selenium	05/12/2010 13:53:00	4	ug/L	N/A	E	1	No
STW500	g	Total Selenium	05/18/2010 20:40:00	ND	ug/L	N/A	E	1	Yes
STW500	g	Total Selenium	06/14/2010 14:24:00	ND	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	06/21/2010 11:50:00	2	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	06/26/2010 16:55:00	ND	ug/L	N/A	E	1	Yes
STW500	g	Total Selenium	06/28/2010 11:30:00	1	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	07/07/2010 11:19:00	1	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	07/09/2010 18:25:00	ND	ug/L	N/A	E	1	Yes
STW500	c	Total Selenium	07/10/2010 10:45:00	ND	ug/L	N/A	E	1	Yes
STW500	g	Total Selenium	07/12/2010 11:33:00	ND	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	07/19/2010 17:00:00	2	ug/L	N/A	E	1	Yes

Table A-1. Ambient Water Quality Sampling (Page 4 of 4)

Site	Sample Type	Characteristic	Date/Time	Result	Units	Comments	Base Versus Event	Detection Limit	Meets QA/QC Requirements
STW500	g	Total Selenium	07/21/2010 17:30:00	2	ug/L	N/A	E	1	Yes
STW500	g	Total Selenium	08/03/2010 23:00:00	ND	ug/L	N/A	E	1	No
STW500	g	Total Selenium	08/04/2010 18:10:00	ND	ug/L	N/A	E	1	No
STW500	g	Total Selenium	08/09/2010 11:00:00	ND	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	08/16/2010 11:20:00	1	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	08/23/2010 11:43:00	1	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	08/30/2010 11:23:00	2	ug/L	N/A	B	1	Yes
STW500	g	Total Selenium	09/01/2010 11:08:00	3	ug/L	N/A	B	1	No

Table A-2. Frontier 003 Estimated and Actual Effluent Data (Page 1 of 3)

Reporting Period Begin Date	Reporting Period End Date	Frontier Outfall 003 Monthly Average Flow (mgal/day)	Concentration at WWTP influent (ug/L)	Concentration at Outfall 003	Estimated Load (lb/day)	Actual Load (lb/day)
8/1/2006	8/31/2006	0.79	97.0	N/A	0.64	N/A
9/1/2006	9/30/2006	0.78	71.6	N/A	0.47	N/A
10/1/2006	10/31/2006	0.68	78.0	N/A	0.44	N/A
11/1/2006	11/30/2006	0.77	435.8	N/A	2.80	N/A
12/1/2006	12/31/2006	0.74	122.8	N/A	0.76	N/A
1/1/2007	1/31/2007	0.8	105.5	N/A	0.70	N/A
2/1/2007	2/28/2007	0.54	80.2	N/A	0.36	N/A
3/1/2007	3/31/2007	0.81	111.6	N/A	0.75	N/A
4/1/2007	4/30/2007	0.63	68.7	N/A	0.36	N/A
5/1/2007	5/31/2007	0.78	41.5	N/A	0.27	N/A
6/1/2007	6/30/2007	0.78	29.2	N/A	0.19	N/A
7/1/2007	7/31/2007	0.77	47.0	N/A	0.30	N/A
8/1/2007	8/31/2007	0.64	41.8	N/A	0.22	N/A
9/1/2007	9/30/2007	0.81	34.6	N/A	0.23	N/A
10/1/2007	10/31/2007	0.6	135.7	N/A	0.68	N/A
11/1/2007	11/30/2007	N/A	85.9	N/A	N/A	N/A
12/1/2007	12/31/2007	0.52	118.7	N/A	0.52	N/A
1/1/2008	1/31/2008	0.63	66.8	N/A	0.35	N/A
2/1/2008	2/29/2008	0.57	122.1	N/A	0.58	N/A
3/1/2008	3/31/2008	0.546	89.7	N/A	0.41	N/A

Table A-2. Frontier 003 Estimated and Actual Effluent Data (Page 2 of 3)

Reporting Period Begin Date	Reporting Period End Date	Frontier Outfall 003 Monthly Average Flow (mgal/day)	Concentration at WWTP influent (ug/L)	Concentration at Outfall 003	Estimated Load (lb/day)	Actual Load (lb/day)
4/1/2008	4/30/2008	0.56	116.2	N/A	0.54	N/A
5/1/2008	5/31/2008	0.48	98.0	N/A	0.39	N/A
6/1/2008	6/30/2008	0.62	166.0	N/A	0.86	N/A
7/1/2008	7/31/2008	0.64	209.2	N/A	1.12	N/A
8/1/2008	8/31/2008	0.78	177.5	N/A	1.16	N/A
9/1/2008	9/30/2008	0.69	231.6	N/A	1.33	N/A
10/1/2008	10/31/2008	0.54	264.7	N/A	1.19	N/A
11/1/2008	11/30/2008	N/A	190.0	N/A	N/A	N/A
12/1/2008	12/31/2008	0.81	153.7	N/A	1.04	N/A
1/1/2009	1/31/2009	0.81	126.4	N/A	0.85	N/A
2/1/2009	2/28/2009	N/A	175.1	N/A	N/A	N/A
3/1/2009	3/31/2009	N/A	221.0	N/A	N/A	N/A
4/1/2009	4/30/2009	N/A	137.1	N/A	N/A	N/A
5/1/2009	5/31/2009	N/A	116.0	N/A	N/A	N/A
6/1/2009	6/30/2009	N/A	59.2	N/A	N/A	N/A
7/1/2009	7/31/2009	0.54	50.6	N/A	0.23	N/A
8/1/2009	8/31/2009	0.71	44.5	N/A	0.26	N/A
9/1/2009	9/30/2009	0.74	80.9	N/A	0.50	N/A
10/1/2009	10/31/2009	0.6	147.2	N/A	0.74	N/A
11/1/2009	11/30/2009	0.531	192.7	N/A	0.85	N/A

Table A-2. Frontier 003 Estimated and Actual Effluent Data (Page 3 of 3)

Reporting Period Begin Date	Reporting Period End Date	Frontier Outfall 003 Monthly Average Flow (mgal/day)	Concentration at WWTP influent (ug/L)	Concentration at Outfall 003	Estimated Load (lb/day)	Actual Load (lb/day)
12/1/2009	12/31/2009	0.71	46.2	N/A	0.27	N/A
1/1/2010	1/31/2010	0.725	13.1	N/A	0.08	N/A
2/1/2010	2/28/2010	0.588	42.8	N/A	0.21	N/A
3/1/2010	3/31/2010	0.402	13.9	N/A	0.05	N/A
4/1/2010	4/30/2010	0.457	19.2	N/A	0.07	N/A
5/1/2010	5/31/2010	0.51	1.4	N/A	0.01	N/A
6/1/2010	6/30/2010	0.554	4.2	N/A	0.02	N/A
7/1/2010	7/31/2010	0.471	24.6	N/A	0.10	N/A
8/1/2010	8/31/2010	0.717	N/A	N/A	N/A	N/A
9/1/2010	9/30/2010	0.723	N/A	N/A	N/A	N/A
10/1/2010	10/31/2010	0.778	N/A	N/A	N/A	N/A
11/1/2010	11/30/2010	0.8	12.8	N/A	0.09	N/A
12/1/2010	12/31/2010	0.775	N/A	N/A	N/A	N/A
1/1/2011	1/31/2011	0.7	N/A	N/A	N/A	N/A
2/1/2011	2/28/2011	N/A	N/A	N/A	N/A	N/A
11/1/2011	11/30/2011	N/A	N/A	150.0	N/A	N/A
12/1/2011	12/31/2011	0.4	N/A	150.0	N/A	0.53
1/1/2012	1/31/2012	0.4	N/A	210.0	N/A	0.72
2/1/2012	2/29/2012	0.5	N/A	180.0	N/A	0.69
3/1/2012	3/31/2012	0.4	N/A	190.0	N/A	0.66

Table A-3. Crow Creek Wastewater Treatment Plant Effluent Data (Page 1 of 2)

Date	Flow (mgd)	Remarks	Conc (ug/L)	Load, (lb/d)
3/21/2001	N/A	<	5	N/A
8/23/2001	N/A	<	5	N/A
6/12/2002	N/A	<	5	N/A
9/17/2002	N/A	<	5	N/A
5/23/2003	N/A	<	5	N/A
9/23/2003	N/A	<	5	N/A
3/3/2004	N/A	<	5	N/A
8/11/2004	N/A	N/A	6	N/A
10/19/2004	N/A	N/A	17	N/A
6/15/2005	N/A	N/A	13	N/A
8/26/2005	N/A	<	4	N/A
10/28/2005	N/A	<	2	N/A
10/29/2005	N/A	<	5	N/A
11/1/2005	N/A	<	4	N/A
1/19/2006	3.846	<	2	0.06
3/22/2006	3.324	<	2	0.06
5/10/2006	3.061	<	2	0.05
11/29/2006	3.1	<	5	0.13
3/7/2007	3.628	N/A	2	0.06
5/23/2007	3.602	N/A	31	0.93
8/24/2007	3.612	<	1	0.03
9/6/2007	3.601	N/A	2	0.06
11/7/2007	3.76	N/A	4	0.13
3/12/2008	3.449	N/A	11	0.32
6/4/2008	4.522	N/A	7	0.26
9/10/2008	4.027	N/A	14	0.47
11/19/2008	3.502	N/A	5	0.15

Table A-3. Crow Creek Wastewater Treatment Plant Effluent Data (Page 2 of 2)

Date	Flow (mgd)	Remarks	Conc (ug/L)	Load, (lb/d)
2/4/2009	3.341	N/A	7	0.20
3/20/2009	3.69	N/A	29	0.89
4/29/2009	3.7	N/A	8	0.25
8/12/2009	3.126	<	5	0.13
10/21/2009	3.755	<	5	0.16
2/24/2010	2.779	<	3	0.07
6/23/2010	4.386	<	3	0.11
8/18/2010	3.558	<	3	0.09
11/12/2010	3.217	<	3	0.08

ENCLOSURE 2

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Selenium Total Maximum Daily Load for Crow Creek, Laramie County, Wyoming**
Submitted by:	**Kevin Hyatt, Wyoming Department of Environmental Quality**
Date Received:	**August 13, 2012**
Review Date:	**September 7, 2012**
Reviewer:	**Vern Berry, US Environmental Protection Agency**
Rough Draft / Public Notice / Final Draft?	**Public Notice**
Notes:	

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

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

Approval Notes to the 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 TMDL review elements identified in the following 8 sections:

1. Problem Description
   1.1. TMDL Document Submittal
   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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ 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 ☐ N/A

Summary: *The notification of the availability of the public notice draft TMDL document was submitted to EPA via an email received on August 31, 2012. The email includes the details of the public notice, explains how to obtain a copy of the TMDL, and requests the submittal of comments to WDEQ by September 18, 2012.*

Comments: *No comments.*

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.

Review Elements:

☒ 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:
Physical Setting and Listing History*:*
The impaired stream segment included in this TMDL document is Crow Creek from 0.5 miles below Morrie Avenue in Cheyenne downstream to Hereford Reservoir #1 (3.2 miles; WYSP101900090107_02). This impaired stream segment lies within the Crow sub-basin (HUC 10190009) in southeast Wyoming and is part of the larger South Platte River drainage basin. The impaired segment is located in Laramie County which covers a watershed area of approximately 17,500 acres. This segment of Crow Creek is listed as impaired for Selenium and is a high priority for TMDL development.

The Wyoming Surface Water Classification list, Table A, lists the classification for the Crow Creek segment addressed in this TMDL document as follows:

Class 2C – Crow Creek, WYSP101900090107_02

Impairment status*:*
The 2012 Wyoming Integrated Report identifies this segment of Crow Creek as not supporting the following designated uses:

Stream Segment	**Designated Use / Support Status**	**Impairment Cause**	**TMDL Priority**
Crow Creek WYSP101900090107_02	*Non-game fishery, Aquatic life other than fish / Not supporting*	*Selenium*	*High*
	Non-game fishery, Aquatic life other than fish / Not supporting	*Sediment*	*High*
	Recreation / Not supporting	*E. coli*	*High*

Comments: *The summary table on page i, as well as Table 1-1 on page 1, references the impairment status from the 2010 303(d) list. The TMDL needs to be written using the information from the most recently approved 303(d) list. The 2012 303(d) list says that the segment begins 0.7 miles below Morrie Avenue and the impaired segment length is 3.7 miles. The TMDL needs to be revised to include this information. Also, references to the 2010 303(d) list should be changed to the 2012 303(d) list.*

The TMDL document should also mention that the sediment and E. coli impairments in this segment will be addressed separately and include any current plans for addressing these additional impairments.

WDEQ Response: The 2012 Integrated Report was not complete at the initiation of this project and, therefore, this TMDL is written for segments in the 2010 Integrated Report [Wyoming Department of Environmental Quality, 2010]. This sentence was added to the document and this will not be changed.

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).

Review Elements:

☒ 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 identified sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> 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 Crow Creek stream segment addressed by this TMDL document is impaired based on selenium concentrations impacting the aquatic life uses. This stream segment is given a classification of Class 2C as defined by the WDEQ.*

> ***Class 2C -*** *Class 2C waters are those known to support or have the potential to support only nongame fish populations or spawning and nursery areas at least seasonally including their perennial tributaries and adjacent wetlands. Class 2C waters include all permanent and seasonal nongame fisheries and are considered "warm water". Uses designated on Class 2C waters include nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic value.*

Numeric criteria for selenium in Wyoming, Class 2C streams have been established and are presented in the excerpted Table 1-2 shown below. Discussion of additional applicable water quality standards for this stream segment can be found on pages 1 – 2 of the TMDL document.

Table 1-2. State Surface Water-Quality Standards for Crow Creek

Parameter	Aquatic Life Acute Value[a]	Aquatic Life Chronic Value[a]	Units
Selenium, total recoverable	**20**	**5**	**µg/L**
Selenium, dissolved	18.44	4.61	µg/L

(a) Acute value = 1-hour average concentration; chronic value = 4-day average concentration [Wyoming Department of Environmental Quality, 2007].

Comments: *Section 1.1, Clean Water Act Section 303(d) Listing Information, page 2, mentions using the 0.922 conversion factor to calculate the acute dissolved selenium criterion. Wyoming's water quality standards specifically mention using the conversion factor for the chronic criterion only. We suggest deleting the wording in this section that includes conversion of the acute criterion as well as the converted value shown in Table 1-2.*

WDEQ Response: As suggested, wording in this section that includes conversion of the acute criteria and the converted value shown in Table 1-2 was deleted.

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, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ 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 target for this TMDL is based on the numeric water quality standards for selenium that was established to protect the warm water aquatic life designated uses for the stream segment of Crow Creek above Hereford Reservoir #1. The selenium standards are expressed as total recoverable metal with units in micrograms per liter (ug/L) of the water sample. The selenium target for the impaired segment is based on the chronic selenium criterion and is proposed to be 5 ug/L. While chronic the standard is intended to be expressed as the 4-day average selenium concentration, the target for the stream segment was used to compare to values from single grab samples. This ensures that the reductions necessary to achieve the target will be protective of both the acute (1-hour average) and chronic (4-day average) standard.*

Comments: *The TMDL document lacks a clear water quality target value or values. The TMDL summary table (page i), lists "endpoints" or "threshold values" which seem to restate the applicable water quality standards. Section 1.1 (page 2), mentions comparing the sample concentrations to the chronic criterion. All TMDLs must include water quality targets that are used to determine the allowable loading capacity and as the basis for determining whether the implementation measures are successful in restoring the waterbody. We recommend adding a sentence or two that includes a clear statement of the water quality target(s) used in this TMDL.*

WDEQ Response: The document now states: "Thus, for the TMDL assessment, the TMDL target was based on 5 µg/L, making this assessment protective of both the acute and chronic criteria."

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 identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. 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.

Review Elements:

☐ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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: *The TMDL document includes the landuse breakdown for the entire Crow Creek watershed based on the 2001 National Land Cover Dataset (NLCD). In 2001, the dominant land use in watershed was grassland. Approximately 81 percent of the landuse in the watershed was herbaceous grassland, 5 percent was cultivated cropland, and the remaining 14 percent was developed space, barren, water or woods. For the sub-drainage contributing to the impaired stream segment the land use is primarily suburban, urban and industrial areas in and around the city of Cheyenne.*

Section 1.2, Watershed Characteristics, beginning on page 3, provides landuse /landcover information for Crow Creek, and Section 2.0, Significant Sources, provides the description of potential pollutant sources that contribute to the stream impairment.

Point source discharges, primarily from Frontier Refining, Inc. (permit number WY0000442) and the Crow Creek wastewater treatment plant (WWTP), are identified as the main contributors of selenium loading to the impaired stream segment.

Comments: *1) There appear to be other permitted point source discharges located in Cheyenne that are not included in the discussion of potential sources to the impaired stream segment (e.g., Lance Oil & Gas, Union Pacific Railroad, Robinson Brick, Cheyenne water treatment plant, Cheyenne MS4). If these point sources are not causing or contributing to the selenium impairment in Crow Creek, then the rationale for each needs to be included in the TMDL document. If a discharge contains even a low average concentration we recommend including a separate WLA for that discharge in the TMDL to provide legal coverage. A zero WLA for a discharge source implies a discharge concentration of zero.*

WDEQ Response: Text was added discussing additional permitted point-source discharges in the watershed. Based on best engineering judgment and the WDEQ Crow Creek Watershed study [Hargett, 2009], there is no reason to believe, nor is there evidence, that any of these permits contribute selenium to the impaired reach besides Frontier and the Crow Creek WWTP.

2) Based on the data discussion included in the TMDL document the Crow Creek WWTP discharge and the Cheyenne MS4 discharge contain selenium loads that cause or contribute to the stream impairment and need to be given separate WLAs.

WDEQ Response: Because the only MS4 evidenced to contribute selenium is Frontier, and the Frontier permit includes both the MS4 and Outfall 003, an additional MS4 allocation is not included.

3) The TMDL contains an assumption (pages 21 & 23) that the selenium concentration being discharged from Frontier outfall 003 is the same as the concentration being sent to the WWTP. It seems that enough data has been collected from both waste streams to make the comparison needed to verify this assumption. Has the data been analyzed to confirm the assumption?

WDEQ Response: Currently, Frontier does not do anything that would cause the two effluent streams to be different. This data analysis will not be completed.

4) Page 19 mentions that a pretreatment agreement was established between Frontier and the Crow Creek WWTP for the discharge being sent from Frontier to the WWTP. It would be helpful to include

some of the details of that agreement in order to understand why the concentrations in the effluent stream have not decreased.

WDEQ Response: Language on the pretreatment agreement has been removed.

5) If Frontier's current permit does not require them to collect selenium discharge data, why did they begin collecting daily maximum discharge data beginning in November 2011? It seems that the statements about Frontier's permit requirements on page 21, second paragraph, and page 23, first paragraph, are not in agreement – perhaps one of them needs to be revised.

WDEQ Response: Frontier was not required to collect selenium data until November 2011 for Outfall 003, but the WWTP did collect selenium data for the influent flows from Frontier. This was clarified in the document.

6) Does Frontier have a permit for stormwater discharge? If so, is there any selenium data available from that discharge? If Frontier has a stormwater permit then we recommend that the load allocated as refinery runoff should be allocated as an industrial stormwater WLA (separate from the outfall 003 WLA) for Frontier.

WDEQ Response: The following information was added to the document: The permit for Frontier includes both Outfall 003 and stormwater runoff sources and, therefore, a separate allocation was not given for the stormwater contribution from STW500. Similarly, based on best engineering judgment as well as the Crow Creek Watershed study [Hargett, 2009], there is no reason to believe, nor is there evidence, that any stormwater permits contribute selenium within the project area besides Frontier.

7) Is Frontier discharge data from outfall 003 available for months more recent than March 2012? If so, is that data consistent with the data provided in Figures 2-7 and 2-8? Given the uncertainties in the concentration being discharged from outfall 003 versus the concentration in the flow being routed to the WWTP, we recommend using more recent data in the final TMDL.

WDEQ Response: The data used in the TMDL are included in the appendices.

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ 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:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- 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…;
- 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);
- 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 impaired segment of Crow*

Creek describes how the selenium loads were derived in order to meet the applicable water quality standards.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach as described in Section 3.0 of the TMDL. To better correlate the relationship between the pollutant of concern and the hydrology of the Section 303(d) listed waterbody, a LDC was developed for the Crow Creek stream segment. Continuous stream flow values were collected at sampling location CRC700 (see Figure 1-6 in the TMDL document for a map of the monitoring location) from July 7, 2010 to September 6, 2010. This data was used to generate daily time-series stream flows using the HSPF modeling program. These simulated stream flow values were used in combination with the 5 ug/L TMDL target and the in-stream selenium data to create the LDC for the impaired segment of Crow Creek.

Observed in-stream selenium data, obtained from the monitoring station, was converted to pollutant loads by multiplying selenium concentrations by the mean daily flow and a conversion factor. These loads were plotted against the percent exceeded flow on the day of sample collection (see Figure 3-1 in the TMDL document). Points plotted above the 5 ug/L target curve exceeded the State water quality standard or TMDL target. Points plotted below the curve are meeting the State water quality standard of 5 ug/L.

The LDC represents a flow-variable TMDL target across the flow regimes shown in the TMDL document. For the Crow Creek segment covered by the TMDL, the LDC is a dynamic expression of the allowable daily load for any given daily flow. Loading capacities were derived from this approach for the listed stream segment at each flow regime. Table 4-1 shows the loading capacity load (i.e., TMDL load) for the impaired segment of Crow Creek.

Comments: *For purposes of this review, we assume that Sections 3.0 and 4.0 contain the information used to demonstrate the technical analysis used in development of the TMDL.*

1) *Section 3.1, Load Duration Curve Analysis, mentions collecting two months of continuous stream flow data at station CRC700. It includes a brief mention of using the HSPF model to generate daily time-series discharge data (i.e., daily average in-stream flows) that was calibrated with observed data. It is not clear from this information whether the "observed data" included any of the USGS flow data referenced in Section 1.3, Table 1-4. Was the USGS flow data used to calibrate the HSPF simulated flows? If so, it should be explained in the TMDL. If not, why not?*

WDEQ Response: The modeling period was from 1995 through 2010. The HSPF model was calibrated for an area that existed upstream and downstream of the selenium-impaired reach. All available observed discharge data (including USGS data) available during this time period was used to calibrate the HSPF simulated flows. The document now states: "Average daily time-series discharge results were generated using HSPF and calibrated to all observed discharge data available during the modeling period (1995 through 2010)."

2) *Section 3.2, Mass Balance Analysis, mentions the selenium load to the stream as: "for the most part" a combination of point-source loads and nonpoint-source loads from the Frontier*

Refinery." In other sections of the document it says the selenium loads are "primarily" from the two point sources, or that the upstream selenium loads are "negligible". While these qualifiers are true, the mass balance analysis, Figure 3-4, demonstrates that these other loads are large enough to warrant separate allocations in the TMDL loading analysis. The pie chart on page 30 shows that the load from the refinery is 70 percent of the total load, the load from the Crow Creek WWTP is 12 percent of the total load, the load from legacy contamination is 4 percent of the total load and the load from the single stormwater outfall is 1 percent of the total load. That leaves approximately 13 percent of the total load unaccounted for unless some of the percentages shown are in error. It seems that one part of the missing load is likely coming from additional stormwater outfalls from the City of Cheyenne. How many other stormwater outfalls discharge to Crow Creek upstream of the end of the impaired segment? Theoretically, each outfall could be contributing 1 percent of the total load which could add up to sizeable amount. Also, the upstream load while small is calculated as having a mean concentration of 1.33 ug/L at CRC600. We recommend that the total stormwater load from Cheyenne's MS4be given a separate WLA in the TMDL and that the upstream (background) load be calculated and included in the TMDL loading table.

WDEQ Response: The 13 percent was accounted for as Legacy Contamination. The document states that Legacy Contamination is calculated as CRC700 – Upstream Inputs, and this was incorrectly calculated in the previous version. Because there is no reason to believe that any portion of the Cheyenne MS4 except that associated with Frontier is contributing to the selenium impairment, and because the MS4 portion of the Frontier permit is encompassed in the 6.21 µg/L, the Cheyenne MS4 was not given a separate WLA. It is stated in the document's Quality Assurance Reporting Section that "When analyzing the current load and reductions needed to meet the TMDL, the full dataset was evaluated. While the results of some of the values seem to have some questions associated with them, there is no clear reason to believe these results are invalid. Including these values in the current load and reduction analysis ensures a more conservative TMDL." If the samples that did not meet QA/QC requirements would not have been included in the analysis, no samples at CRC600 would have been above the detection limit and, therefore, these concentrations are unknown but are between 0 µg/L and 1 µg/L. Data used in the analysis are shown in the appendices, and those samples that did not meet QA/QC requirements are flagged. It is evidenced that concentrations from upstream of CRC600 used to calculate loads are negligible when QA/QC of the samples is taken into consideration.

3) *Section 4.1, Waste Load Allocation, mentions that the WLA calculation for the Crow Creek WWTP is based on the assumption that the effluent concentration in the discharge to the stream will not exceed the in-stream chronic selenium criterion. This assumption seems to be unsupported by the discharge data from the WWTP (Figures 2-3, 2-4) and it appears that the pretreatment agreement with the refinery does not set limits on the concentration coming into the plant. Also, because the discharge permit for the WWTP does not have an effluent limitation for selenium we don't understand how the assumption that the effluent will meet the WQS is valid. We recommend that the WWTP be given a separate WLA in the TMDL.*

WDEQ Response: A table was added in Section 4.1 showing the distribution for the WLA between Crow Creek WWTP and Frontier.

4) *The technical analysis does not demonstrate whether the proposed reductions, as shown in Table 4-1 and 8-1, will meet the applicable selenium WQS which allows an exceedance based on a frequency of once every three years. One method to demonstrate that the standard will be met would be to reduce the loads in each flow regime by the percentages proposed in Table 4-1 and see how many exceedances remain. It may be necessary to reduce the loads in each flow zone by the maximum percent reduction (e.g., 76 percent) in order to ensure that the standards will be met at the required exceedance frequency. Because only two years of data were available during development of the TMDL it will be difficult to say for sure that the exceedance frequency can be met until additional data is collected.*

WDEQ Response: The document states that "reducing the load from the refinery should reduce the in-stream loading in Crow Creek by approximately 61 percent in the low flow zone up to 83 percent in the moist and high flow zones, just by meeting their current permit." Because there is an MOS subtracted from the TMDL to calculate the WLA, these reductions should be enough to meet the TMDL.

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…).

Review Elements:

☒ 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 Crow Creek TMDL data description and summary are included in Section 1.3, Summary of Available Selenium and Discharge Data. Recent water quality monitoring was conducted from by WDEQ in 2007 and 2008 at several sites along Crow Creek and in 2010 RESPEC collected 76 selenium samples from two Crow Creek sites. The data set also includes the in-stream flow record that was used, along with the TMDL target and the selenium data, to develop the load duration curve for the impaired segment of Crow Creek.*

Comments: *The selenium data that was used in the TMDL development and analysis should be provided as an appendix to the TMDL or made available in electronic format.*

WDEQ Response: Selenium data used in the TMDL development and analysis is available in the appendices.

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and 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 TMDL document describes the two main point sources that discharge directly to the impaired segment of Crow Creek. Those two point sources discharges are from the Frontier Refinery (permit number WY0000442) and the Crow Creek WWTP (permit number not provided). In addition, stormwater from the City of Cheyenne's MS4 discharges to Crow Creek and other point sources are located in Cheyenne but are not addressed. The Frontier Refinery is the only point source given a WLA in the TMDL.*

Comments: *As mentioned above in the Pollutant Source Analysis section and the TMDL Technical Analysis section the TMDL needs to include separate WLAs (e.g., in Table 4-1 with supporting calculations in the written text) for the WWTP, the MS4 and possibly the Frontier stormwater discharges.*

WDEQ Response: A table was added showing the separation between the WLA for Frontier and the Crow Creek WWTP. As previously mentioned, the Frontier permit encompasses both stormwater runoff and Outfall 003 and, therefore, the MS4 was not given a separate WLA.

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.

Review Elements:

☒ 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 the 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: *The TMDL document includes the landuse breakdown for the entire Crow Creek watershed based on the 2001 National Land Cover Dataset (NLCD). In 2001, the dominant land use in watershed was grassland. Approximately 81 percent of the landuse in the watershed was herbaceous grassland, 5 percent was cultivated cropland, and the remaining 14 percent was developed space, barren, water or woods. For the sub-drainage contributing to the impaired stream segment the land use is primarily suburban, urban and industrial areas in and around the city of Cheyenne.*

Section 1.2, Watershed Characteristics, beginning on page 3, provides landuse/ landcover information for Crow Creek, and Section 2.0, Significant Sources, provides the description of potential pollutant sources that contribute to the stream impairment. These sections explain why the selenium loads were allocated mainly to point sources in the low, dry and midrange flow zones. In the moist and high flow zones a portion of the selenium loading was allocated to nonpoint sources in the watershed. Because there are no known natural geologic sources of selenium in the project area and selenium loads upstream of the impaired reach are very small, it is assumed that historical or legacy contamination from the Frontier Refinery in the form of alluvial groundwater contamination, stormwater runoff, and erosion of contaminated soils is the primary nonpoint source of selenium in the assessment area.

Comments: *Section 4.2, Load Allocation, mentions that there is not enough loading capacity available in the "two" lowest flow regimes to provide any allocation to nonpoint sources (i.e., zero LA). This*

statement does not seem to match the allocations shown in Tables 3-1 and 4-1 or Figure 3-3. Table 3-1 and Figure 3-3 seem to indicate that the point source load is 100 percent of the allocation in all except the highest flow regime. Whereas Table 4-1 seems to indicate that the loading capacity in the moist flow regime can be allocated to both LA and WLA and that the "three" lowest flow regimes have a zero LA. Please reconcile the statement in Section 4.2 with the tables and figure cited above and revise the information as needed to be consistent between the tables.

We recommend that the "Overall Reduction = 29%" be deleted from the bottom of Table 4-1. By averaging the 0% load reduction needed in the high flow regime, with the reductions needed in the moist, midrange, dry and low flow regimes, it give the misleading impression that the average load reduction is fairly low. Whereas in practice the worst case or critical condition, as shown by the reduction needed during the dry flow conditions, is what should be used when developing the load reduction strategies necessary to meet the water quality standards.

WDEQ Response: Table 3-1 and Figure 3-3 show the makeup of current loads and do not address load allocations. The word "two" was changed to "three" in Section 4.2 to represent the three flow regimes without available loading capacity.

The math was rechecked for the overall flow-weighted reduction, and the overall reduction was calculated to be 60%. This number was changed in the text and in the table.

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).

Review Elements:

☒ 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 Crow Creek TMDL document includes an explicit MOS for the listed segment of the stream. The MOS was derived by calculating 10 percent of the loading capacity. The explicit MOS for each flow regime of the impaired segment of Crow Creek is included in Table 4-1 of the TMDL document.*

Comments*: No comments.*

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.

Review Elements:

☒ 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*: Stream flows in Crow Creek are typically highest in spring and early summer and lowest in late fall and winter. Selenium loads in the impaired reach do not vary seasonally because the two identified point sources discharge continuously. Based on the load duration curve and the calculated load reductions needed, the critical flow period appears to occur during the dry flow conditions when the greatest difference exists between the allowable load and the current load.*

Comments*: No comments.*

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.

Review Elements:

☒ 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 TMDL document includes a summary of the public participation process. It describes the opportunities the public had to be involved in the TMDL development process. Table 6-1 provides a list of the public outreach events that have occurred. The draft TMDL document was posted on WDEQ's website, and a public notice for comment was published in local newspapers.*

Comments: *Section 6.0, Public comment, contains several blanks that appear to be placeholders that were to be filled in prior to making it available to comment. These blanks should be filled in prior to finalizing the TMDL. The final TMDL should also include a summary of the significant comments received during the development of the TMDL along with the State's responses.*

WDEQ Response: Placeholders were filled in regarding public comment.

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.

Review Elements:

☐ 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: *During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDL. Stream water-quality monitoring will need to be performed upstream of the reach (Morrie Avenue Bridge) and at the endpoint of the reach (Hereford Reservoir #1). Selenium samples and flow data should be collected monthly at both points to determine required and achieved load reductions. Selenium concentration and discharge data for their respective effluent discharges should be collected by both Frontier Refinery and the Crow Creek WWTP and reported to WDEQ.*

Comments: *There seems to be a significant amount of uncertainty related to: 1) the selenium concentration and load being sent to the WWTP from Frontier Refinery; 2) the selenium concentration and load being discharged from the WWTP to Crow Creek; 3) the total selenium load from Cheyenne's MS4; and 4) the ability for Crow Creek to assimilate the loads from the Frontier Refinery and Crow Creek WWTP discharges during low flow conditions (i.e., below 7Q10 flow) as mentioned in Section 4.1. We recommend developing a more detailed monitoring plan and schedule to address these uncertainties so that revisions can be made to the TMDL, as needed, during the 5 year review. The monitoring plan can be developed separately from the TMDL document.*

WDEQ Response: The following sentence was added to the monitoring strategy: "These samples are being collected by both the Frontier Refinery and the Crow Creek WWTP and will be evaluated in the future during any TMDL reevaluations."

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.

Review Elements:

☐ 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 Frontier Refinery and the Crow Creek WWTP discharges contribute most of the selenium load to the impaired stream segment. Frontier's permit includes selenium limitations that go into effect on September 1, 2015. The Crow Creek WWTP's permit currently does not have any discharge limitations for selenium.*

Comments: *As previously mentioned in comments above the Crow Creek WWTP should be given a separate WLA in the TMDL. WLAs for continuously discharging facilities are typically implemented during the next permit renewal in the form of an effluent limit unless it can be demonstrated that there is no reasonable potential to cause or contribute to a water quality standard violation.*

WDEQ Response: A table was added showing the separation between the WLA for Frontier and the Crow Creek WWTP.

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.

Review Elements:

☒ 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 TMDL document for the listed segment of the Crow Creek includes daily loads expressed as pounds per day of selenium. The daily TMDL loads are included in the TMDL section (i.e., Section 4.0, Table 4-1), of the document.*

Comments: *No comments.*