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CROW CREEK WATERSHED

TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION PLAN

Topical Report RSI-2281

prepared for

Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building 4-W
122 West 25th Street
Cheyenne, Wyoming 82002

October 2013

RESPEC
CONSULTING & SERVICES

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by

Cindie M. McCutcheon
Megan P. Burke
Adam J. Rutz
Cory S. Foreman

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

prepared for

Wyoming Department of Environmental Quality
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1.0 CROW CREEK WATERSHED TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION PLAN

The purpose of this implementation plan is to recommend best management practices (BMPs) that would reduce *E. coli* and sediment loading to Crow Creek and its tributaries from point and nonpoint sources to achieve the load allocations (LAs) and waste load allocation (WLAs) described by Foreman et al. [2013] and by RESPEC and Ayres Associates [2013]. Total Maximum Daily Load (TMDL) implementation plans are based on an adaptive approach that emphasizes making continued progress toward achieving TMDL milestones and load reductions while using new data and information to reduce uncertainty, modify implementation measures, and evaluate priority areas. This plan summarizes past conservation accomplishments and recommends implementation actions that can assist residents, landowners, and stakeholders in the Crow Creek Watershed TMDL project area in attaining water-quality standards in the impaired waterbodies. Private, local, state, and federal partnership efforts should continue to support and promote the implementation of management measures while additional water-quality monitoring is conducted to guide watershed plan revisions and assess adaptive implementation activities.

The plan builds on past conservation accomplishments in the Crow Creek Watershed project area and complements water-quality efforts by the following organizations:

- City of Cheyenne
- Laramie County Conservation District (LCCD)
- Wyoming Association of Conservation Districts (WACD)
- Wyoming Water Development Commission (WWDC)
- Wyoming Department of Environmental Quality (WDEQ)
- Francis E. Warren Airforce Base (F.E. Warren AFB)
- Natural Resources Conservation Service (NRCS)
- U.S. Forest Service (USFS)
- Bureau of Land Management (BLM).

This implementation plan incorporates the strategies, goals, and objectives of the *Wyoming Nonpoint Source Management Plan* [Wyoming Department of Environmental Quality, 2013a] and addresses the U.S. Environmental Protection Agency's (EPA's) Nine Key Elements as outlined in the WDEQ's *319 Program Guidance Item No. 12: Components of a Watershed-Based Plan* [Wyoming Department of Environmental Quality, 2011]. Table 1-1 displays these nine key elements and their corresponding locations within this implementation plan.

Table 1-1. Sections of the Crow Creek Watershed Total Maximum Daily Load Implementation Plan and Total Maximum Daily Load Report That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning

EPA's Nine Key Elements Plan	Applicable Section of the TMDLs and TMDL Implementation Plan
1. Identification of **causes of impairment and pollutant sources** or groups of similar sources that need to be controlled to achieve needed load reductions and any other goals identified in the watershed plan.	Significant Sources of TMDL Reports TMDL and Allocation of TMDL Reports 1.4 Source Assessment 1.6 Priority Areas for TMDL Implementation
2. Estimate of the **load reductions expected from management measures.**	1.6 Priority Areas for TMDL Implementation 1.7 Recommended BMPs by Land Use
3. Description of the **BMPs** that will need to be implemented to **achieve load reductions** in element 2 and a description of the **critical areas** in which those measures will be needed to implement this plan.	1.6 Priority Areas for TMDL Implementation 1.7 Recommended BMPs by Land Use 1.8 Point Sources 1.9 Past and Current BMPs 1.10 Recommended BMPs
4. Estimate of the amounts of **technical and financial assistance needed**, associated **costs**, and/or the **sources and authorities** that will be relied on to implement these plans.	1.14 Sources of Technical and Financial Assistance
5. Any **information, education, and public participation component** used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint-source management measures that will be implemented.	1.11 Information, Education, and Outreach
6. **Schedule** for implementing the nonpoint-source management measures identified in this plan that is reasonably expeditious.	1.12 Schedule and Milestones for TMDL Implementation
7. A description of **interim measurable milestones** for determining whether nonpoint-source management measures or other control actions are being implemented.	1.12 Schedule and Milestones for TMDL Implementation
8. A set of **criteria** that can be used **to determine whether loading reductions are being achieved** over time and substantial progress is being made toward attaining water-quality standards, and if not, the **criteria for determining whether the Watershed Management Plan needs to be revised**.	1.15 Criteria for TMDL Implementation Goal Achievement
9. A **monitoring component to evaluate the effectiveness of the implementation efforts** over time, measured against the criteria established under element 8.	Monitoring Strategy of the TMDL Reports 1.13 Monitoring BMP Effectiveness

This plan is not intended to identify which specific BMPs or remediation actions should be included in certain discharge permits, ordinances, stormwater pollution prevention plans (SWPPPs), or conservation plans but, rather, provide an adaptive implementation approach with suggested structural and nonstructural BMPs necessary to address the point and nonpoint sources of *E. coli* and sediment. Because the magnitude of required reductions was found to be much greater for *E. coli* than for sediment, and because many of the practices recommended to reduce *E. coli* loading would simultaneously reduce sediment loading, the recommendations put forth in this plan focus primarily on BMPs that will help achieve the necessary *E. coli* load reductions. For the purposes of this plan, BMPs refer to structural and nonstructural actions or measures installed or implemented to reduce the delivery of *E. coli* bacteria and sediment to waterbodies in the Crow Creek Watershed TMDL project area. Sources of available funding and technical assistance for, and associated estimated costs of, these BMPs are included in this section to provide landowners, residents, stakeholders, community leaders, and public agencies some perspective on the technical and economic demands of implementing these TMDLs.

1.1 CROW CREEK WATERSHED TOTAL MAXIMUM DAILY LOAD PROJECT AREA

For the purposes of this implementation plan, the impaired reaches for the *E. coli* TMDL and the sediment TMDL are illustrated in Figures 1-1 and 1-2, respectively. The project area, which is the same for both TMDLs, contains the contributing area for the impaired waterbodies that exist in the Crow Creek Watershed downstream of the confluence of North Fork and Middle Fork Crow Creek and the Wyoming/Colorado border. The Crow Creek Watershed (Hydrologic Unit Code [HUC] 10190009) is located in Laramie County in the southeastern part of Wyoming. The headwaters of Crow Creek originate in Albany County. The project area begins approximately 8.5 miles west of Cheyenne, Wyoming. Crow Creek flows east to southeast to its confluence with the South Platte River in Colorado.

A summary of the Crow Creek project area's land cover characteristics was completed using the 2001 National Land Cover Dataset (NLCD). The NLCD is a 16-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]. The Crow Creek project area comprises suburban, urban, industrial, and grazing areas in and around the city of Cheyenne. Above and below the project area, land use is primarily characterized by dryland farming, irrigated farming, industry, livestock grazing, and small housing developments. As seen in Figure 1-3, approximately 81 percent of the Crow Creek Watershed project area consists of rangeland. The remaining 19 percent of the Crow Creek Watershed project area consists of 11 percent urban, 5 percent croplands, and 3 percent of other various small land-use types. Cheyenne is the only large urban area in the watershed with a population of 60,000 and an incorporated area of approximately 45 square miles. Much of the cropland (88 percent) is located downstream of the urban area.

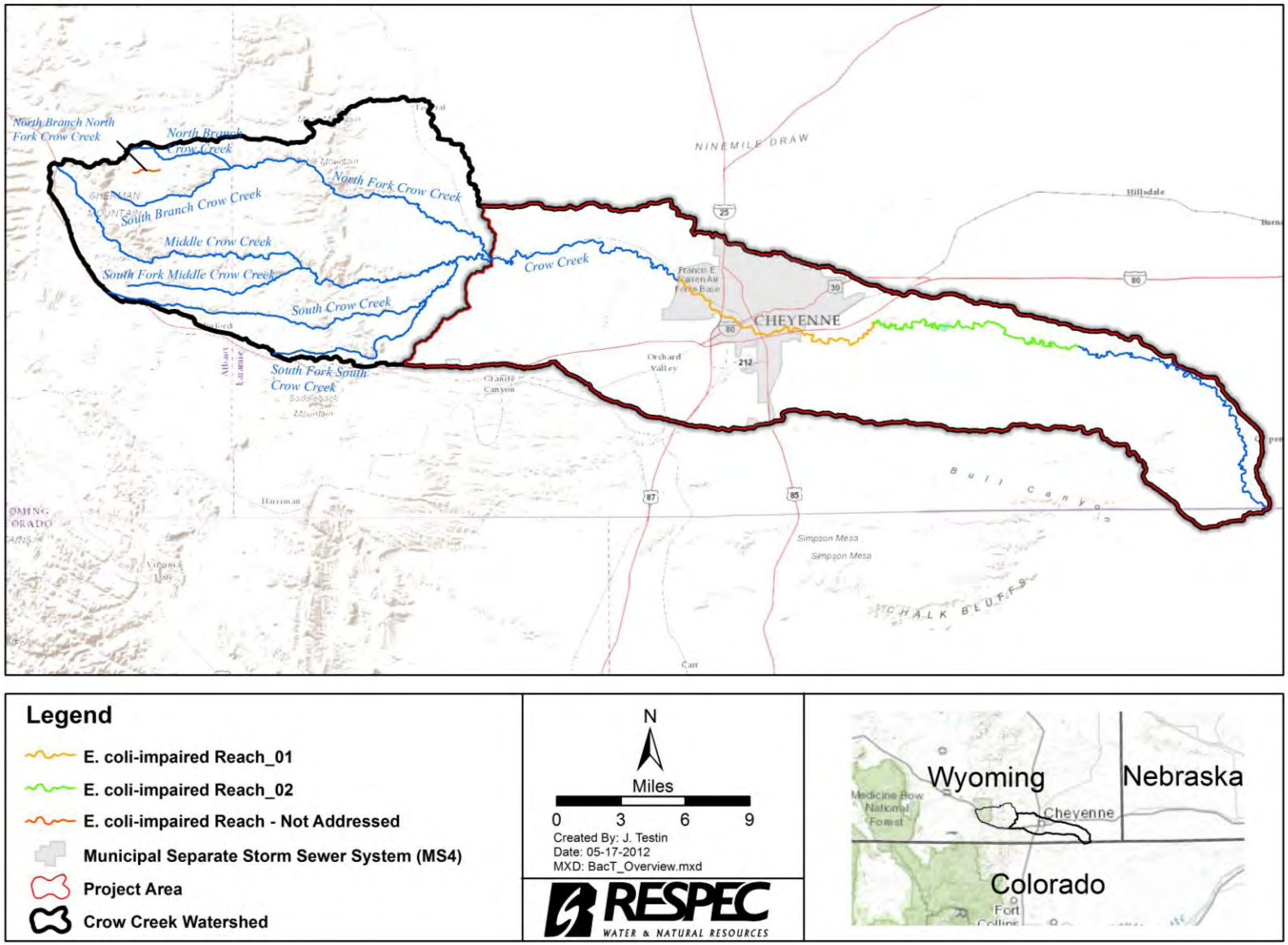

Figure 1-1. Crow Creek Watershed Project Area and *E. coli*-Impaired Reaches.

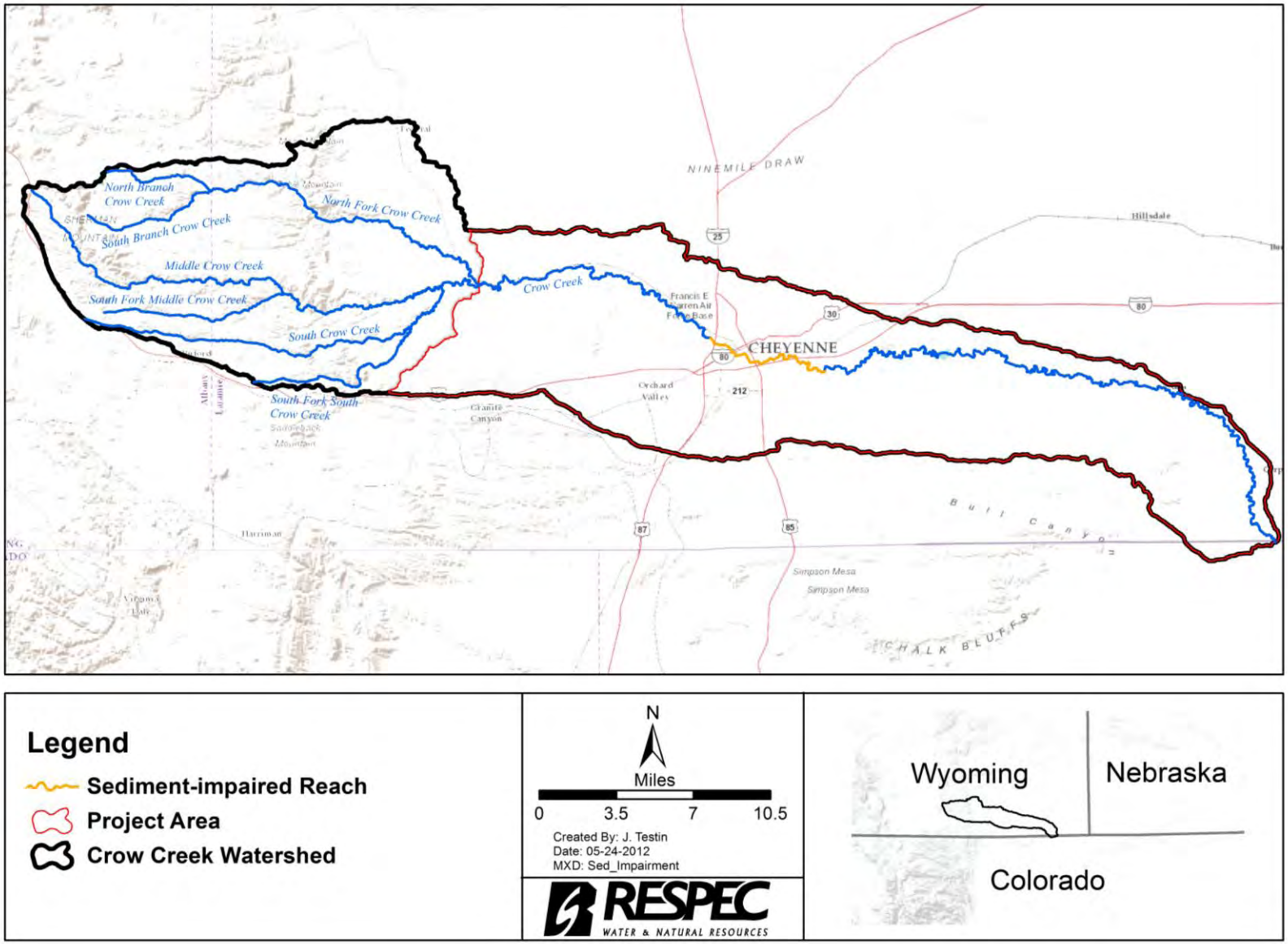

Figure 1-2. Crow Creek Watershed Project Area and Sediment-Impaired Reach.

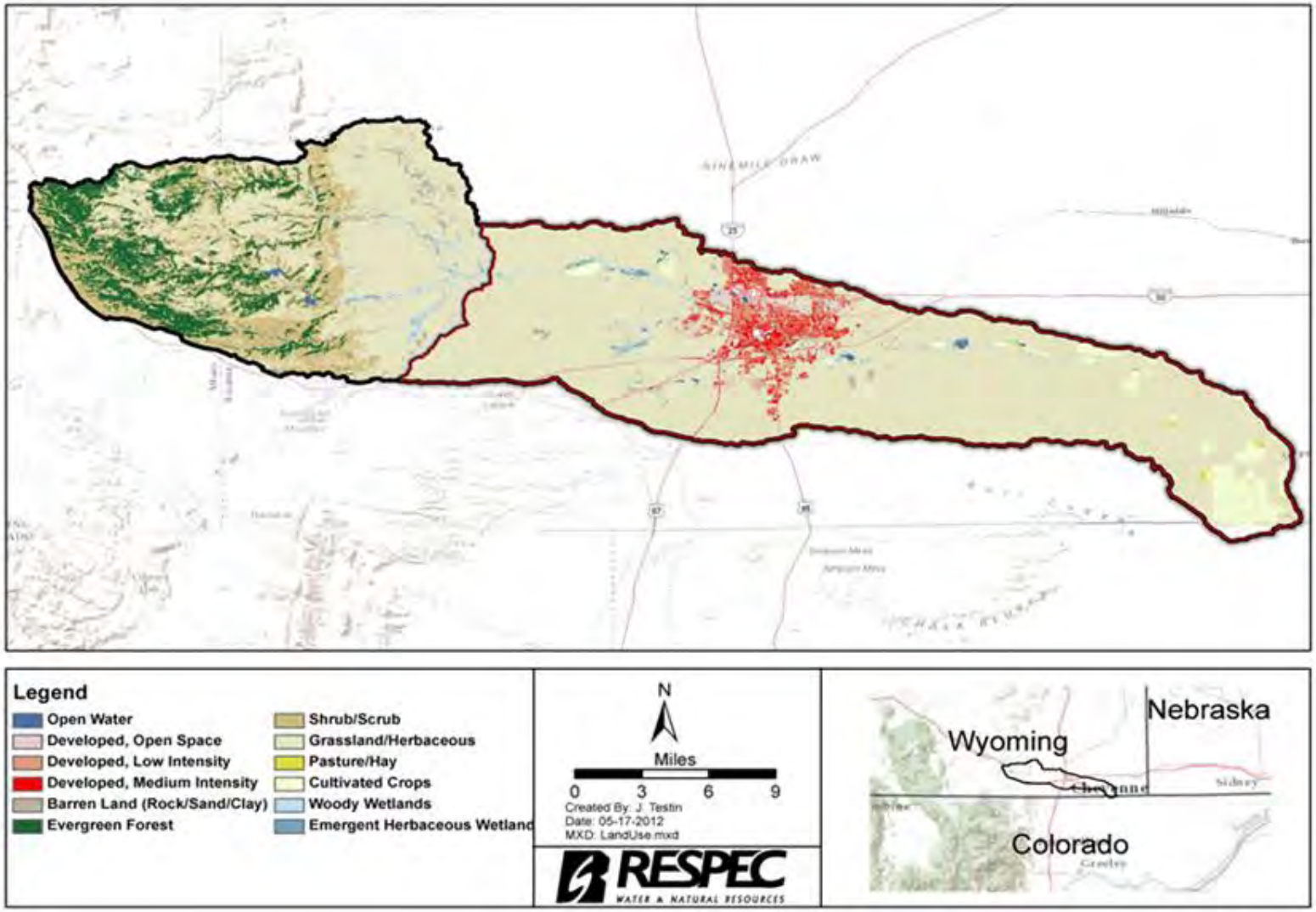

Figure 1-3. Predominant Land Cover/Land Use of the Crow Creek Watershed Project Area.

Precipitation varies throughout the state of Wyoming but is generally consistent throughout the Crow Creek project area. Typical annual precipitation is between 13 and 17 inches per year [Natural Resources Conservation Service, 2011]. 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, and the primary source is surface water. Irrigation waters from surface sources in the watershed are 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 are also in the watershed [Wyoming Water Development Commission, 2010].

The bedrock geology of the Crow Creek project area is displayed in Figure 1-4. The project area is located 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 from the Laramie Mountains beginning after the mountains were uplifted as part of the Laramie orogeny approximately 60 million years ago. 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. Two small areas of exposed Tertiary White River Formation exist at the east and west ends of the watershed. The White River Formation is dominantly composed of pale-to-white, tuffaceous claystone and sandstone. Thin, Quaternary alluvial and gravel deposits are also present at the easternmost edge of the watershed.

1.2 WATERSHED PLANNING

Many conservation accomplishments have been achieved within the Crow Creek project area, which can be attributed to the local planning and implementation efforts of a proactive, local, conservation district working together with community, state, and federal partners. In 1998, the WDEQ listed one reach segment of Crow Creek, extending from the city of Cheyenne to the Wyoming/Colorado border, as impaired by fecal coliform and placed this reach segment on the Clean Water Act (CWA) Section 303(d) list of waters not meeting CWA goals. It was this listing that led the LCCD, through a joint effort with the WACD and the NRCS, to develop the Crow Creek Watershed Plan (CCWP). The LCCD held a public meeting in February 1999 to determine if there was local support for a watershed planning effort and to solicit volunteers. Volunteers from local government, the F.E. Warren AFB, private industry, and farming and ranching operations as well as local citizens came together in a local watershed planning effort and formed the Watershed Steering Committee. The LCCD sponsored the planning effort, and the NRCS and other agencies provided technical assistance.

The LCCD carried out a water-quality monitoring program for Crow Creek, which was supplemented by additional monitoring efforts provided by the WDEQ, the U.S. Geological

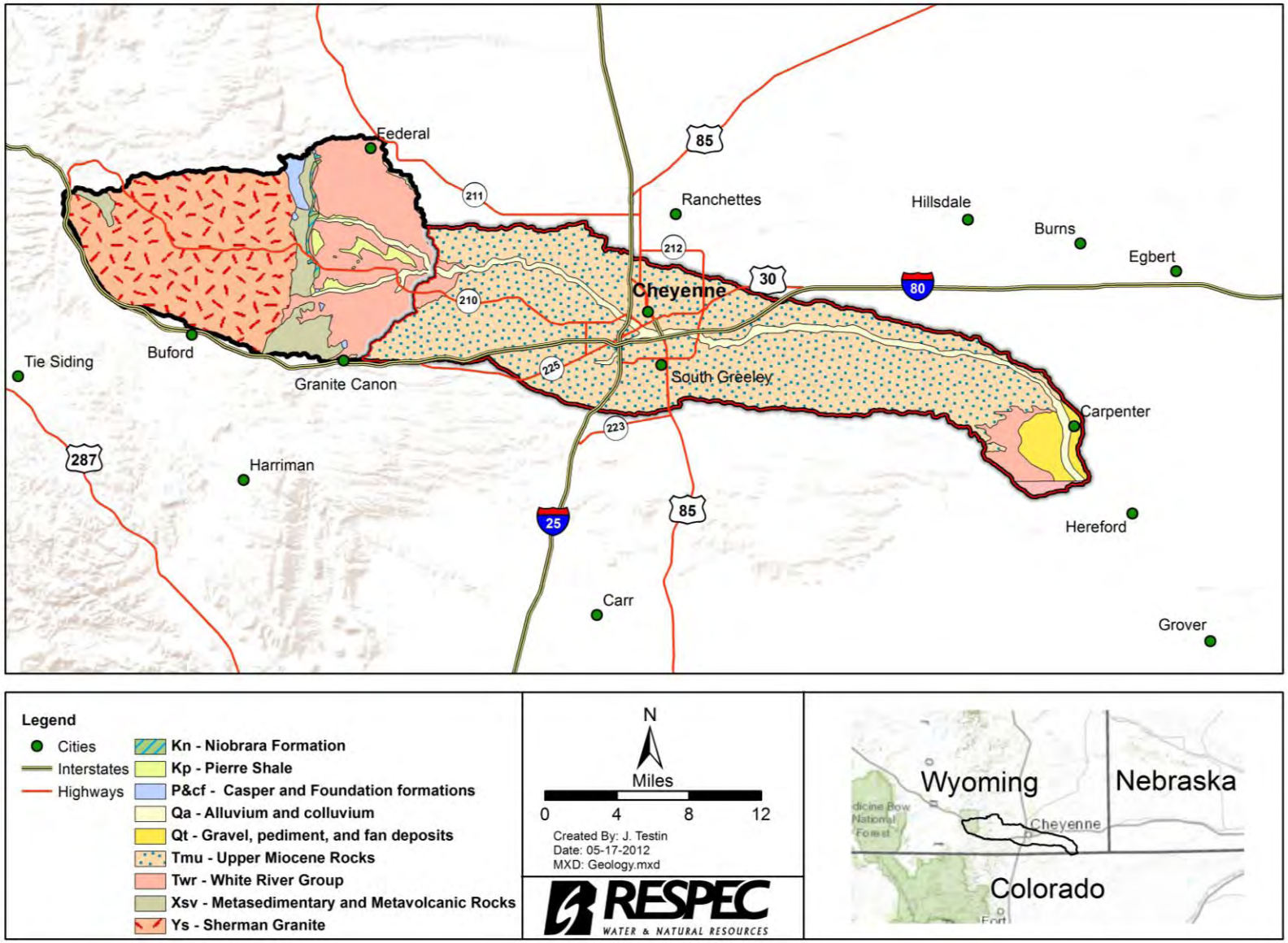

Figure 1-4. Geologic Setting of the Crow Creek Watershed Project Area.

Survey (USGS), and F.E. Warren AFB. The LCCD's monitoring program revealed that fecal coliform concentrations exceed the standard within the city of Cheyenne and near the community of Carpenter. Contamination was attributed to both point-source and nonpoint-source pollution. The CCWP was completed in February 2008 [Laramie County Conservation District, 2008]. The plan did not, nor was it intended to, provide a complete solution to the present impairments, but it did provide some initial direction and identify tools to improve Crow Creek's water quality. A key accomplishment of the CCWP was establishing open communication between agencies at the local, state, and federal levels.

In addition to the CCWP, watershed management and rehabilitation plans were developed as part of the WWDC Level I studies for Cheyenne and North Cheyenne. These studies were primarily conducted to better manage water supplies and recommend methods for improvement. Table 1-2 provides a list of WWDC Level I Study watershed management and rehabilitation plans that were developed in the Crow Creek Watershed to address land and water resource concerns.

Table 1-2. Wyoming Water Development Commission Level I Studies

WWDC Watershed Level I Study	Consultant	Year	Location
North Cheyenne Master Plan	States West Water Resources Corporation	1993	Laramie County
Cheyenne Water Supply Master Plan	Black & Veatch	1994	Laramie County

1.3 PAST PROJECTS IN THE CROW CREEK WATERSHED

Numerous conservation measures and BMPs have been completed and are currently being implemented within the Crow Creek Watershed. These projects have been made possible through the Wyoming Nonpoint Source Program, EPA Section 319 grant funding, NRCS programs, and the WWDC.

1.3.1 Wyoming Nonpoint-Source Program Grants

Past conservation projects in the Crow Creek Watershed have shown progress toward meeting TMDL goals. These projects have been sponsored by the city of Cheyenne and the LCCD. Specifically, past projects have included public outreach through community information and education programs, various studies to assess water-quality conditions, developing monitoring plans, and implementing BMPs outlined in the CCWP. Table 1-3 lists completed WDEQ grants, local sponsors, and expenditures applied and implemented within the Crow Creek Watershed.

1.3.2 Wyoming Water Development Commission Projects

Numerous projects in the Crow Creek Watershed have been completed through the WWDC water development programs. These projects were included in this implementation plan to provide some insight regarding the level of effort that has been dedicated to developing water resources within the project area. WWDC projects are listed in Table 1-4.

Table 1-3. Wyoming Department of Environmental Quality Nonpoint-Source Grants Implemented in the Crow Creek Watershed (Page 1 of 2)

Applied Conservation Projects	Project Number	Completion Date	Project Lead	EPA Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Lower Dry Creek Wetland Restoration Project	NPS2010C	2011	LCCD	149,457	204,728	Constructed wetlands features to passively treat stormwater runoff with the goal of reducing sediment, nutrients, hydrocarbons, and heavy metals entering lower Dry Creek and ultimately entering Crow Creek. Postconstruction monitoring to assess project effectiveness.
Reduction of Nonpoint-Source Pollution through Conservation Education	ON014	1995	LCCD	25,564	25,564	Provided technical assistance and education for reducing nonpoint pollution through improved management.
BMPs through Conservation Education	ON028	1998	LCCD	48,485	32,803	Provided technical assistance and education for reducing nonpoint pollution through improved management.
BMPs through Conservation Education	ON037	1999	LCCD	38,229	28,157	Provided technical assistance and education for reducing nonpoint pollution through improved management.
BMPs through Conservation Education	ON079	2000	LCCD	45,521	30,232	Provided technical assistance and education for reducing nonpoint pollution through improved management.
BMPs through Conservation Education	ON094	1998	LCCD	48,485	32,803	Provided technical assistance and education for reducing nonpoint pollution through improved management.
Crow Creek Water-Quality Improvement Project	ON108	1998	LCCD	48,485	32,803	Constructed artificial wetland to treat urban runoff, strategically planted trees and shrubs to catch sediment and absorb nutrients from the water, and installed infiltration trenches to filter contaminants that otherwise would be carried by the drainage into the creek.
Implementing BMPs in the Crow Creek Watershed	ON10E	2005	LCCD	252,432	170,122	Implemented BMPs recommended in the CCWP including a constructed wetland, 5 grazing demos, urban demonstrations, riparian buffers, riparian fencing, storm drain stenciling, classroom presentations, tours and seminars, public outreach, and a study of Cheyenne's storm drain system.

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Table 1-3. Wyoming Department of Environmental Quality Nonpoint-Source Grants Implemented in the Crow Creek Watershed (Page 2 of 2)

Applied Conservation Projects	Project Number	Completion Date	Project Lead	EPA Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Crow Creek/Dry Creek Water-Quality Improvements Project	ON20D	2003	City of Cheyenne	8,500	5,705	291 trees and shrubs were ordered and planted by the city staff with help from volunteers. Maintenance included watering, fencing, and weeding provided by city crews. Planted grass in areas along and above the creek banks to hold the soil down to prevent erosion and subsequent water pollution. The trees and shrubs provide a "filter" for trapping sediment and absorbing nutrients from urban runoff and shade to better water quality by cooling the water.
Addressing New Listings in the Crow Creek Watershed	ON409	2008	LCCD	113,532	113,310	Implemented BMPs recommended in the CCWP including a constructed wetland, 6 grazing demos, 3 urban BMPs, 2 riparian buffers, riparian fencing, 8 spring developments, 10 off-site water developments, 82 classroom presentations, 30 group presentations, public events, and the implementation of a pet waste cleanup program. A monitoring program was developed and conducted to asses project effectiveness.
Crow Creek Wetlands: Dry Creek and Clear Creek Constructed Wetlands	ON60C	2009	City of Cheyenne	188,945	134,658	The Dry Creek Wetland feature was constructed in conjunction with the city of Cheyenne's Dry Creek–Sheridan Reach Flood Control Project. The wetland feature was constructed at the lower end of the city's flood bypass project. The Clear Creek Wetland is an extension of an existing wetland.
Crow Creek Public Awareness	ON803	2011	LCCD	32,003	24,149	The LLCD implemented public outreach and education items as recommended in the CCWP and the amendment to the plan. Actions in this project encompassed both urban water-quality concerns in the Cheyenne area of Crow Creek as well as recreational outreach in the headwaters.
Crow Creek Watershed Project	ON899	2001	LCCD	42,381	28,006	Developed the CCWP
Historic Sunrise Creamery Rain Gardens	ON902	2012	LCCD	6,590	5,413	Created multiple rain gardens on the project site to demonstrate BMPs in southeast Wyoming. A handout was created and distributed to help property owners design and plant their own rain gardens.

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Table 1-4. Wyoming Water Development Commission Projects (Not Including Level I) in the Crow Creek Watershed

Level	Project	Consultant	Year Completed
III	Cheyenne Southern Pipeline	Burns & McDonnell	Ongoing
II	Cheyenne Belvoir Ranch Groundwater Level II	Lidstone & Associates Inc.	2012
I/II	Managed Aquifer Recharge Storage and Recovery Project	Lytle Water Solutions LLC	2011
N/A[a]	Belvoir Ranch High Plains Aquifer–White River Study Project Report	TriHydro Corporation	2009
III	Cheyenne's Granite Dam Spillway Improvements	States West Water Resources Corporation	2009
II	Cheyenne/Laramie County Water Service Area Level II Study East Cheyenne Water Master Plan	AVI Professional Corporation	2008
II	Cheyenne/Laramie County Water Service Area Level II Study Archer Special Use District Water Master Plan	AVI Professional Corporation	2008
N/A	Cheyenne Raw Water Supply #2	States West Water Resources Corporation	2008
III	Cheyenne Supply Pipeline	Black & Veatch	2008
II	Cheyenne Belvoir Ranch Level II Study	JR Engineering	2007
II	Belvoir Wells No. 5 & 6 Pumping Test Report Aquifer Impact	JR Engineering	2007
III	Cheyenne South Crow Dam Water Supply	States West Water Resources Corporation	2004
II	Cheyenne Hydropower Feasibility Study Level II	ECI	2003
I/II	Cheyenne South Crow Diversion Project Phase II	ECI	2000
N/A	Cheyenne Raw Water Supply	States West Water Resources Corporation	1999
III	Cheyenne Stage I Rehabilitation	CH2M Hill	1999
II	Cheyenne Aquifer Storage Recovery Test Project	CH2M Hill	1998
N/A	Cheyenne Well Rehabilitation	Bearlodge Ltd.	1997
II	Cheyenne Water Supply Level II Project	States West Water Resources Corporation	1996
II	Pipeline Corrosion Investigation Cheyenne Water Supply Level II Project	States West Water Resources Corporation	1996
II	Cheyenne Water Supply Level II Project	States West Water Resources Corporation	1996
III	Cheyenne King II Storage Facility	Black & Veatch	1996
III	Cheyenne Upper North Crow Reservoir	States West Water Resources	1995
I	Cheyenne Water Supply Master Plan Level I	Black & Veatch	1994
II	Cheyenne Stage I Pipeline Rehabilitation Level II Feasibility Study	Civil Engineering Professionals Inc.	1993
I	North Cheyenne Master Plan Level I Project	States West Water Resources Corporation	1993
II	Crow Creek Groundwater Recharge Project Level II Evaluation	States West Water Resources Corporation	1990
II	Cheyenne North Crow Rehabilitation Project Level II	ESA Geotechnical Consultants	1989
II	Crow Creek Flood Control Project Level II Evaluation	States West Water Resources Corporation	1989
III	Cheyenne Water (Stage II)	Banner Associates, Inc.	1987
I/II	Surface Water Hydrology of the Crow Creek Drainage Basin Laramie and Albany Counties, Wyoming	WWDC	1986
II	Cheyenne Water Project Feasibility Study	Water Resources Research Institute	1979

(a) N/A = Not Available.

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1.4 SOURCE ASSESSMENT

The bacteria TMDL addressed two impaired segments and the sediment TMDL addressed one impaired segment. These segments are classified as 2AB and 2C streams [Wyoming Department of Environmental Quality, 2010]. Designated uses and causes of impairment for these listings are provided in Table 1-5. Additional information on the segmentation of Crow Creek is provided in Appendix A. The reaches upstream and downstream of the bacteria-impaired segments do exceed water-quality standards and would also benefit from implementation practices throughout the project area discussed in this implementation plan.

Table 1-5. Crow Creek 303(d)-Impaired Waterbodies Summary

Impairment I.D.	Class	Location	Uses	Cause	Source	List Date	TMDL Integrated Report Year
WYSP101900090107_03	2AB/2C	From Happy Jack Road downstream to Hereford Reservoir #1	Aquatic Life	Sediment	Stormwater	2010	2010
WYSP101900090107_01	2AB	From Dry Creek upstream an undetermined distance above Roundtop Road	Recreation	*E. coli*	Stormwater	1996	2008
WYSP101900090203_01	2C	From Dry Creek an undetermined distance downstream	Recreation	*E. coli*	Unknown	1996	2008

The *E. coli*-impaired reaches have a primary contact recreation designated use. For primary contact recreation waterbodies, the summer recreation season criterion, applicable from May 1 through September 30, is defined as a geometric mean of 126 organisms per 100 milliliters (org/100 mL) based on a minimum of five samples collected during separate 24-hour periods for any 30-day period. From October 1 through April 30, the winter recreation season criteria apply, which are defined as a geometric mean of 630 org/100 mL based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period.

The sediment-impaired reach has an aquatic life designated use. The WDEQ water-quality standards [Wyoming Department of Environmental Quality, 2007] for sediment state:

> *In Wyoming surface waters, substances attributable to, or influenced by, the activities of man that will settle to form sludge, bank, or bottom deposits shall not be present in quantities that could result in significant aesthetic degradation; significant degradation of habitat for aquatic life; or adversely affect public water supplies, agricultural or industrial water use, plant life, or wildlife.*

The aquatic life impairment for this TMDL was attributed to excess bottom deposits, or specifically excess bedload, by the WDEQ. For this reason, the sediment criteria for the impairment on this segment of Crow Creek was based on sediment transport capacity within Crow Creek.

Both bacteria and sediment sources in the Crow Creek Watershed project area are factors of point-source and nonpoint-source pollution. Wyoming Pollutant Discharge Elimination System (WYPDES) point sources include wastewater treatment plants (WWTPs) and the Municipal Separate Storm Sewer System (MS4). Nonpoint sources related to bacteria consist primarily of sources that can be transported through wash-off as well as septic systems and direct defecation from livestock and wildlife outside of permitted areas. Nonpoint sources of sediment consist of sources that contribute sediment through wash-off outside of the permitted areas.

A hydrologic modeling program called **Hydrologic Simulation Program–Fortran** (**HSPF**) was developed to determine the contribution of *E. coli* and sediment loadings from identified sources in the project area and evaluate different scenarios of implementing BMPs to control these sources. The Crow Creek drainage basin was represented in the model using 39 subwatersheds and one boundary condition, which represented the confluence of North Fork Crow Creek and Middle Fork Crow Creek.

For the Crow Creek TMDL project, bacteria and sediment loading from nonpoint-source runoff were proposed to be simulated by using event mean concentrations (EMCs) in the project area. EMCs use discharge data from a storm event to composite samples based on flow volume to create a single sample concentration. An EMC inherently accounts for the physical, biological, and chemical processes that occur over and in land segments; thus, it eliminates using another model to simulate those processes and predict a concentration or load to receiving waterbodies. Furthermore, using EMCs allows for a more streamlined, conceptual framework that can potentially reduce compounded uncertainty from the inclusion of multiple models. Results from the composite sample analysis yielded land use-specific EMCs for bacteria and sediment. EMCs were applied to the surface outflow, and fate and transport processes in the reaches were then simulated throughout the system to predict bacteria and sediment loadings.

1.4.1 *E. coli* Source Assessment

Source assessment modeling results for the two *E. coli* bacteria-impaired reaches on Crow Creek were summarized using the following categories: urban areas (including cross-connection contributions), nonurban areas, and point sources. A time series of average daily loads was created by source from the model application occurring on each date from 1995 through the end of September 2010. Figure 1-5 indicates that, throughout the summer recreation season, source load allocation at the endpoint of Reach_01 (identified in Figure 1-1) is mainly attributed to loadings from the MS4 (94.8 percent). Approximately 49 percent of this load occurs in response to runoff from the MS4, and the remaining 51 percent of this load comes from cross connections between the stormwater sewer and the sanitary sewer. Cross connections are a potential cause

of loading during both baseflows and events. Cross-connection loads were estimated in the **HSPF** model using differences between concentrations (both baseflow and event) from basins that have known cross connections and those that have no known cross connections. Nonurban areas and point sources contributed small percentages of loading at 5 percent and 0.2 percent, respectively. Figure 1-6 represents load contributions throughout the summer recreation season to Reach_02 on Crow Creek (identified in Figure 1-1). Modeling results have shown that 97 percent of the loading to Reach_02 originates from Reach_01, and the remaining 3 percent originates from local sources. Although a majority of the load is coming from the urbanized area, there are exceedances of the *E. coli* concentration standards in Crow Creek upstream of the urbanized area; therefore, implementation needs to occur on both urban and nonurban areas.

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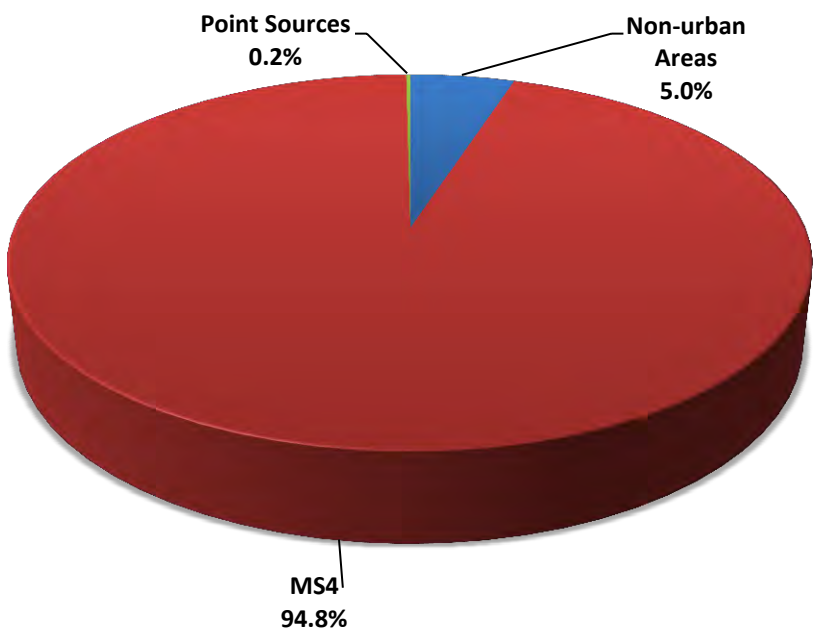

Figure 1-5. Load-Based *E. coli* Source Assessment Modeling Results for Reach_01 of Crow Creek During the Recreation Season.

1.4.2 Sediment Source Assessment

Source assessment modeling results for the sediment-impaired reach on Crow Creek were summarized by urban and nonurban areas. Urban areas include the MS4 as well as construction, industrial, and mining activities occurring in the watershed. Nonurban areas include areas outside of the MS4. A time series of average daily loads by source from the model application occurring on each date from 1995 through the end of September 2010 was created. Figure 1-7 displays corresponding urban and nonurban sediment loads at the endpoint of the impaired reach. Source contributions were observed to originate primarily from urban areas (95 percent).

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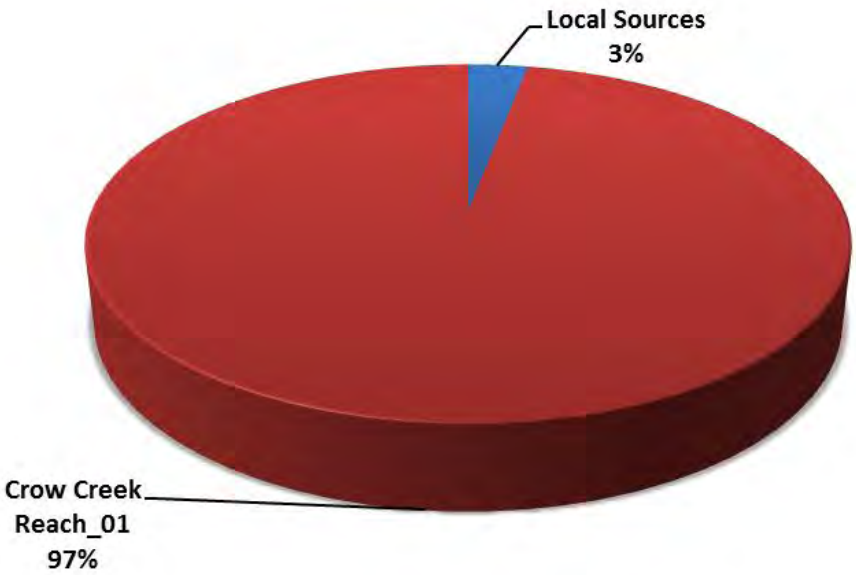

Figure 1-6. Load-Based *E. coli* Source Assessment Modeling Results for Reach_02 of Crow Creek During the Recreation Season.

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Figure 1-7. Load-Based Source Assessment Modeling Results for the Sediment-Impaired Reach on Crow Creek During the Recreation Season.

1.5 TOTAL MAXIMUM DAILY LOAD-REQUIRED LOAD REDUCTIONS

TMDL-required load reductions were derived from the Load Duration Curve (LDC) approach, which results in a flow-variable target that considers the entire flow regime of the summer recreation season (May 1 through September 30) and the entire flow regime of the winter recreation season (October 1 through April 30). To aid in interpreting and implementing each TMDL, the TMDL and 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), as per guidance provided by the U.S. EPA [2007].

1.5.1 Required *E. coli* Load Reductions

TMDL load reductions needed in the Crow Creek Watershed's two *E. coli*-impaired reaches are shown in Table 1-6. In Reach_01, reductions are required in all flow zones during the summer recreation season. The greatest load reductions are required in the upper flow zones for Reach_01 through the urbanized area where loads are the highest. In Reach_02, reductions are required in all flow zones during the summer recreation season as well. No load reductions are required during the winter recreation season for either reach. The flow-weighted percent reductions for all flow zones combined, that are required to meet the TMDL based on the summer recreation water-quality criterion, were 74 percent in Reach_01 and 47 percent in Reach_02.

1.5.2 Required Sediment Load Reductions

TMDL load reductions needed in the Crow Creek Watershed's sediment-impaired reach are shown in Table 1-7. Reductions are required in the midrange and dry flow zones. The flow-weighted percent reduction for all flow zones combined required to meet the TMDL is 11 percent. The 11 percent load supply reduction should help the stream adjust toward the desired geomorphic conditions without a substantial risk of destabilizing the system and causing channel transformation, excessive bank and bed erosion, and other (undesirable) geomorphic and habitat impacts.

1.6 PRIORITY AREAS FOR TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION

Priority areas are those that significantly contribute to exceedances of the water-quality standards. The **HSPF** model was used to identify priority areas for BMP implementation. The *E. coli* and sediment source assessments both indicated that, although agricultural sources are present, urban sources have far higher contributions in comparison. Therefore, the urbanized area would be the primary priority area for implementing BMPs that positively impact both *E. coli* and sediment supply.

Table 1-6. Required *E. coli* Load Reductions Based on the Summer Recreation Season Criterion for Crow Creek Reach_01 and Reach_02

Reach_01	Flow Zone				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	> 106 cfs	**106–53 cfs**	**53–45 cfs**	**45–37 cfs**	**< 37 cfs**
TMDL (mpn[(a)] × 10^9/day)	750	308	163	139	114
Current Load (mpn × 10^9/day)	3,635	1,571	284	213	198
Load Reduction (mpn × 10^9/day)	2,885	1,263	121	74	84
% Load Reduction	79	80	43	35	42
Reach_01 Overall Reduction Required = 74%					
Reach_02	**Flow Zone**				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	> 84 cfs	**84–28 cfs**	**28–20 cfs**	**20–11 cfs**	**< 11 cfs**
TMDL (mpn ×10^9/day)	717	238	85	59	33
Current Load (mpn × 10^9/day)	1,236	557	113	87	46
Load Reduction (mpn × 10^9/day)	519	319	28	28	13
% Load Reduction	42	57	25	31	29
Reach_02 Overall Reduction Required = 47%					

(a) mpn = most probable number.

Table 1-7. Required Sediment Load Reductions Based on the Summer Recreation Season Criterion for Sediment-Impaired Reach on Crow Creek

Sediment-Impaired Reach	Flow Zone				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	> 435 cfs	**248–126 cfs**	**126–86 cfs**	**86–47 cfs**	**< 47 cfs**
TMDL (tons/day)	229	106	52	24	17
Current Load (tons/day)	216	91	65	41	15
Load Reduction (tons/day)	0	0	13	17	0
% Load Reduction	0	0	20	41	0
Overall Reduction Required = 11%					

1.6.1 *E. coli* Priority Areas

The model shows that the urbanized area contributed a majority (95 percent) of the bacteria loads. A pie chart showing load contribution by basin within the urbanized area is included in Figure 1-8. Because Capitol Basin attributes the largest portion of the load to Reach_01 (63 percent), and Reach_01 contributes a majority of the load to Reach_02 (97 percent), beginning implementation efforts in Capitol Basin would be the most effective.

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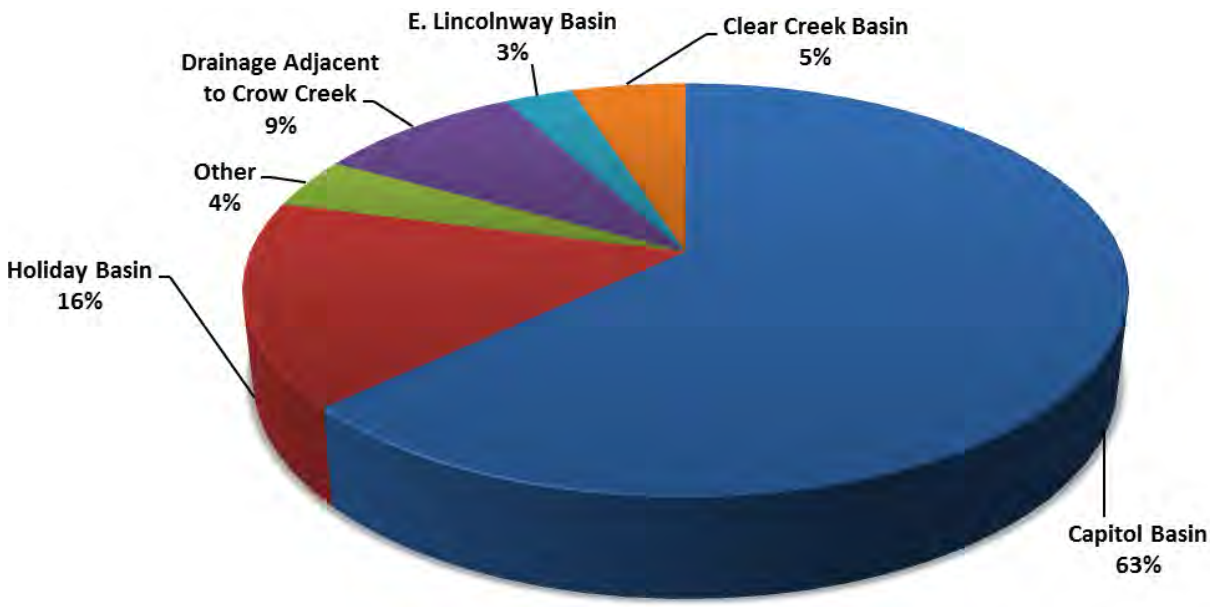

Figure 1-8. *E. coli* Source Assessment Modeling Results by Drainage Basin for Recreation Season in the Crow Creek Project Area.

Six management milestones were simulated in **HSPF** for each bacteria-impaired reach for the summer recreation season. If the following milestones are met, bacteria loads would be reduced by 95 percent in Reach_01 and 96 percent in Reach_02 and consist of the following:

- A cross-connection repair in the city of Cheyenne
- An *E. coli* reduction of 90 percent on all of the MS4 area
- An *E. coli* reduction of 90 percent on all of the agricultural land upstream of Crow Creek at Roundtop Road
- Compliance with the summer recreation season standard in Crow Creek at Roundtop Road

- An *E. coli* reduction of 90 percent on all agricultural land downstream of Crow Creek at Roundtop Road
- Reach_01 compliance with the summer recreation season standard (for milestone impacts on the downstream *E. coli*-impaired reach, Reach_02).

Recommended actions for achieving these milestones are presented in Section 1.7 of this implementation plan.

1.6.2 Sediment Priority Areas

The **HSPF** model shows the urbanized area contributed a majority (95 percent) of the total sediment supply. A pie chart depicting the load contribution by basin within the urbanized area is shown in Figure 1-9. Capitol Basin and Holiday Basin attribute the largest portions of the sediment supply, and therefore, beginning implementation efforts in these basins would be the most effective.

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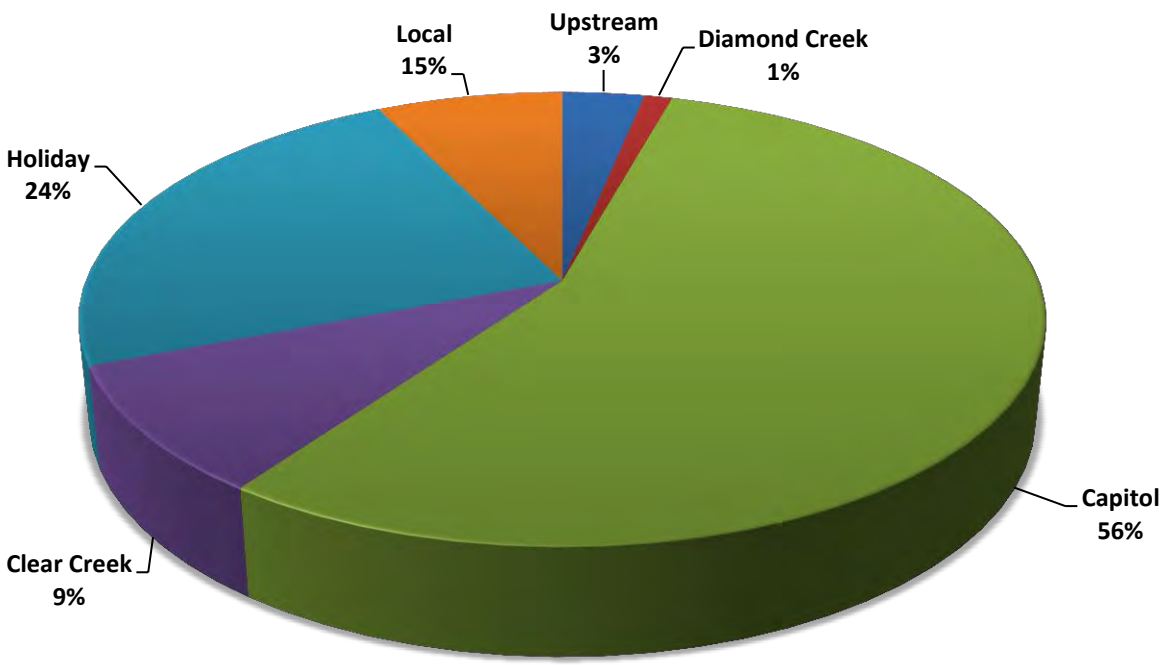

Figure 1-9. Sediment Source Assessment by Drainage Basin Within the Crow Creek Project Area.

Two management milestones were simulated in **HSPF** for the sediment-impaired reach that would cumulatively reduce loads by 19 percent in the impaired reach. These include the following:

- Bedload reductions of 25 percent on all of the MS4 area
- Bedload reductions of 50 percent on all agricultural area upstream of Crow Creek at Roundtop Road.

The model indicates that the urban reductions would result in an 18.8 percent reduction in sediment supply, and the agricultural BMPs would result in a 0.2 percent reduction in sediment supply.

As the results of the simulated management scenarios for *E. coli* and sediment suggest, urban and agricultural areas should continue to be the land uses of focus for implementation efforts. More specifically, urban area implementation should focus on cross-connection identification and repairs (for bacteria reductions) and installing detention basins, infiltration basins, and retention ponds (for bacteria and sediment reductions) in and around the urbanized area. Agricultural BMPs should focus on water development, riparian area management, and grazing land management.

1.7 RECOMMENDED BEST MANAGEMENT PRACTICE SELECTION

This implementation plan makes recommendations for both point sources (including the MS4) and nonpoint sources. Point source recommendations focus on the MS4 and are based on the WDEQ's urban BMP manual [Wyoming Department of Environmental Quality, 2013b], and nonpoint-source recommendations focus on the WDEQ's livestock/wildlife and cropland BMP manuals [Wyoming Department of Environmental Quality, 2013c; 2013d]. The WDEQ BMP manuals are located at *http://deq.state.wy.us/wqd/watershed/nps/NPS.htm*. Other practices that could be considered for implementation are listed in the NRCS Conservation Practice Physical Effects (CPPE) for Laramie County [Natural Resources Conservation Service, 2012], which identifies BMPs that potentially have slight, moderate, and significant improvement effects on surface water pathogens and sediments that are present at a level that degrades surface water quality.

1.7.1 Point-Source Recommendations

Point-source *E. coli* and sediment implementation measures should include review and revisions to WYPDES permits (WWTPs, oil production facilities, and MS4s), where necessary.

1.7.1.1 Municipal Separate Storm Sewer Systems

Stormwater from rainfall, snow melt, or other surface water runoff and drainage originates from impervious areas in towns; cities; residential developments; and industrial, manu-

facturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, or storm drains and other impervious surfaces and may play a role in the contribution of *E. coli* or sediment loading because of the proximity of these impervious areas to the impaired waterbodies. These stormwater discharges are permitted under the Wyoming General MS4 Stormwater Permit under the WYPDES (WYR04-0000). Under this general permit, a community may discharge stormwater to a water of the state of Wyoming. The general MS4 permit was issued on December 1, 2008, and will expire on September 30, 2013 [Sahl, 2012]. The MS4 area refers to stormwater runoff from the boundary of the city of Cheyenne into Crow Creek, as determined by the 2000 Decennial Census conducted by the U.S. Census Bureau [Wyoming Department of Environmental Quality, 2008]. This boundary includes the city of Cheyenne MS4, the Laramie County MS4 (portions in the urbanized area), the F.E. Warren AFB 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, 2012]. A majority of the urban/residential land in the project area lies within the MS4.

Bacterial sources in urban settings can also include cross connections between sanitary sewers and storm drain systems, overflows from sanitary sewer systems, and wet weather discharges from centralized wastewater collection and treatment plants. The city of Cheyenne has investigated cross connections, and the removal of identified cross connections is in progress. According to Mr. Mike Vinson [2013], a city of Cheyenne Staff Engineer, two cross connections have already been eliminated. Additionally, a common land source of bacteria in urban areas is pet waste. Bacteria loading from pet waste can be reduced by educating residents on preventative practices and using programs to remove waste from common areas, such as parks. Urban wildlife can also contribute to bacteria in urban areas. Establishment of riparian vegetation can decrease bacteria that reaches the stream.

Removing bacteria and sediment from urban stormwater runoff has been documented to be effectively achieved by regional (large-scale) BMPs including infiltration trenches/basins, stormwater wetlands, and detention ponds. As part of a TMDL adaptive implementation approach, BMPs that reduce *E. coli* contributions from urban/residential areas should continue to focus on rehabilitating failing septic systems, reducing pet waste contributions, and urban stormwater detention and/or infiltration. Also, identification and removal of cross connections should continue. Similarly, BMPs that reduce sediment contributions from urban/residential areas should continue to focus on urban stormwater runoff. A summary of these recommended BMPs is shown with removal efficiencies in Table 1-8. Removal efficiencies are listed as variable for some practices in Table 1-8, because these efficiencies depend on how widespread the practice is. Note that any practice that incorporates infiltration should have a thorough groundwater impact evaluation before implementation.

Table 1-8. Recommended Urban/Residential Best Management Practices in the Crow Creek Watershed [Wyoming Department of Environmental Quality, 2013b]

Recommended Urban/ Residential BMPs	Bacteria Removal (Percent)	Sediment Removal (Percent)
Dry Detention Ponds	0–30	0–65
Wet Detention Ponds	65–100	30–100
Stormwater Wetlands	30–100	65–100
Infiltration Trenches	65–100	65–100
Infiltration Basins	65–100	65–100
Permeable Pavement Systems	30–65	30–65
Bioretention Systems	30–100	65–100
Grassed Swales	0–30	30–65
Vegetated Filter Strips	Insufficient Data	65–100
Sand and Organic Filters	30–65	65–100
Storm Drain Inlet Modifications	0–30	65–100
Green Roofs	Variable	Variable
Native Landscaping	Variable	Variable
Wind Erosion Control	Variable	Variable
Structural Erosion Control	Variable	Variable
Education	Variable	Variable
Rain Barrels and Cisterns	Variable	Variable
Preventative Practices	Variable	Variable
Septic Systems	Variable	Variable
Low-Impact Development	Variable	Variable

According to Mr. Vinson [2013], any new development within the city of Cheyenne is required to have a detention pond. Additionally, the city of Cheyenne is in the conceptual stages of designing constructed wetlands at the outfall of Capitol Basin.

Widespread stormwater source control can also have a major impact on adjacent stream water quality. This includes BMPs referred to as low-impact development that serve to reduce, attenuate, or eliminate stormwater runoff and remove pollutants on the scale of individual lots. Practices that are used as low-impact development include bioretention systems, grass swales, green roofs, permeable pavement systems, rain barrels, and cisterns. Low-impact development practices are often incorporated in newly developed areas or as stormwater retrofits [Wyoming Department of Environmental Quality, 2013b].

As part of the Crow Creek *E. coli* and sediment TMDLs, each MS4 is recommended to evaluate the potential for *E. coli* and sediment discharges from urbanized areas and review their stormwater management programs to consider including *E. coli* and sediment monitoring of stormwater systems that discharge to Crow Creek and its tributaries. Additionally, general discharge permits issued by the WDEQ for large and small construction, industrial, and mining (except fuel production) stormwater activities should consider including BMPs that eliminate or minimize *E. coli* and sediment mobilization in stormwater runoff as part of the facilities' SWPPPs.

1.7.1.2 Wastewater Treatment Plants

Within the Crow Creek TMDL project area, two WYPDES-permitted WWTPs have *E. coli* discharge criteria. These permitted point sources include the Dry Creek WWTP (WY0022934) and the Crow Creek WWTP (WY0022381). Both treatment plants are located in Reach_01.

Three WYPDES-permitted WWTPs with sediment discharge criteria to the impaired reach or upstream of the impaired reach are located within the Crow Creek TMDL project area. These permitted facilities include the Crow Creek WWTP (WY0022381), the Cheyenne Board of Public Utilities Water Treatment Plant (WY0031721), and the Frontier Oil Refinery (WY0000442). The Dry Creek WWTP (WY0022934) is located downstream of the sediment-impaired reach and is, therefore, not addressed in this TMDL. WWTPs within the Crow Creek Watershed TMDL project area are listed in Table 1-9.

Table 1-9. Point Sources in the Crow Creek Watershed Total Maximum Daily Load Project Area

WWTP	WYPDES Permit	County	TMDL Stream Impacted	May–Sept Monthly Effluent Limit	Oct–April Monthly Effluent Limit
Crow Creek	WY0022381	Laramie	Crow Creek	126 mpn/100 mL (*E. coli*)	630 mpn/100 mL (*E. coli*)
Crow Creek	WY0022381	Laramie	Crow Creek	30 Mg/L (TSS[a])	30 Mg/L (TSS)
Dry Creek	WY0022934	Laramie	Crow Creek	126 mpn/100 mL (*E. coli*)	630 mpn/100 mL (*E. coli*)
Cheyenne Board of Public Utilities Water Treatment Plant	WY0031721	Laramie	Crow Creek	20 Mg/L (TSS)	20 Mg/L (TSS)
Frontier Oil Refinery	WY0000442	Laramie	Crow Creek	265 lbs/day (TSS)	265 lbs/day (TSS)

(a) TSS = total suspended solids

If not already included in their current WYPDES permits, monthly influent and effluent stream monitoring and effluent limit requirements for *E. coli* and sediment should be included as part of these WYPDES permits in accordance with their respective WLAs. Recommended BMPs for *E. coli* and sediment point sources should focus on reviewing permit conditions for WWTPs to ensure monthly influent and effluent monitoring is taking place and to ensure

discharge limits in WYPDES permits are in accordance with the WLA. During the TMDL implementation, permit conditions should be reviewed for WYPDES-permitted *E. coli* and sediment discharges from WWTPs. Any permits that are lacking monthly influent and effluent stream monitoring as well as effluent limit requirements for *E. coli* and sediment should be revised in accordance with the PSAs and WLAs described in Foreman et al. [2013] and RESPEC and Ayres Associates [2013].

1.7.1.3 Concentrated Animal Feeding Operations

One concentrated animal feeding operation (CAFO) is permitted by the WYPDES within the Crow Creek project area. This CAFO is not allowed to discharge to the surface waters of the state of Wyoming, except in the case of a chronic or catastrophic storm event that would cause an overflow from facilities designed, constructed, and operated to contain all process-generated wastewaters and the runoff from a 25-year, 24-hour precipitation event. In the TMDL, it was assumed that waste from this CAFO did not discharge and, therefore, did not contribute to bacteria loadings within the project area.

1.7.2 Nonpoint-Source Recommendations

Recommended BMPs in the project area were based on the WDEQ's BMP manuals and the NRCS' "Electronic Field Office Technical Guide" [Wyoming Department of Environmental Quality, 2013b, 2013c, and 2013d; Natural Resources Conservation Service, 2012]. The NRCS CPPE for Wyoming were also used to identify BMPs that have slight, moderate, and significant improvement potential on surface water-suspended sediment, turbidity, and pathogen populations (i.e., viruses, protozoa, and bacteria), and could be considered for implementation [Natural Resources Conservation Service, 2012].

1.7.2.1 Recommended Rangeland Best Management Practices

Approximately 132,597 acres of grass and shrublands cover approximately 81 percent of the project area. Livestock in Laramie County is predominantly cattle. Other livestock in the county include sheep, horses, poultry, goats, and pigs. Wildlife includes waterfowl, small mammals living near the stream or in the stormwater system, and large game species. Livestock and wildlife contribute bacteria loads on rangelands that are washed off during precipitation events. Livestock and wildlife also contribute bacteria loads to Crow Creek directly by defecating in the stream. Livestock and wildlife also contribute to sediment loadings, because riparian degradation and stream degradation can occur when they access water.

As part of a TMDL adaptive implementation approach, BMPs that reduce *E. coli* and sediment contributions from livestock and wildlife located on rangelands should continue to focus on improving rangeland health, enhancing livestock or wildlife distribution, improving wintering animal areas, and increasing livestock and wildlife water availability. A summary of these recommended rangeland BMPs is provided in Table 1-10. Eighty-one percent of the

project area is rangeland, and this land use is the primary cause of exceedances of the water-quality standards upstream and downstream of the urban area. It will be important to continue to implement rangeland BMPs throughout the project area to address this loading.

Table 1-10. Recommended Rangeland Best Management Practices in the Crow Creek Watershed

Practice	NRCS Practice Code	Bacteria Potential Improvement	Sediment Potential Improvement
Critical Area Planting	342	Slight	Moderate-to-Substantial
Access Control	472	Slight-to-Moderate	None
Forage Harvest Management	511	Slight	Slight-to-Moderate
Pasture and Hay Planting	512	Slight	Slight-to-Moderate
Prescribed Grazing	528	Slight	Moderate
Grazing Land Mechanical Treatment[(a)]	548	Slight-to-Moderate	Slight-to-Moderate
Range Planting	550	Slight	Moderate
Heavy Area Use Protection	561	Slight-to-Moderate	Slight-to-Moderate
Spring Development	574	Slight	Slight
Streambank and Shoreline Protection	580	Slight	Moderate
Vegetative Barrier	601	Slight-to-Moderate	Slight-to-Moderate
Tree/Shrub Establishment	612	Moderate	Moderate-to-Substantial
Watering Facility	614	Slight	Slight-to-Moderate
Vegetated Treatment Area	635	Moderate-to-Substantial	Slight-to-Moderate

(a) Practice impacts sage grouse.

1.7.2.2 Recommended Stream/Riparian/Wetland Best Management Practices

As part of this implementation plan, BMPs that reduce *E. coli* contributions from livestock, wildlife, human, and pets in streams and adjacent riparian areas and wetlands should continue to focus on improving riparian and wetland conditions and reducing direct access to streams. These recommended BMPs are listed in Table 1-11, but practices should certainly not be limited to these recommendations.

1.7.2.3 Recommended Cropland Best Management Practices

Approximately 7,947 acres of cropland are in the project area. A majority of the cropland is located downstream of the city of Cheyenne. Therefore, cropland impacts the downstream *E. coli* impairment (Reach_02) much more than the upstream *E. coli* impairment (Reach_01). Because cropland contributes to the *E. coli* loads in the bacteria-impaired Reach_02, cropland BMPs should continue to be implemented, especially downstream of the urbanized area. Much of the irrigated land in the watershed has already been converted to sprinkler. A summary of recommended cropland BMPs is provided in Table 1-12.

Table 1-11. Recommended Stream/Riparian/Wetland Best Management Practices in the Crow Creek Watershed

Practice	NRCS Practice Code	Bacteria Potential Improvement	Sediment Potential Improvement
Riparian Forest Buffer	391	Moderate	Moderate-to-Substantial
Riparian Herbaceous Cover	390	Moderate	Moderate-to-Substantial
Tree/Shrub Establishment	612	Moderate	Moderate-to-Substantial
Access Control	472	Slight-to-Moderate	None
Prescribed Grazing	528	Slight	Moderate
Heavy Use Area Protection	561	Slight-to-Moderate	Slight-to-Moderate
Constructed Wetland	656	Slight-to-Moderate	Moderate-to-Substantial
Watering Facility	614	Slight	Slight-to-Moderate
Critical Area Planting	342	Slight	Moderate-to-Substantial
Grassed Waterway	412	Slight	Slight-to-Moderate
Streambank and Shoreline Protection	580	Slight	Moderate
Wetland Creation	658	Slight	Slight-to-Moderate
Wetland Enhancement	659	Slight	Slight-to-Moderate
Wetland Restoration	657	Slight	Slight-to-Moderate
Wetland Wildlife Habitat Management	644	Slight	Moderate

1.8 PAST AND CURRENT BEST MANAGEMENT PRACTICES

A significant amount of BMPs have been, and are currently being, implemented in the Crow Creek Watershed. These were mainly facilitated by the city of Cheyenne, LCCD, NRCS, F.E. Warren AFB, federal agencies, and other interested groups. The following BMPs have been or are being implemented by the city of Cheyenne and LCCD to improve the water quality of stormwater runoff in urban areas.

- **Pet waste management programs**—Bag stations for pet waste are located at parks and animal owners are responsible for keeping their property clear of animal waste (see Appendix B for more information)
- **Septic system assessment and inventory of systems within city limits**—Use of city sewer in the urban density areas is promoted (see Appendix C)

Table 1-12. Recommended Cropland Best Management Practices in the Crow Creek Watershed

Practice	NRCS Practice Code	Bacteria Potential Improvement	Sediment Potential Improvement
Deep Tillage	324	Moderate	Slight-to-Moderate
Conservation Cover	327	Slight	Moderate
Conservation Crop Rotation	328	Slight	Slight-to-Moderate
Contour Farming	330	Slight	Moderate
Contour Buffer Strip	332	Slight	Moderate
Cover Crop	340	Slight	Slight-to-Moderate
Residue Management (Seasonal)	344	Slight	Slight
Sediment Basin	350	Slight-to-Moderate	Moderate-to-Substantial
Diversion	362	Slight	Slight-to-Moderate
Field Border	386	Slight	Slight-to-Moderate
Filter Strip	393	Slight	Substantial
Irrigation System–Sprinkler	442	Slight-to-Moderate	None
Irrigation System–Surface and Subsurface	443	Slight	None
Irrigation System–Tailwater Recovery	447	Slight	Slight
Irrigation Water Management	449	Moderate	Moderate
Irrigation Land Leveling	464	Slight-to-Moderate	Slight
Mulching	484	Slight	Slight-to-Moderate
Drainage Water Management	554	Slight	None
Stripcropping	585	Slight	Moderate
Nutrient Management	590	Slight	None
Terrace	600	Slight-to-Moderate	Moderate
Manure Transfer	634	Moderate	None
Water and Sediment Control Basin	638	Slight-to-Moderate	Moderate-to-Substantial
Constructed Wetland	656	Slight-to-Moderate	Moderate-to-Substantial

- **Replace, repair, or connect failing septic systems to the city sewer system**—New developments within the city limits must connect to the city sewer; there is no specific program for existing systems. Any property capable of being served by the sanitary system shall be connected (see Appendix C).
- **Wet and dry detention ponds**—See Appendix D for existing detention ponds. Note the city does not specifically require detention basins; however, they are a commonly selected BMP to comply with stormwater control requirements (see Appendix E)
- **Stormwater wetlands**—A 3-acre detention pond with a wetland bottom is located on Dry Creek, south of Dell Range Boulevard between Rue Terre and Ridge Road.

- **Infiltration trenches**—Infiltration trenchs are planned for 1st Street and Morrie Avenue. and at Dell Range Boulevard and Converse Avenue
- **Sand and organic filters**—Will be a part of an upcoming Capitol Basin project
- **Storm drain inlet modifications**—Water-quality manholes at Sloans Lake, Lyons Park, Missile Drive and Martin Luther King Park, and the Morrie Avenue pipe drain to Holliday Park; there is currently no maintenance scheduled for these structures
- **Native landscaping**—The Planning Department would prefer irrigated bluegrass; the Engineering Department is trying to promote native landscaping and xeriscaping
- **Wind erosion control**—Occurs at construction sites
- **Structural erosion control**—Reseeding is a requirement of construction permits
- **Low-Impact Development**—A formalized program does not exist, but new development in Cheyenne typically incorporates low-impact development principals
- **Permeable pavement systems**—One permeable pavers project was completed by a private company near the Maverick store at Yellowstone Road and Gardenia Drive; the city of Cheyenne is interested in how permeable pavement will work in their climate
- **Grassed swales, vegetated filter strips, and bioretention systems**—Many of these are in the city, primarily located in parks and new developments (see Appendix E)
- **Street sweeping**—Sand is used when it is too cold to use deicer; the sand is typically swept up within 1 week of application
- **Cross-connection eliminations**—Occurred in the 1980s and 1990s. There was an odor complaint in the train depot area (roughly Central Avenue and Lincolnway Highway) in 2009. 2 cross connections were found and repaired. One additional cross connection was identified in 2012 during a construction project.
- **Goose control**—The Parks and Recreation Department addles eggs for population control and steepens banks to waterbodies to discourage geese from entering the water.
- **Storm Water Quality/Management Manual**—This is currently being drafted and includes drainage criteria (see Appendix E)
- **Standard Operating Procedure**—Developed for waste disposal at municipal facilities. The SOP tracks the number of gallons of used oil and other waste collected from municipal operations
- **Development and Redevelopment Management**—Occurs in accordance with city and county regulations
- **Ordinances**—Are in place to prohibit dumping and non-stormwater discharges within the city (see Appendices C and F)
- **City inspection program**—This exists for construction sites

- **Compliance of all state and local public notice requirements**—This occurs throughout the city of Cheyenne.
- **Monitoring**—LCCD has conducted storm sewer monitoring in the past

F.E. Warren Air Force Base has a Storm Water Pollution Prevention Plan [HydroGeoLogic, Inc. and Tetratech, Inc., 2011] and a Storm Water Management Plan in place to minimize negative impacts to Crow Creek. Section 3.3 of the plan outlines Sediment and Erosion Control regulations. These regulations include prevention of any visible or measureable erosion associated with industrial activities. Additionally, the plan outlines that if an acre or more of land are disturbed on the Air Force Base, the WDEQ general stormwater permits must be complied with and an SWPPP must be developed and implemented, and if 5 acres or more of land are disturbed on the Air Force Base a WYPDES large construction permit must be obtained with an SWPPP developed and implemented. A Horizontal Maintenance Storage Yard is located on the Air Force Base, which could potentially be a source of sediment or erosion; however, sediment or erosion control rip rap and check dams exist along the access road to help control these issues. The Air Force Base Water Program Manager stated that the Air Force Base practices street sweeping, has pet waste policies in place for all residents, performs egg addling when necessary to control the goose population, and employs several other industrial and construction related BMPs to prevent or reduce the pollution of stormwater runoff [Brunner, 2013].

Additionally, multiple lakes and wetlands (Appendix G) exist throughout the project area which helps in settling sediment. The Swan Ranch Lakes on Clear Creek, which detain a 2-year storm, are approximately 2 miles west of I-25. Lake Minnehaha is located on the Holiday Basin and has approximately 6 acres of surface area. The city is currently dredging Lake Minnehaha to approximately double the depth. A 25-acre WYDOT detention (half of which is wetlands) collects the runoff from the Henderson and Lincolnway Basins. A wetland on Dry Creek, mentioned in the above list, is approximately 3 acres. Hereford Ranch Reservoir #1 is on the main stem of Crow Creek and is at the confluence with the drainage from the WDOT detention. Although a decrease in sediment and *E. coli* would be expected below these lakes and wetlands, concentrations remain high at monitoring points located downstream of them (*E. coli* and sediment data are summarized in the TMDL documents). Therefore, the inlets and outlets of these features would be an ideal location for *E. coli* and sediment monitoring. Further information about lake/wetland/pond monitoring is located in the Monitoring Best Management Practice Effectiveness Section. In addition to existing lakes and wetlands, a wetland project is being planned for the Capitol Basin drainage.

Some implementation projects have also been performed in agricultural areas to improve rangeland condition. Table 1-13 provides a summary of all NRCS conservation practices implemented in the project area from 2005 to 2012. Prescribed grazing, off-site water, and other BMPs have been implemented on rangeland upstream of the urbanized area and have positive effects on controlling sources of *E. coli* and sediment. Additionally, an AFO

Table 1-13. Summary of Applied Conservation Practices in the Crow Creek Watershed Project Area by 12-Digit Hydrologic Unit Code (HUC-12) From 2006 to 2011 [Natural Resources Conservation Service, 2012]

Applied Conservation Practice, NRCS Code (Associated Unit)	Contributing to Sediment Impairment and Reach_01 *E. coli* Impairment		Contributing to Reach_02 *E. coli* Impairment	Downstream of Impaired Reaches	Total
	HUC-12 101900090106	HUC-12 101900090107	HUC-12 101900090202	HUC-12 101900090203	
Cover Crop, 340 (ac)				400	400
Fence, 382 (ft)				760	760
Irrigation System, Sprinkler, 442 (ac)				620	620
Irrigation Water Conveyance, High Pressure Underground Plastic Pipeline, 430DD (ft)				8,132	8,132
Nutrient Management, 590 (ac)				400	400
Pasture and Hay Planting, 512 (ac)				73	73
Pest Management, 595 (ac)	11,885				11,885
Pipeline, 516 (ft)				115	115
Prescribed Grazing, 528 (ac)	72,389	794			73,183
Pumping Plant, 533 (no)				7	7
Seasonal High Tunnel System for Crops, 798 (sq ft)				1,248	1,248
Structure for Water Control, 587 (no)				3	3
Water Well, 642 (no)	11		1	1	13
Watering Facility, 614 (no)	11			1	12
Windbreak Shelterbelt Establishment, 380 (ft)				8,140	8,140
Structure for Water Control, 587 (no)	3				3
Forage Harvest Management, 511 (ac)		181			181

ac = acres
ft = feet
no = number

(calving facility) that has approximately 300 animals was recently moved offstream [Cochran, 2013]. Implementation projects have also occurred in agricultural areas to improve irrigation efficiency on croplands. Most of the cropland in the project area (88 percent) is located downstream of the urbanized area and, therefore, many of the cropland BMPs listed have been implemented in this area.

This summary provides an estimate of implementation accomplishments in the project area but this does not include all of the BMPs that have been, or are currently being, implemented on private and public lands.

1.9 INFORMATION, EDUCATION, AND OUTREACH

Conservation districts; nongovernmental organizations; and local, state, and government agencies have created several effective information, education, and outreach products and programs that have reached residents, landowners, and stakeholders during water-quality management planning and implementation efforts. Examples of information, education, and outreach occurring are listed below:

- All new or replacement storm drain inlets are marked with "Do Not Dump—Drains to Creek."
- Signs and containers for bags along Crow Creek exist to remind pet owners to pick up pet waste.
- Water-quality awareness signs were placed in Dave Ramiro Park and Dry Creek Park.
- Tributary signage is placed at waterway crossings and other local waterbodies.
- The stormwater sewer system for the Cheyenne area was mapped.
- A storm drain inspection and maintenance program (minimum of one inspection of each outfall per year) exists.
- WYPDES information is made available to contractors.
- A report mechanism called "Report a Concern" for stormwater is available on the city's website.
- A program for the receipt and consideration of public concerns and inquiries related to construction sites exists.
- A "Keep Cheyenne Clean Program" was administered.
- The Greenway Volunteer Clean-Up Program was administered.
- Public education on the hazards associated with illegal dumping was made available at the library.

- Educational materials regarding rain barrels and grassed waterways were given to the public.
- Recycling services are provided to local residents.

Current communication, education, and outreach efforts established by the city of Cheyenne, LCCD, and other organizations should continue, and efforts should be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs.

Coordinated outreach efforts should continue to increase the awareness of specific audiences about the *E. coli* and sediment problems and solutions and available technical and financial assistance programs for BMPs on urban/residential areas, rangelands, in riparian areas, and on croplands. Stakeholders should continue to expand upon their public outreach efforts and communicate to the general public through website updates, newsletters, news articles, flyers, displays, and public meetings. As part of an adaptive implementation approach, education and outreach activities should survey targeted audience members to obtain information regarding effective delivery methods to help develop and improve future outreach efforts.

1.10 SCHEDULE AND MILESTONES FOR TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION

Because of the substantial size of the project area, a multitiered approach is necessary to achieve the TMDL reductions. This approach should include outlining priority management areas, recommending BMPs by land use, updating and revising local watershed plans, describing milestone measures, and monitoring BMP effectiveness. Successfully achieving load reductions and meeting load allocations, as outlined within the TMDL, depends upon a number of factors including the amount of voluntary participation, the availability of technical and financial assistance, and the effectiveness of BMPs intended to reduce applicable loads; thus, improving water quality in Crow Creek.

Implementing the TMDLs will take many years to attain water-quality standards. To attain this implementation plan's goal of reducing *E. coli* bacteria and sediment impairments by implementing point and nonpoint-source BMPs, a 10-year adaptive implementation schedule is recommended. This plan should be revisited and revised as necessary after the first 5 years. For point sources, such as WWTPs and MS4s, it is anticipated that future WYPDES permits will include recommended control measures. Reductions from nonpoint-source *E. coli* bacteria and sediment loadings will most likely require a significant, increased amount of technical and financial program assistance, BMP implementation through on-the-ground projects, proper watershed planning, and cooperation with willing landowners and land management agencies. A proposed implementation schedule and associated milestones for achieving the Crow Creek Watershed *E. coli* and sediment TMDLs is provided in Table 1-14.

Table 1-14. Proposed Crow Creek Watershed Implementation Schedule and Milestones (Page 1 of 2)

Source or Land-Use Category	Recommended BMP or Implementation Activity	Description of Measurable Milestone	Measureable Milestones	
			0–5 Years	0–10 Years
Point Sources				
Stormwater/MS4s	Develop a Stormwater Management Plan for drainage basins with *E .coli* and sediment BMPs	Number of plans	TBD[a]	TBD
	Comprehensive study of *E. coli* discharge potential from urbanized areas	Number of areas evaluated	TBD	TBD
	Comprehensive study of sediment discharge potential from urbanized areas	Number of areas evaluated	TBD	TBD
Nonpoint Sources				
Agricultural	Watering Facilities (614)[b]	Number developed	3	6
	Pasture and Hay Planting (512)	Number of acres	20	40
	Irrigation System–Sprinkler (442); Irrigation System–Surface and Subsurface (443); Irrigation System–Tailwater Recovery (447); Irrigation Water Management (449)	Number of acres	175	350
	Cover Crop (340)	Number of acres	125	250
	Nutrient Management (590)	Number of acres	125	250
	Prescribed Grazing (528)	Number of acres	20,000	All
	Forage Harvest Management (511)	Number of acres	50	100
Urban/Residential	Initiate pet waste management programs in areas along Crow Creek and stormwater drainage networks	Number of programs	2	5
	Perform rural septic system assessment and inventory of systems within riparian zone buffer	Number of systems assessed	TBD	TBD
	Replace/repair failing rural septic systems within riparian zone buffer	Number of systems updated	TBD	TBD
	Perform septic system assessment and inventory of systems within urbanized areas	Number of towns/cities assessed	TBD	TBD
	Replace, repair, or connect failing urban septic systems to publicly owned treatment works	Number of systems updated/connected	TBD	TBD
	Structural stormwater systems	Number of sites	TBD	TBD
	Initiate low-impact development program which includes practices such as porous landscape design, bio-swales, green walls and green roofs, lawn aeration, and permeable paving	Number of programs	1	1

Table 1-14. Proposed Crow Creek Watershed Implementation Schedule and Milestones (Page 2 of 2)

Source or Land-Use Category	Recommended BMP or Implementation Activity	Description of Measurable Milestone	Measureable Milestones	
			0–5 Years	0–10 Years
Outreach	Hold public information and progress report meetings	Number of meetings	10	20
	Administer watershed tours	Number of tours	5	10
	Enhance outreach activities within the watershed	Number of people contacted	1,000	2,000
	Increase public support for BMP implementation within watershed via media messaging	Number of media messages completed	20	40
Monitoring	Rural water-quality sampling	Number of sites	TBD	TBD
	Rural discharge measurement	Number of sites	TBD	TBD
	Urban water-quality sampling and flow measurement, stream ambient, and storm events	Number of sites	TBD	TBD
	Urban water-quality sampling and flow measurement, MS4 outfall storm events	Number of sites	TBD	TBD
	Monitor implemented agricultural BMP effectiveness	Number of BMPs	TBD	TBD
	Monitor implemented urban BMP effectiveness	Number of BMPs	TBD	TBD
	Monitor NPDES-permitted facility discharges	Number of facilities	All	All

(a) TBD = to be determined.
(b) NRCS code.

1.11 MONITORING BEST MANAGEMENT PRACTICE EFFECTIVENESS

During and after implementing BMPs, monitoring will be necessary to ensure attainment of the TMDLs. Some of the monitoring needed can be completed simply by the LCCD continuing to perform their current or previous monitoring efforts, which ensures that chemistry data are valid under the "Credible Data Law." The LCCD has monitored many key locations in the watershed. Collecting five individual samples in 30-day periods is important to meet the data needs for evaluating the geometric mean criteria.

Monitoring BMP effectiveness helps evaluate the adequacy of implementation strategies that are targeted to reduce bacteria loads or transport. Monitoring strategies depend on the type of BMP but typically include water-quality sampling and discharge measurements upstream and downstream of the BMP. Optimally, historic *E. coli*, sediment, and flow data would exist for segments immediately upstream and downstream of BMPs to allow for a robust trend and BMP

effectiveness analyses. BMP effectiveness data will improve the understanding of bacteria and sediment implementation and management measures. These data will increase the knowledge base that will help watershed managers select the most appropriate BMPs that are targeted toward local watershed characteristics. For example, BMP effectiveness monitoring of current wetland/lake/pond BMPs shown in Appendix G should occur at the inlet and the outlet of each wetland/lake/pond to ensure these are decreasing concentrations. Future BMP effectiveness efforts should continue to follow the guidance provided by Mesner and Paige [2011] and the Wyoming Department of Environmental Quality [2012a].

Additional monitoring and evaluation efforts should occur throughout the MS4 . Monitoring sites upstream and downstream of areas where storm drains and tributaries enter Crow Creek, and within storm drains and tributaries would help evaluate contributions. Samples should also be taken in upstream in stormwater drains throughout the city (particularly in Capitol Basin and Holiday Basin, which had very high maximum concentrations) to begin isolating the major sources of bacteria. Additionally, monitoring inlets and outlets of Hereford Reservoir #1 and Hereford Reservoir #2 should occur. Samples could be taken at F.E. Warren AFB watershed outlets to determine if more sampling needs to be done throughout the AFB. A detailed monitoring plan that identifies additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows improves load calculations. Future monitoring would ideally include additional synoptic discharge measurements at existing water-quality sampling locations and at new sites to fill in data gaps at storm drains, confluences, reservoirs, and upstream and downstream segment endpoints in the watershed from the 2012 303(d) list (refer to Appendix A) [Wyoming Department of Environmental Quality, 2012b]. Continuous-stage recorders should be installed at key locations in the watershed, and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Synoptic and continuous flow data will increase the accuracy in future load calculations and the evaluation of BMPs and implementation practices.

1.12 SOURCES OF TECHNICAL AND FINANCIAL ASSISTANCE

Sources of technical and financial assistance are available to implement TMDLs in the Crow Creek Watershed. Existing watershed plans have made estimates of the amount of technical and financial assistance needed, and updating or revising those plans is recommended once the TMDL is completed. Numerous private companies and organizations along with local, state, and federal agencies provide technical assistance to address point- and nonpoint-source pollution. A smaller number of these organizations and agencies also provide financial assistance to address point- and nonpoint-source pollution. Agencies and organizations with technical and financial programs that can possibly assist with conservation and water-quality implementation projects are listed in Table 1-15.

Table 1-15. Sources of Technical and Financial Assistance in the Crow Creek Watershed (Page 1 of 2)

Agency or Organization	Website	Assistance	BMP Categories							
			WWTPs	Discharge Permits	MS4s and Stormwater	Stream	Residential	Rangeland	Cropland	Outreach
LOCAL										
City of Cheyenne	*www.cheyennecity.org*	Financial, Technical	X		X	X	X	X	X	X
Laramie County	*webgate.co.laramie.wy.us*	Financial, Technical							X	X
LCCD	*www.lccdnet.org*	Financial, Technical				X	X	X	X	X
STATE										
University of Wyoming–Cooperative Extension Service	*www.uwyo.edu/ces*	Technical	X	X	X	X	X	X	X	X
WACD	*www.conservewy.com*	Financial, Technical				X	X	X	X	X
WDEQ	*deq.state.wy.us*	Financial, Technical	X	X	X	X	X	X	X	X
Wyoming Game and Fish Department	*gf.state.wy.us*	Financial, Technical						X	X	X
Wyoming Department of Agriculture	*wyagric.state.wy.us*	Financial, Technical				X	X	X	X	X
University of Wyoming–Water Resources Data System	*www.wrds.uwyo.edu*	Technical				X	X	X	X	
Wyoming State Engineer's Office	*seo.state.wy.us*	Financial, Technical				X	X	X	X	
WWCD	*wwdc.state.wy.us*	Financial, Technical				X	X	X	X	X
Wyoming Wildlife and Natural Resource Trust	*wwnrt.state.wy.us*	Financial							X	
Wyoming Office of State Lands and Investments	*lands.state.wy.us*	Financial	X			X	X			

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Table 1-15. Sources of Technical and Financial Assistance in the Crow Creek Watershed (Page 2 of 2)

Agency or Organization	Website	Assistance	BMP Categories							
			WWTPs	Discharge Permits	MS4s and Stormwater	Stream	Residential	Rangeland	Cropland	Outreach
FEDERAL										
Wyoming Oil and Gas Conservation Commission	*wogcc.state.wy.us*	Financial, Technical	X					X		
U.S. Army Corps of Engineers	*www.usace.army.mil*	Financial, Technical		X				X	X	
USDA–NRCS	*www.nrcs.usda.gov*	Financial, Technical				X	X	X	X	X
USDA–Farm Service Agency	*www.fsa.usda.gov*	Financial, Technical				X	X		X	X
USDA–Rural Development	*www.rurdev.usda.gov*	Financial, Technical	X			X	X		X	X
USDA–BLM	*www.blm.gov*	Financial, Technical	X					X	X	
USDI–Bureau of Reclamation	*www.usbr.gov*	Financial, Technical				X	X	X		X
EPA	*www.epa.gov*	Financial, Technical	X	X	X	X	X	X	X	X
USDA–Forest Service	*www.fs.fed.us*	Financial, Technical						X	X	
USFS	*www.fws.gov*	Financial, Technical				X	X	X	X	X
USGS	*www.usgs.gov*	Technical				X	X	X	X	
PRIVATE										
Ducks Unlimited	*www.ducks.org*	Financial, Technical						X	X	
Wyoming Council of Trout Unlimited	*wyomingtu.org*	Financial, Technical						X	X	
Wyoming Association of Rural Water Systems	*www.warws.com*	Financial, Technical				X	X	X		
Mule Deer Foundation	*www.muledeer.org*	Financial, Technical						X	X	
Rocky Mountain Elk Foundation	*www.rmef.org*	Financial, Technical						X	X	
National Fish and Wildlife Foundation	*www.nfwf.org*	Financial				X	X	X	X	

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Monitoring BMP effectiveness helps evaluate the adequacy of implementation strategies that are targeted to reduce bacteria and sediment loads or transport. Monitoring strategies depend on the type of BMP but typically include water-quality sampling and discharge measurements upstream and downstream of the BMP. Optimally, historic *E. coli*, sediment, and flow data would exist for segments immediately upstream and downstream of BMPs to allow for a robust trend and BMP effectiveness analyses. BMP effectiveness data will improve the understanding of bacteria and sediment reduction implementation and management measures. These data will increase the knowledge base that will help watershed managers select the most appropriate BMPs that are targeted toward local watershed characteristics. Future BMP effectiveness efforts should continue to follow the guidance provided by Mesner and Paige [2011] and the Wyoming Department of Environmental Quality [2013d].

1.13 CRITERIA FOR TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION GOAL ACHIEVEMENT

The WDEQ's criteria to determine if TMDL goals are being achieved in the Crow Creek Watershed for bacteria are based on the primary contact recreation designated use. For primary contact recreation waterbodies, the summer recreation season criterion, applicable from May 1 through September 30, is defined as a geometric mean of 126 org/100 mL, based on a minimum of five samples collected during separate 24-hour periods for any 30-day period. From October 1 through April 30, the winter recreation season criteria apply, which are defined as a geometric mean of 630 org/100 mL, based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period. The individual BMP milestones developed during the local watershed planning efforts should also be used as criteria for TMDL achievement.

The WDEQ's criteria to determine if TMDL goals are being achieved in the Crow Creek Watershed for sediment are based on sediment transport capacity within Crow Creek. The water-quality standards [Wyoming Department of Environmental Quality, 2007] for sediment state that "in Wyoming surface waters, substances attributable to or influenced by the activities of man that will settle to form sludge, bank, or bottom deposits shall not be present in quantities that could result in significant aesthetic degradation; significant degradation of habitat for aquatic life; or adversely affect public water supplies, agricultural or industrial water use, plant life, or wildlife." The aquatic life impairment for this TMDL was attributed to excess bottom deposits, or, specifically, excess bed load, by the WDEQ.

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APPENDIX A

CROW CREEK 303(d) LIST SEGMENTATION EVOLUTION AND CORRELATION TO THE 2013 *E. coli* TOTAL MAXIMUM DAILY LOAD DOCUMENT

APPENDIX A
CROW CREEK 303(d) LIST SEGMENTATION EVOLUTION AND CORRELATION TO THE 2013 *E. coli* TOTAL MAXIMUM DAILY LOAD DOCUMENT

The segmentation of Crow Creek on the State's 303(d) list changed during the listing periods of 2008, 2010, and 2012. The Crow Creek *E. coli* Total Maximum Daily Load (TMDL) project started in 2009 and was initially based on the 2008 303(d) listed segmentation, which was subsequently further refined based on given, defined endpoints in the 2010 303(d) list. For the 2012 303(d) list, the segmentation of Crow Creek was redefined to include six segments to more accurately reflect surface water classification and sources of pollution and to align with water-quality sample reaches used by the Wyoming Department of Environmental Quality's (WDEQ's) Surface Water Monitoring group and the Laramie County Conservation District (LCCD). A description of the segmentation process for listing purposes on Crow Creek is contained in the 2012 Integrated Report under the description of the Crow Creek Subbasin, which begins on page 86, and the Summary of 303(d) List Changes, which begins on page 116. The evolution of the segmentation of Crow Creek is illustrated in Figure A-1.

At the time of the 2012 303(d) list publication, the Crow Creek *E. coli* TMDL project was complete. The **HSPF** model incorporated 39 reaches along the project study area and already accounted for changes in the surface water classification, land use, pollutant sources, and water-quality sampling. Individual TMDLs and Load Duration Curves (LDCs) for each of the six 2012 listed segments (some of which are very short) were not ideal for this TMDL, because sufficient flow data, water-quality data, and unique sources within each segment were lacking. In addition, evaluating pollution reduction scenarios based on the original two impaired segments was logical, because they represented two different implementation environments (Reach_01 is an urbanized environment driven primarily by point sources of pollution; whereas, Reach_02 is a rural environment with nonpoint sources of pollution). The correlation between this *E. coli* TMDL document and the current 2012 303(d) list is provided in Table A-1.

Two additional segments of Crow Creek are listed for *E. coli* impairment: WYSP101900090101_01 (Middle Fork Crow Creek) and WYSP101900090104_01 (North Branch North Fork Crow Creek). These segments were not included in this TMDL analysis and will be addressed at a future date.

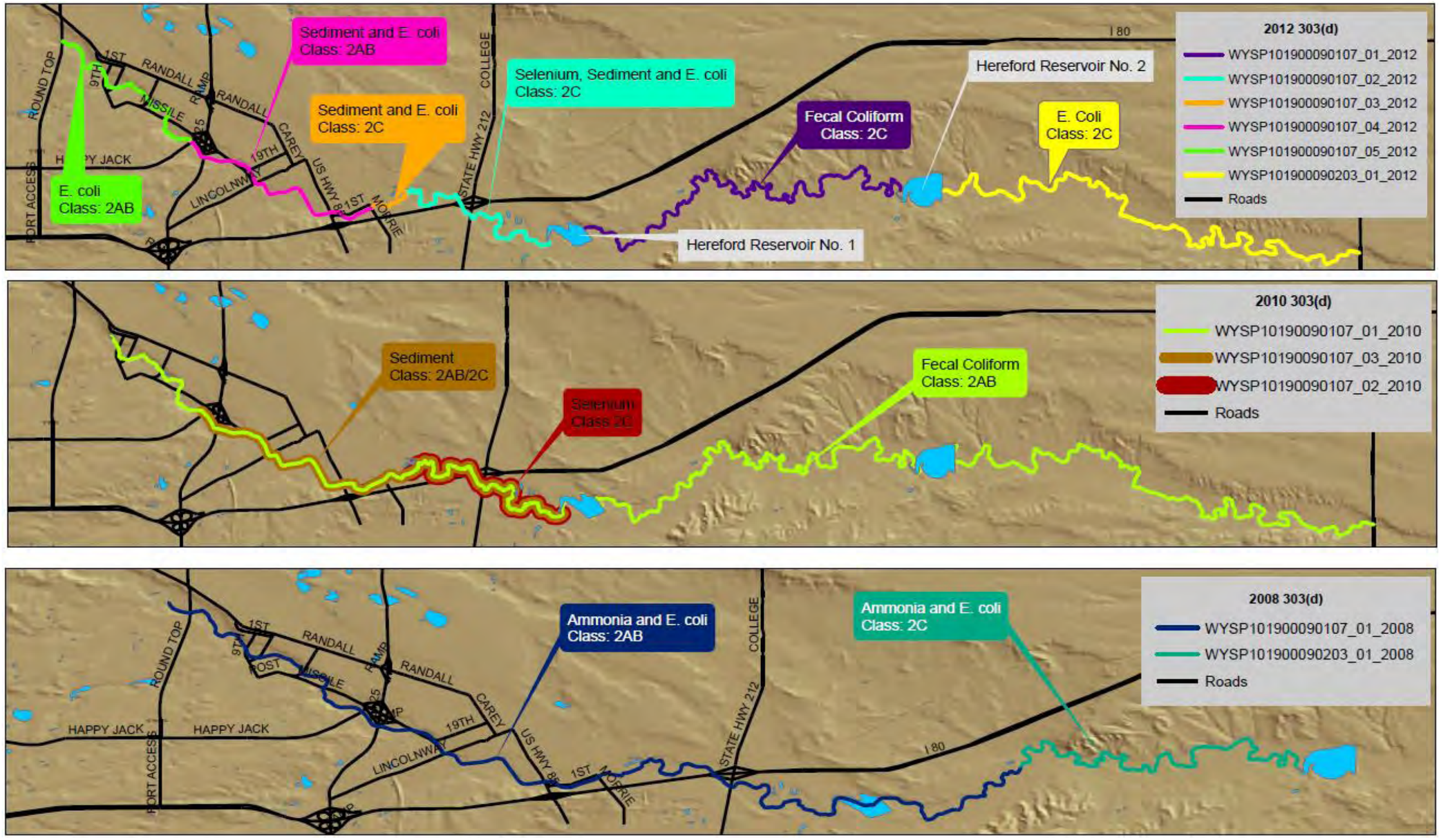

Figure A-1. Crow Creek 303(d) List Segmentation Changes During 2008, 2010, and 2012.

Table A-1. Summary of Load and Exceedance Reductions for *E. coli* Best Management Practices Summer Recreation Season

2012 303(d) List					2013 *E. coli* TMDL Document			
305(b) Identifier	**Class**	**Impairment**	**Location**	**Mile(s)**	**TMDL Report Identifier**	**Location**	**Miles**	**Corresponding 305(b) Identifier**
WYSP101900090107_05	2AB	*E. coli*	From Happy Jack Road upstream to Roundtop Road	3.1	Reach_01	From Roundtop Road to directly downstream of the confluence with Dry Creek	13.6	All of WYSP101900090107_05, WYSP101900090107_04, WYSP101900090107_03, WYSP101900090107_02, and approximately 3 miles of WYSP101900090107_01[a]
WYSP101900090107_04	2AB	*E. coli*	From Morrie Avenue upstream to Happy Jack Road	3.4				
WYSP101900090107_03	2C	*E. coli*	From Morrie Avenue to a point 0.7 mile downstream[b]	0.7				
WYSP101900090107_02	2C	*E. coli*	From 0.7 mile below Morrie Avenue[b] downstream to the inlet of Hereford Reservoir #1	3.7				
WYSP101900090107_01	2C	Fecal Coliform	From the inlet of Hereford Reservoir #2 upstream to the outlet of Hereford Reservoir #1	9.4	Reach_02	From Missile Road (HWY 217) upstream to directly downstream of the confluence with Dry Creek	16.2	Approximately 6.4 miles of WYSP101900090107_01 and all of WYSP101900090203_01[a]
WYSP101900090203_01	2C	*E. coli*	From Missile Road (HWY 217) upstream to the outlet of Hereford Reservoir #2	10.1				

(a) A difference of 0.6 mile exists between the sum of miles of the 2012 listed 303(d) segments and the sum of miles for Reach_01 and Reach_02 from the TMDL document. This difference is attributed to increasing the precision of the database used to delineate the 2012 303(d)-listed segments instead of the database used to delineate the 2008 303(d)-listed segments (which the TMDL document was initially based upon).

(b) 0.7 mile downstream of Morrie Avenue is the approximate location of the point of discharge from Frontier Refinery.

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APPENDIX B

ANIMAL MUNICIPAL CODE

6.08.140 Animal wastes.

A. A person owning, keeping, possessing or harboring any animal must remove and dispose of, in a prompt and sanitary manner, feces left by the animal on any public property or any private property not owned or lawfully occupied by such person.

B. An animal owner is responsible for keeping his or her property free and clear of animal waste to prevent potential harm to the public health, as determined by the city/county health officer, or his or her designee. If a determination is made that a potentially dangerous situation to the public's health exists, a notice of violation may be issued.

C. This section does not apply to persons utilizing a seeing-eye dog or to persons physically handicapped to such a degree that they are incapable of compliance.

D. This section does not apply to owners of animals participating in events for which a permit has been issued by the city clerk.

(2001 In-house code § 7-28)

6.08.180 Feeding geese and ducks prohibited.

A. No person may feed, provide, or give any food or other edible item to any goose or duck, or to any gaggle of geese or flock of ducks, in or upon:

1. Any property owned by the city of Cheyenne within the city limits;
2. Any park, golf course, or other recreation, open space, or public use area within the city limits which is operated by the city of Cheyenne; or
3. Any park, golf course, or other recreation, open space, or public use area within the city limits which is owned by the city of Cheyenne and operated by any third person or entity pursuant to a lease or other use agreement with the city of Cheyenne.

B. Any person who violates the provisions of this section shall, upon conviction, pay a fine of not less than ten dollars ($10.00) and not more than twenty-five dollars ($25.00), together with court costs as may be assessed by the municipal court for convictions of other violations of the Cheyenne City Code for which a criminal penalty is provided.

C. In lieu of a citation, a police officer may issue one written warning to any person who has not previously been convicted of violating this section.

D. No more than one citation alleging a violation of this section may be issued to any one person in any twenty-four (24) hour period.

(Ord. No. 3962, § 1, 10-22-2012)

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APPENDIX C

SEWER SYSTEM MUNICIPAL CODE

13.12.020 Sewer connection required.

All occupied property in the city which is capable of being served by the sanitary sewer system shall be connected with the system. A written or printed notice to connect with the system shall be given by the city health officer to all owners or occupants of properties which are not connected with the system but which are capable of being connected therewith, and unless the time for connection is extended by the governing body, all connections shall be made within thirty (30) days after the mailing of a notice.

(2001 In-house code § 44-41)

13.12.030 Deposit of excrement, garbage or objectionable waste prohibited.

No person shall place, deposit or permit to be placed or deposited in any unsanitary manner, on public or private property within the city or in any area under the city's jurisdiction, any human or animal excrement, garbage, objectionable waste, or pollutants as defined in Section 13.20.020 of the city code.

(2001 In-house code § 44-42)

13.12.040 Outhouses and cesspools declared nuisances—Abatement of same.

All outhouses, septic tanks, cesspools and all means of sewage disposal other than the city sewer system are declared to be nuisances endangering the peace, health and lives of the inhabitants of the city and must be abated. The board shall take such steps as may be necessary to abate such nuisances.

(2001 In-house code § 44-43)

13.12.060 Disposal of sewage to storm sewers or natural outlets prohibited.

It is unlawful to discharge to any natural outlet or storm sewer within the jurisdiction of the city any sewage or other polluted waters.

(2001 In-house code § 44-45)

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APPENDIX D

DETENTION PONDS

Table D-1. Detention Ponds (Page 1 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	89,330	2004		
Detention Pond	16,287	2004		
Detention Pond	17,138	2004		
Detention Pond	16,973	2004		
Detention Pond	52,131	1982		
Detention Pond	86,735	1981	County	
Detention Pond	21,218			
Detention Pond	108,751	1981	County	
Detention Pond	238,86	2005		
Detention Pond	8,876			
Detention Pond	4,067		Private	
Detention Pond	20,799	1996	Private	
Detention Pond	65,308	2004		
Detention Pond	54,390	2002		
Detention Pond	5,713		Private	
Detention Pond	52,728	2004		
Detention Pond	29,365			
Detention Pond	22,707			
Detention Pond	51,712		Private	
Detention Pond	47,632			
Detention Pond	6,950		Private	
Detention Pond	16,837	1998	Private	
Detention Pond	81,790	1989	Private	
Detention Pond	209,915		County	
Detention Pond	39,812			
Detention Pond	1,246,085		County	
Detention Pond	7,923	2005	Private	
Detention Pond	13,145	2002		
Detention Pond	45,305	1998	Private	

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Table D-1. Detention Ponds (Page 2 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	4,703	2005	Private	
Detention Pond	25,359	1989		
Detention Pond	33,745	1989		
Detention Pond	28,217	1993		
Detention Pond	7,923	2006	County	
Detention Pond	18,597			
Detention Pond	7,597	1995	Private	
Detention Pond	1,640	1996		
Detention Pond	18,059	2004		
Detention Pond	12,546	2002		
Detention Pond	1,378	2004		
Detention Pond	21,289	2002		
Detention Pond	14,486	1985	Private	
Detention Pond	13,173			
Detention Pond	41,462			
Detention Pond	198,826			
Detention Pond	157,694	1995		
Detention Pond	3,992	1996	Private	
Detention Pond	22,945	2002		
Detention Pond	446	2005		
Detention Pond	730	2005		
Detention Pond	6,963	2002		
Detention Pond	181,955			
Detention Pond	35,027	1997		
Detention Pond	49,679	1999		
Detention Pond	4,410	1996	Private	
Detention Pond	6,304	1996		
Detention Pond	33,426			
Detention Pond	82,309	1998		

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Table D-1. Detention Ponds (Page 3 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	11,036		Federal	
Detention Pond	197,364			
Detention Pond	2,636		Private	
Detention Pond	51,919	1995		
Detention Pond	42,112	1995		
Detention Pond	52,574	2005		
Detention Pond	28,087	2005		
Detention Pond	2,426			
Detention Pond	14,644	2005		
Detention Pond	52,692	1995		
Detention Pond	15,215	2005		
Detention Pond	11,038	2005		
Detention Pond	22,968			
Detention Pond	35,431	1999		
Detention Pond	63,837	1979		
Detention Pond	25,806			
Detention Pond	4,961	2000		
Detention Pond	2,361	2006		
Detention Pond	85,236	1994		
Detention Pond	1,392			
Detention Pond	29,515			
Detention Pond	344,043	1984		
Detention Pond	8,610	2005	Private	
Detention Pond	854			
Detention Pond	1,010	1998	Private	
Detention Pond	1,317	1998	Private	
Detention Pond	7,004		Private	
Detention Pond	2,097	1994	Private	
Detention Pond	3,816			

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Table D-1. Detention Ponds (Page 4 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	7,076		Private	
Detention Pond	7,400	2005		
Detention Pond	25,743			
Detention Pond	19,309	1990		
Detention Pond	6,859		Private	
Detention Pond	19,818		Private	
Detention Pond	16,776	1992	Private	
Detention Pond	37,999		Private	
Detention Pond	33,623		Private	
Detention Pond	3,503	1995		
Detention Pond	2,583	1996	Private	
Detention Pond	1,589	2004		
Detention Pond	2,580	1998		
Detention Pond	15,715	2000	Private	
Detention Pond	12,718	2000	Private	
Detention Pond	1,585	2004		
Detention Pond	886	2003	Private	
Detention Pond	4,061	2003	Private	
Detention Pond	3,665		Private	
Detention Pond	27,864	2005		
Detention Pond	15,000	2005		
Detention Pond	12,189		Private	
Detention Pond	32,307	1980		
Detention Pond	19,572	2005		
Detention Pond	7,323			
Detention Pond	7,259	1997		
Detention Pond	25,268			
Detention Pond	37,730		Private	
Detention Pond	5,714			

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Table D-1. Detention Ponds (Page 5 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	15,219			
Detention Pond	8,599	1994		
Detention Pond	91,485	2007	Private	
Detention Pond	26,253	1995		
Detention Pond	12,593			
Detention Pond	4,796			
Detention Pond	9,458	1995		
Detention Pond	8,014	2001		
Detention Pond	27,381	2004		
Detention Pond	17,944			
Detention Pond	4,399	1983	Private	
Detention Pond	2,585	1983	Private	
Detention Pond	4,585	1983	Private	
Detention Pond	15,791			
Detention Pond	34,856	1984		
Detention Pond	2,272	1984		
Detention Pond	5,471	1993		
Detention Pond	14,859	1998		
Detention Pond	3,421	2005		
Detention Pond	6,744			
Detention Pond	10,856	2004		
Detention Pond	7,176	2006		
Detention Pond	6,407	2006		
Detention Pond	15,056	2004		
Detention Pond	10,192	2004		
Detention Pond	12,089			
Detention Pond	1,462	2005		
Detention Pond	2,893	2005		
Detention Pond	4,326	2001		

— DRAFT —

Table D-1. Detention Ponds (Page 6 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	1,5240	2004		
Detention Pond	9,267	2001		
Detention Pond	62,662	1990		
Detention Pond	25,342	2003		
Detention Pond	3,760	2001		
Detention Pond	36,398	2003		
Detention Pond	31,665	1991		
Detention Pond	20,417	2003		
Detention Pond	7,011	2002		
Detention Pond	80,832	1991		
Detention Pond	47,015	1991		
Detention Pond	12,898	2003		
Detention Pond	31,754	1981		
Detention Pond	19,421	1986		
Detention Pond	10,900			
Detention Pond	14,929			
Detention Pond	18,481			
Detention Pond	17,838			
Detention Pond	66,236			
Detention Pond	22,390			
Detention Pond	211,854			
Detention Pond	10,322	2006	Private	0.55
Detention Pond	8,630	2006	Private	0.65
Detention Pond	6,006	2000	City	
Detention Pond	9,809			
Detention Pond	137	2008	County	
Detention Pond	28,435	2008		2.01
Detention Pond	134,896	2008		
Detention Pond	3,978	2008	Private	

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Table D-1. Detention Ponds (Page 7 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	10,343		Private	
Detention Pond	84,809	2008		5.76
Detention Pond	323,348	2008		18.75
Detention Pond	21,238	2008		
Detention Pond	4,060	2008		
Detention Pond	4,633	2008		
Detention Pond	4,011	2008		
Detention Pond	1,892	2008		
Detention Pond	20,409	2009	County	
Detention Pond	4,002	2008		
Detention Pond	3,403	2006	Private	0.173
Detention Pond	1,111	2008	Private	
Detention Pond	472	2008	Private	
Detention Pond	711	2008	Private	
Detention Pond	1,409	2008		
Detention Pond	4,972	2006	Private	
Detention Pond	2,043	2006	Private	
Detention Pond	196,568	2009		38.6
Detention Pond	481,951	2009		72.6
Detention Pond	106,192	2009		31.8
Detention Pond	402,474	2009		142
Detention Pond	4,371	2008		
Detention Pond	17,407	2006		
Detention Pond	1,220	2006		
Detention Pond	2,779	2006	Private	
Detention Pond	3,833	2008	Private	
Detention Pond	1,169	2008	Private	
Detention Pond	190,849	2009		26.6
Detention Pond	2,567			

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Table D-1. Detention Ponds (Page 8 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	15,101	2009		
Detention Pond	1,901	2009	Private	
Detention Pond	1,802	2009	Private	
Detention Pond	1,646	2009	Private	
Detention Pond	1,481	2009	Private	
Detention Pond	1,255	2009	Private	
Detention Pond	6,623	2009	Private	
Detention Pond	2,162	2009	Private	
Detention Pond	984	2009	Private	
Detention Pond	172	2009	Private	
Detention Pond	2,582	2005	Private	
Detention Pond	7,581	2005	Private	
Detention Pond	2,511	2005	Private	
Detention Pond	3,936	2005	Private	
Detention Pond	6,711			
Detention Pond	42,445	2009		
Detention Pond	31,802	2009		
Detention Pond	3,275	2009		
Detention Pond	15,508	2009	Private	
Detention Pond	48,469	1993		
Detention Pond	4,592	2007	Private	
Detention Pond	20,941	2008	Private	0.5
Detention Pond	19,195		Private	
Detention Pond	24,934	2009		
Detention Pond	154,318		Federal	
Detention Pond	1,812	2007	Private	
Detention Pond	1,551	2009	Private	
Detention Pond	2,337	2006	Private	
Detention Pond	2,416	2006	Private	

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Table D-1. Detention Ponds (Page 9 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	24,616	2009	Private	1.33
Detention Pond	16,647	2009	Private	0.74
Detention Pond	4,473	2009	Private	0.25
Detention Pond	19,476	2009	Private	0.36
Detention Pond	15,503	2008	Private	
Detention Pond	3,381	2008	Private	
Detention Pond	23,223	2007	Private	
Detention Pond	11,852			
Detention Pond	4,980	2010	Private	
Detention Pond	13,282	2010	Private	
Detention Pond	4,594	2010		
Detention Pond	4,936	2009		
Detention Pond	3,359	2008	Private	
Detention Pond	38,006	2008	Private	
Detention Pond	1,017	2006	Private	
Detention Pond	510	2006	Private	
Detention Pond	970	2006	Private	
Detention Pond	10,100		Private	
Detention Pond	4,233	2009	County	
Detention Pond	7,318	2007	Private	
Detention Pond	1,336	2007	Private	
Detention Pond	1,407	2010	Private	
Detention Pond	1,254	2010	Private	
Detention Pond	1,896	2010	Private	
Detention Pond	1,911	2005	Private	
Detention Pond	995	2005	Private	
Detention Pond	12,897	2011		
Detention Pond	8,152	2011		
Detention Pond	2,591	2011		

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Table D-1. Detention Ponds (Page 10 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	5,519	2011		
Detention Pond	13,025	2006		
Detention Pond	143,369	2011		
Detention Pond	22,317	2011		
Detention Pond	71,381	2011		
Detention Pond	3,678	2011		
Detention Pond	3,503		Private	
Detention Pond	6,206	1998	Private	
Detention Pond	4,710			
Detention Pond	8,905			
Detention Pond	50,246	2002	Private	
Detention Pond	7,238	2009	State	
Detention Pond	3,446	2009		
Detention Pond	9,954	2002	Private	
Detention Pond	4,280	2008		
Detention Pond	78,365	2012		
Detention Pond	7,854	2011		
Detention Pond	26,719	1997	Private	
Detention Pond	1,180	2001	Private	
Detention Pond	994	2001	Private	
Detention Pond	22,059	2007		
Detention Pond	9,389	2007		
Detention Pond	7,046	2007		
Detention Pond	5,192	2012	Private	
Detention Pond	28,890	2012	Private	
Detention Pond	14,760	2012		
Detention Pond	6,293	2012	Private	
Detention Pond	29,091	2012		
Detention Pond	3,343			

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Table D-1. Detention Ponds (Page 11 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	2,853	2007	Private	
Detention Pond	269,36	2012		
Detention Pond	13,554	2012		
Detention Pond	8,322	2012	Private	
Detention Pond	3,560	2012	Private	
Detention Pond	3,294	2012	Private	
Detention Pond	1,903	2012	Private	
Detention Pond	44,775			
Detention Pond	99,090	2007	Private	
Detention Pond	654	2005	Private	
Detention Pond	911			
Detention Pond	6,352	2011	Private	
Detention Pond	31,696	2011	Private	
Detention Pond	3,759	1991	Private	
Detention Pond	6,404			
Detention Pond	9,627	2013		
Detention Pond	10,440	2013		
Detention Pond	2,162	2013		
Detention Pond	13,505	2013		
Detention Pond	3,482			
Detention Pond	21,422			
Detention Pond	8,449	2006	Private	
Detention Pond	2,837	2013	Private	
Detention Pond	50,916	2013	Private	
Detention Pond	72,627	2013	Private	
Detention Pond	17,551	2013	Private	
Detention Pond	67,353	2013		
Detention Pond	27,787	2013	Private	
Detention Pond	48,867	2013		

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Table D-1. Detention Ponds (Page 12 of 12)

Name	Area	Year	Maint_	Acre_ft
Detention Pond	292,501	2012	Private	
Detention Pond	6,815			
Detention Pond	11,320			
Lake	295,952			
Lake	68,014			
Lake	53,110			
Lake	61,755			
Lake	877,743		Federal	
Lake	514,422		Federal	
Lake	604,495			
Lake	476,657			
Lake	461,275			
Lake	551,994			
Lake	1,404,533			
Lake	423,170		Private	
Lake	222,664		Private	
Lake	37,195			
Lake	76,916			
Lake	3,868,285			
Retention Pond	222,538	1988		
Retention Pond	11,362			
Retention Pond	150,237	2003		
Retention Pond	20,139	2009	County	
Retention Pond	21,847	2009	County	
Retention Pond	19,736	2009	County	
Retention Pond	139,807	2009	County	

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APPENDIX E

CHEYENNE DRAINAGE IMPACT STUDIES

3.2 Drainage Impact Studies

3.2.1 General Provisions

a. ***Purposes.*** In addition to the general purposes of these regulations, this Section purposes to establish minimum stormwater management requirements and controls to protect and safeguard the general health, safety, and welfare of the public residing in watersheds within the City. Specifically to:

1. Assure stormwater facilities are planned and designed to minimum criteria.
2. Minimize increases in nonpoint source runoff and pollution caused by stormwater runoff from development in order to reduce flooding, erosion, increases in stream temperature, and maintain the integrity of existing stormwater systems.
3. Treat stormwater runoff at the source by preserving or enhancing natural flow paths and vegetative cover, preserving or enhancing natural open spaces and riparian areas, disconnecting impervious surfaces, and other measures that replicate pre-development hydrologic conditions to preserve the natural hydrologic functions, stream characteristics and groundwater recharge to the maximum extent practical.
4. Mitigate increases in stormwater runoff rates and volumes due to development, wherever possible, through stormwater management controls.
5. Ensure that stormwater management controls pose no threat to public safety and are properly maintained.

b. ***Applicability.*** This Section applies to all land development activities, including rezoning, site plan applications, subdivision, grading applications, or other development activities.

c. ***Waiver*****.** Requests for waivers for drainage impact studies shall be made in writing to the City Engineer. The City Engineer shall review the request and approve the grant for a waiver or identify the level of study required for the proposed development action. The City Engineer may waive the requirement for a drainage study based on the following:

1. Information is provided to substantiate there are no potential drainage problems at the site or downstream of the site (including impacts to downstream floodplains).
2. The development or redevelopment will not create drainage problems.
3. The development or redevelopment will not result in an increase in the impervious area.
4. The development or redevelopment of an area is immediately adjacent to a major drainageway that is capable of conveying the fully developed basin 100-year flood without impact to the base flood elevation.

d. ***Applicant Responsibilities.***

1. All responsibilities for the planning, design and construction of drainage improvements required in conjunction with land development shall be vested in the person or party who is developing the land (developer).

2. The developer shall be responsible for obtaining all approvals and/or permits from regulatory entities (i.e. City, County, State, and Federal) and shall comply with all applicable statutes pertaining to water quality and water pollution control.
3. The developer shall be responsible for securing approval of a final drainage report and construction plans prior to issuance of a Grading, Sediment & Erosion Control (GESC) permit and construction of any drainage improvements. This requirement will not apply to proposed land disturbance activities or projects where the requirement for a drainage report has been waived.

e. ***City Responsibilities.*** Drainage system design and construction shall be accomplished under the authority of the City Engineer. The City Engineer shall assume the responsibility of reviewing proposed projects and activities that disturb the land surface to insure general compliance with City regulations and with approved plans. The City does not coordinate approvals with other regulatory agencies on items under this Section.

The City Engineer shall review the submitted materials for compliance with design parameters outlined below and provide comments and recommendations on the submitted plans. Acceptance of a drainage report implies the City Engineer concurs with the project's overall stormwater management concept. Approval of a drainage report submitted without construction plans or improvement plans outlining a detailed drainage design constitutes only a conceptual approval and should not be construed as final approval of drainage plan design. Submitted reports and analyses shall be performed following the intent of professionally recognized methods.

The City shall have the right and option to designate surface water storage areas to serve large land areas, which may include multiple subdivisions, developments and/or land owners. This option may be exercised when the City/County Drainage Plan has designated areas for storage as part of the overall surface water plan, or, when in the opinion of the City Engineer, a single storage facility serving a large area is more efficient to construct, less expensive to maintain, and more easily adapted to multiple land uses.

In such cases, the City Engineer may initiate an Improvement District or utilize the reimbursement program allowed in Chapter 1.16.080 as a means of constructing the required improvements. On the occasion that the Developer constructs these improvements that directly benefits other areas or properties, the Developer may utilize the reimbursement program in accordance with Chapter 1.16.070.

3.2.2 Levels of Study

The following levels of analysis apply. These Categories are intended as guidelines and may be revised, when warranted, by the City Engineer.

a. ***Less than 20,000 square feet (sf).*** New, infill, or re-development with a total area of the project site less than 20,000 sf when all phases are complete shall complete the Drainage Worksheet. Detailed studies and detention and water quality requirements are waived.

b. ***Infill or re-development 20,001 sf to 40,000 sf.*** A detailed drainage study shall be completed and the WQCV shall be treated in a post-construction BMP. Detention requirements to control the peak discharge are waived*.

c. ***Infill or re-development 40,001 sf to 75,000 sf*.*** A detailed drainage study shall be completed, the WQCV shall be treated in a post-construction BMP, and detention for the 10-year storm provided. Detention requirements to control the 100-year peak discharge are waived*.

d. ***Infill or re-development greater than 75,000 sf or new development greater than 20,000 sf.*** A detailed drainage study shall be completed and all water quality and detention requirements shall be complied with to the maximum extent feasible.

* Not applicable if 1) the site is located in an area of known drainage problems, 2) the site is located within a floodplain, 3) there is a channel, swale, or other drainage conveyance on the site, or 4) the topography immediately downstream from the site obstructs the run-off in a way that may cause risk to buildings or roadways.

3.2.3 Drainage Design

a. ***General.***

1. Design shall preserve existing natural features, drainage features and historical flow patterns to the extent they can be incorporated into the site development plan and they fit the context and urban design principles for the general area.
2. Drainage facilities shall be designed and constructed in accordance with the City Construction Specifications, the City Stormwater Management Manual and/or the UDFCD Urban Storm Drainage Criteria Manual (UDFCD Manual).
3. Provisions shall be made in the planning and development of land to provide for the temporary and/or permanent storage of surface water run-off. Storage shall be provided to the extent that the peak rate of flow from the project area after development shall not exceed the specified peak rate of flow prior to development, in accordance with the design standards as established herein.

   The City Engineer is authorized to require a lower allowable discharge rate in specific basins or sub-basins if, in his professional judgment, a lower allowable discharge rate is required to prevent additional adverse impacts on downstream properties. A lower allowable discharge rate shall be documented in writing and be supported by reproducible engineering calculations, referenced to the Drainage Master plan.

   If it can be demonstrated, subject to City approval, that the increased volume and rate of run-off caused by a proposed development when considered in

combination with other existing or planned development or land uses will not cause the design criteria herein to be exceeded or that the required storage is provided in an off-site facility, then it shall not be required that the individual project (or projects) provide the storage as outlined above or that a partial amount of the required storage be provided.

4. City rainfall Intensity-Duration-Frequency information is presented in Table 1 and Figure 1.

TABLE 1: Rainfall Intensity – Duration – Frequency

Duration (Minutes)	Rainfall Intensity (inches per hour)					
	(2 Year)	(5 Year)	(10 Year)	(25 Year)	(50 Year)	(100 Year)
5	3.42	4.75	5.70	6.98	8.00	9.07
10	2.64	3.66	4.38	5.40	6.12	6.90
15	2.20	3.04	3.60	4.36	4.96	5.56
30	1.34	1.96	2.42	3.06	3.56	4.12
60 (1 hr.)	0.73	1.10	1.41	1.87	2.27	2.73
120 (2 hr.)	0.41	0.63	0.83	1.16	1.46	1.84
1440 (24 hr.)	0.06	0.08	0.10	0.13	0.15	0.18

Data Source: USGS Water Resources Investigation (WRI) 87-4225 Precipitation Records and Flood-Producing Storms Cheyenne, Wyoming.

5. Drainage planning and design shall evaluate rainfall event frequencies of a 5-Year, 10-Year, 50-Year, and 100-Year peak runoff. Design rainfall events from drainage master plans, FEMA FIS studies, and subsequent references to those documents shall generally be accepted. It is recommended to contact the City Engineer for appropriate design parameters early in the planning stages of a project.
6. Drainage planning shall provide for conveyance from areas upstream of, and within, a project to be maintained for a 100-Year frequency storm event.
7. All drainage improvements shall be designed to convey the Minor Storm, as a minimum, with provisions made to maintain the Major Storm conveyance needs of facilities. Specific requirements are outlined in Table 2 below.

TABLE 2: Design Storm Frequency

Zoning District/Land Use	Minor	Major
Parks/Open Public Lands	2-Year	100-Year
Agricultural/Rural Residential	5-Year	100-Year
Urban Residential	5-Year	100-Year
Commercial	10-Year	100-Year
Industrial	10-Year	100-Year

8. Drainage facilities shall be designed to minimize mosquito breeding.
9. Potential impacts of groundwater or sub-surface water shall be quantified, to the extent possible, and considered during drainage planning and design.
10. The developer/property owner shall be responsible for obtaining approvals for new bridges or large span culverts from the Wyoming Department of Transportation.
11. To ensure for the proper construction, maintenance, and access to the drainage system, drainage easements shall be provided in all areas traversed by channels, drainage swales, storm sewers and detention or storage areas.
12. Existing stormwater management facilities on redevelopment sites are not required to be retrofitted to meet the current design standards if the existing facilities remain hydraulically isolated from the redevelopment area.

b. ***Design Criteria and Parameters.***

1. Storm Sewers
   (a) Storm sewers shall not be designed surcharged for the minor storm (surcharged is a depth of flow greater than 80% of the diameter). The maximum hydraulic head shall be 0.5 feet below the lip of drop inlets for the minor storm. Hydraulic grade lines (HGLs) shall be shown on design profiles.
   (b) Minimum velocity is 3 feet per second (fps) (at 25% of height). Maximum velocity is 18 fps, or per manufacturer specifications.
   (c) Manholes shall be placed at junctions, or whenever there is a change in size, direction, or grade. Maximum spacing is 350 feet.
   (d) Minimum clearance between adjacent pipes within manholes or inlets is 12 inches (measured outside to outside).
   (e) All conduits 54” and greater shall have headwalls and wingwalls. Smaller pipes shall have headwalls and wingwalls or flared-end sections. Flared-end sections shall require joint fasteners and toe walls extending 3 feet below the invert.
   (f) Headwalls and wingwalls shall have guardrails, handrails, or fencing in conformance with local building codes and roadway safety requirements. Handrails shall be required in areas frequented by pedestrians or bicycles. Handrail heights shall be 42 inches for pedestrian walkways or open areas, and 54 inches for bicycle traffic. Acceptable materials include, but are not limited to galvanized or painted steel, aluminum, and chain-link fence.
   (g) Maximum headwater depth is 1.5 times the storm sewer height for the design storm (HW/D = 1.5). This criteria does not apply to stormwater detention pond outlets.
   (h) Storm sewer flows exceeding 5 fps velocity or 5 feet of depth shall provide outlet protection. Outlets shall be protected with riprap, concrete or a stilling basin per the UDFCD Manual.
   (i) Storm sewers and appurtenant structures shall be designed to withstand HS-20 loading.
2. Channels

(a) Channels shall be designed for the 100-year flood assuming a fully developed watershed, with freeboard of 1.0 foot. The freeboard is measured vertically from the design water surface elevation to the top of bank.
(b) Grass-lined channels are desirable, including a low-flow channel with a minimum capacity of 1/3 the 2-year flood.
(c) Maximum velocities are 5 fps for erosive soils and 7 fps for non-erosive soils.
(d) The centerline radius shall be a minimum of two times the 100-year flood topwidth.
(e) Bank slopes a minimum of 4:1 (horizontal to vertical) are desirable; slopes steeper require review and approval. Riprap bank protection is required for bank slopes steeper than 4:1 and to stabilize channels along the outside of bends. Riprap bank protection shall consist of soil riprap, buried with 6 inches of topsoil and revegetated. Riprap bank protection shall extend to the depth of the 2-year flood, or as approved by the City Engineer.
(f) A 15 foot maintenance access shall be provided along one side, adjacent to the top.

3. Detention
   (a) Detention of stormwater shall be based on the more restrictive of: 1) no increases in peak discharge rates; 2) 100-year post-project peak rate no greater than the 50-year pre-project peak rate; or 3) the downstream conveyance capacity of a project. Drainage facilities shall be designed to, at a minimum, not adversely impact downstream properties. Proposals to increase downstream conveyance capacity of an area may be considered in-lieu of over-detention on a project, with justification.
   (b) Drainage planning shall not include the use of right-of-way or road embankments as detention storage areas unless approved by the City Engineer.
   (c) Drainage planning and design shall provide for stormwater detention based on a design storm up to a 100-Year frequency. The design shall maintain post-development runoff rates to pre-development rates for return periods up to the 50-year frequency. The 100-year post-development rate shall be held to the 50-year pre-development rate.
   (d) The 10-year peak discharge and volume for infill or re-development project sites of 40,001 sf to 75,000 sf shall be based on the following equations:

$$Q_{10} = \text{Area} * 0.23$$

$$\text{Volume}_{10} = \text{Area} * [(0.95 * I - 1.90) / 1000]$$

where Area is the project area, in acres
I is the project imperviousness, in percent
Q_{10} is the allowable 10-year peak release rate, in cfs
Volume_{10} is the 10-year detention volume, in acre-feet

   (e) A waiver for any detention storage requirements shall include all information necessary to substantiate the detention waiver request.
   (f) Minimum longitudinal slopes are 0.5% for concrete and 2% for grass. Minimum cross slope is 2%. Detention facilities designed with underdrains may reduce the longitudinal and/or cross slopes to 1% with approval of the City Engineer.

(g) Outlet structures shall be functional for controlling the design release rates, provided with oversized safety/debris grates to reduce the potential for debris plugging, easy to maintain, and designed with favorable aesthetics. Grate sizing shall be per the UDFCD Manual.

(h) Embankments shall be no steeper than 4:1 below the 100-year water surface elevation and no steeper than 3:1 above the 100-year water surface elevation. Embankment top width shall be 40% of the maximum dam height plus 4 feet, consistent across the entire dam. Earthen slopes shall be covered with 6 inches of topsoil and vegetated.

(i) Emergency spillways shall be included in the design planning for detention facilities. The emergency overflow spillway shall be sized to convey the 100-year inflow peak. Spillway design velocities exceeding 5 fps shall require buried soil riprap.

(j) Minimum freeboard shall be 1 foot, measured above the emergency overflow spillway design water surface elevation to the top of dam.

(k) A 15 foot maintenance access with an 8 foot all weather surface shall be provided as needed to assure access to all pond components.

(l) Retaining walls within ponds are generally discouraged.

(m) Two signs, with a minimum area of 3 SF shall be provided. The signs shall be fabricated using red lettering on a white background with the following message:

WARNING
THIS AREA IS A STORMWATER FACILITY
AND IS SUBJECT TO PERIODIC FLOODING

(n) Parking lot detention criteria include:

(1) The maximum allowable design depth above pavement surfaces is 3 inches for the water quality volume, and 9 inches for the 100-year flood.

(2) All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum area of 1.5 SF and contain the following message:

WARNING
THIS AREA IS A DETENTION POND AND
IS SUBJECT TO PERIODIC FLOODING
TO A DEPTH OF 9 INCHES OR MORE

4. Water Quality

(a) Construction projects meeting any of the following criteria are required to submit for review and approval 1 copy (signed) of the applicable Construction Activity WyPDES Permit and 1 copy of the SWPPP:

(1) Any project required to submit site construction plans to the City for review and approval, excluding building permit plans;

(2) Any project that disturbs 1.0 acre or more;

(3) Installation or repair of utility lines in excess of 1000 linear feet (outside of the City Right-of-Way);

(4) Installation of utilities for a new development exceeding one single-family residence and appurtenant structures, prior to the start of overlot clearing or grading;

(5) Any clearing, grubbing, grading or filling operations located within 100 feet of a major drainageway or designated flood hazard area;
(6) Fill or excavation of 50 or more cubic yards of material, not related to building of a detached single family residential unit;
(7) Any building demolition project; or
(8) Any project that the City Engineer determines to have a potential impact to the health, safety and welfare of people and/or the environment.

(b) Post-construction BMPs are required to treat a minimum of the WQCV as defined in the UDFCD Manual. The WQCV shall be added to the detention volumes up to the 50-year, and a minimum of 50% of the WQCV shall be added to the 100-year detention volume.

(c) Reducing Directly Connected Impervious Area (DCIA) is required. At least 20 percent of the upstream impervious area shall be disconnected and drain through a receiving pervious area comprised of at least 10 percent of the upstream disconnected impervious area. The receiving pervious area shall consist of some combination of grass buffers, swales or porous pavement, designed in accordance with the UDFCD Manual.

(d) Exemptions from Post-Construction BMP Requirements may include: 1) Single-family residential lots with a disturbed area less than 0.5 acres, not part of a larger subdivision; 2) Projects with a total imperviousness less than 10 percent for any given acre; 3) Roadway improvement projects that add less than 1.0 acre of new pavement; 4) Subwatershed areas less than 0.5 acre draining off a site; or 5) Other projects determined by the City to have negligible effect on stormwater quality.

5. Roads

(a) General. New culverts shall not impound runoff to cause inundation of surrounding properties unless associated with a designed stormwater detention facility. Crossings in floodplains shall meet the City Floodplain and Surface Water Management Regulations and FEMA National Flood Insurance Program requirements. The major storm shall be contained within the public right-of-way or easements.

(b) Urban

(1) Local Street Storm Sewer/Street Networks:
Minor Storm – No curb overtopping. Maximum depth of 6” in cross pans.
Major Storm – Maximum depth 12’’ above gutter flowline.

(2) Collector/Minor Arterial Street Storm Sewer/Street Networks:
Minor Storm – No curb overtopping and one 10 foot interior drive lane clear of spread. Maximum depth of 6” in cross pans, where allowed.
Major Storm – Maximum depth 12’’ above gutter flowline. Maximum depth of 12” at cross street intersections.

(3) Major Arterial Street Storm Sewer/Street Networks:
Minor Storm – No curb overtopping and two 10 foot interior drive lanes clear of spread. No cross street flows allowed.
Major Storm – Maximum depth 12’’ above gutter flowline. Maximum depth of 6” at cross street intersections.

(c) Rural

(1) Public Roads: Culverts - Minor Storm; Roadside ditches - Major Storm.
(2) Drainage Channels or Swales (Major Storm within easement).

6. Easements. Easements shall include access from the public right-of-way. Drainage easements shall be shown on the drainage plan and final plat. Drainage easements shall be kept clear of impediments to the flow.

(a) Storm Sewers

TABLE 3: Minimum Acceptable Storm Sewer Easement Widths

Pipe Size	Easement Width
Less than 36-inch diameter	25 feet*
36-inch diameter and larger	30 feet*

*Or as required to meet Occupational Safety and Health Administration (OSHA) and/or construction requirements

(1) When relatively large diameter pipes are proposed or when design depths are excessive, greater easement widths will be required, as determined by the City.
(2) The pipe shall be constructed at one-third of the easement width to allow for stockpiling of material on one side of the storm sewer trench.
(3) Storm sewer easements should be designed to convey above ground flows in the event the storm sewer or inlet becomes clogged or full. It is therefore necessary to limit uses within the easement to ensure that surface conveyance redundancy and maintenance access is not impaired. Minor landscaping, including rock, shrubs etc. may be appropriate where it can be demonstrated that the function of the easement is not compromised by the presence of the materials. Pavement over a storm sewer easement is allowable, providing that the property owner assumes responsibility for replacement in the event it is necessary to remove it to access the pipe. Improvements that are not allowed on storm sewer easements include structures of any kind, retaining walls, permanent fencing, trees and others if determined by the City to be a problem and/or costly to replace. Surface treatments on drainage easements shall be shown on the drainage plan, and accepted by the City.

(b) Channels

(1) To ensure that drainageways and the associated conveyances are adequately preserved and properly maintained, all drainageways that convey flows from other properties should be placed on tracts of land owned by a public entity (i.e., special district, homeowner's association, City, other regional agencies, etc.). Easements are allowed for drainage swales between individual lots.
(2) Required easement widths for natural drainageways need to provide for conveyance of design flow rates, required freeboard, and access for maintenance. Any banks allowed to remain in place at a slope steeper than 4 to 1 shall have the easement line set back from the top of the bank to allow for some lateral movement or future grading improvements to the

bank. The easement line shall be no closer than the intersection of a 4 to 1 line extending from the toe of the slope to the proposed grade at the top of the bank, plus an additional width of 15 feet for an access bench, if access is not feasible within the floodplain.

(c) Ponds. The minimum easement requirements for detention basins are as required to contain storage and WQCV including freeboard, associated facilities, and adequate maintenance access around the perimeter.

c. ***Special Flood Hazards.*** The drainage requirements and regulations for the development of land located in and adjacent to permanent or periodic streams subject to flooding, and identified and designated as potential flood areas by the Federal Emergency Management Agency (FEMA), or the City's Special Flood Hazard Area map, shall also be in accordance with Chapter 13.24 – FLOODPLAIN AND SURFACE WATER MANAGEMENT.

d. ***Alternative Compliance Measures.*** The developer may propose and the City Engineer may approve alternative compliance measures. Alternative compliance measures include new technologies, overall system improvements, innovative procedures, and new materials. It shall be the applicant's responsibility to demonstrate that alternative compliance measures meets these criteria and meets the Purposes of this Section. The review of alternative compliance measures shall be based upon:

1. Whether the alternative compliance proposed is part of a plan to improve stormwater management equally or better on a larger scale beyond the immediate site.
2. The extent that alternative site design strategies construct all or a portion of the larger-scale improvements in the chain of treatment and complies to these standards to the fullest extent possible.
3. Data and calculations, studies, industry publications, or additional evidence such as successful use in other jurisdictions to demonstrate any of these criteria.

e. ***Exceptions.*** Where due to the physical limitations of the project site, topography or ground slopes, soil or rock conditions or other physical or context limitations, meeting the mitigation Standards and Design Criteria is not feasible, the City Engineer may grant exceptions to the standards. Review of requested exceptions shall be based upon:

1. Whether the situation giving rise to the requested exception is due to the applicant's actions.
2. Whether the alternative compliance proposed will harm offsite properties, either in the interim or permanent conditions.
3. Whether the requested exception complies with this chapter to the fullest extent possible.

The City may condition any exception in any way that ensures the above criteria are met, including participation in the funding of any off-site improvements, the formation

of a local improvement district, or other stormwater master planning strategies and facilities that ensure the Purposes of this Section are met.

3.2.4 Study Reports

The primary purpose of a drainage study/investigation is to identify drainage related issues and outline a plan to mitigate all potential negative impacts resulting from the proposed development action. The design representative is recommended to contact the City Engineer to discuss drainage related issues and potential mitigation efforts early in a project.

Final drainage reports will be valid for one year from the date of City Engineer's approval. If construction drawings have not been developed and accepted by the City Engineer within one year, the final drainage report must be submitted for re-acceptance. Review and re-acceptance will be based upon any new criteria or standards adopted since the drainage report was initially accepted.

a. ***General Requirements.***
   1. A cover sheet with project name and location, type of report (Conceptual, Preliminary, or Final), name of firm or agency preparing the report, date of the report, table of contents, and page numbers.
   2. A certification sheet with the following statement, and appropriate signatures:

      "I hereby attest that this report for the (Conceptual, Preliminary or Final) drainage design of (Name of Development) was prepared by me, or under my direct supervision, in accordance with the provisions of City of Cheyenne Land Use Regulations for the responsible parties thereof. I understand that City of Cheyenne does not and shall not assume liability for drainage facilities designed by others.

      _____
      Registered Professional Engineer

      State of Wyoming No._____ (Affix Seal)

   3. A vicinity map (if not included with a plat map) along with applicable addresses, Township, Range, and Sections and ¼ Section. Identify adjacent existing and proposed streets and subdivision names.
   4. Discussion of the major drainage basin and subbasins, if applicable.
   5. Discussion of the existing property and adjacent right-of-ways impacted by the project and predevelopment drainage characteristics. This shall include identifying current floodplain and flood hazard areas.
   6. Discussion of any upstream properties and existing upstream drainage characteristics.
   7. Discussion of existing conveyance downstream of project to nearest major drainageway. This shall include identifying potential downstream conveyance/capacity issues.

8. Discussion of proposed stormwater management plan to mitigate post-development drainage impacts. This shall include outlining a plan to maintain conveyance from upstream projects and proposed stormwater detention systems on the site.
9. Other items of discussion may be included to provide additional background information or substantiate the proposed drainage plan.
10. For projects anticipated to be sold off for future development by others, the conceptual drainage report shall outline a conceptual drainage plan (anticipated surface and storm drain conveyances along with detention requirements) for the entire development. This shall include accounting for all initially anticipated improvements.
11. An overall drainage plan map is required for projects larger than 2 acres or at the request of the City Engineer. Drainage map(s) shall be a minimum of 11” x 17” in size with a scale of 1”=20’ to 1”=100’ as required to show sufficient detail. The overall drainage plan map(s) shall include the following:
    (a) Outline of upstream area including existing & proposed inflow points;
    (b) Outline of overall project area, including property lines, street right-of-ways, and all easements;
    (c) Outline of downstream conveyance path to nearest major drainageway;
    (d) Outline of proposed drainage features;
    (e) Existing/proposed drainage patterns. Contours shall be at two foot intervals unless otherwise approved by the City Engineer, with proposed elevations sufficient to analyze drainage patterns extending 100 feet beyond property limits. Contour elevations shall be referenced to USGS vertical datum where contours are taken from USGS maps, or referenced to the most current aerial mapping of the City and County. Locate and label all drainage basins, sub-basins and floodplains;
    (f) Proposed outfall location of point discharges and ultimate receiving drainageway.
12. References to master plans or other relevant local studies shall be included in the conceptual report narrative.
13. For hydrology computations, include and clearly identify the following, if applicable:
    (a) Any computer modeling software and version used with an analysis;
    (b) Precipitation/runoff methodology/model used for analysis on the project (i.e. Rational Method, Kinematic Wave, SCS Unit Hydrograph, EPA SWMM, CUHP, etc.). Rational Method may be used for tributary acres of 30 acres or less;
    (c) Rainfall data or design storm source references;
    (d) Rainfall loss method (i.e. runoff coefficient(s), curve number, Horton, Green-Ampt, etc.) and input parameters;
    (e) All other input parameters and calculations (area, timing, connectivity, rating curves, etc.);
    (f) Summarized results with complete computer modeling output.
14. For hydraulic computations, include and clearly identify the following, if applicable:

(a) Any computer modeling software and version used with an analysis;
(b) Parameters (materials, lengths, size, roughness, rating curves, etc.);
(c) Summarized results with complete computer modeling output.

15. Geotechnical investigations and reports are required if planned detention ponds or other drainage facilities rely on infiltration.

b. ***Conceptual Plan.*** Conceptual drainage reports are primarily for development projects which are being developed before or during a preliminary plat/preliminary development plan stage and anticipated to evolve into final drainage plans with future development action submittals. The intent of the Conceptual Drainage Report is to outline drainage planning for the project in narrative and visual format for review by the City Engineer prior to preparing more detailed studies and designs. The conceptual report shall include all the above general requirements.

c. ***Preliminary Plan.*** Preliminary drainage reports are primarily for projects which are being developed before or during a final plat/final development plan stage. The Preliminary Drainage Report is an intermediate drainage planning report to provide sufficient detail required for projects anticipated to evolve into future construction plans or site plans. The intent of the Preliminary Drainage Report is to finalize drainage planning for the project in narrative, visual, and computational format for review by the City Engineer. For large development or multi-stage, multi-lot projects, the preliminary drainage plan shall serve as a reference documents for future drainage planning when improvements are not fully completed by the persons/entities requesting the development action.

The Preliminary Drainage Report shall contain the following information:

1. All the above general requirements.
2. Overall drainage map and plans with increased detail.
3. Detailed runoff computations from the pre-development area (on-site, upstream).
4. Detailed computations on existing downstream conveyance systems to be utilized with the project.
5. Preliminary computations on proposed street and drainage conveyance systems.
6. Preliminary computations on proposed detention systems and outlet controls, including time of total evacuation. Volume computations shall include a detention systems storage volume in cubic feet or acre-feet and the proposed volume in terms of inches of storage for gross tributary area. For areas being platted specific for detention, the preliminary design of the detention facility shall be included showing preliminary design contours.
7. Computations and computer modeling results to substantiate findings and recommendations.
8. For projects being approved without final details such as a Final Plat, a letter shall be submitted with the drainage report which includes the following:

   "<Name of Developer/Property Owner> hereby acknowledges that the stormwater management planning outlined in <drainage report title & date> was prepared for <development action> without final design details or construction plans. I understand that acknowledgement of receipt of this drainage plan by the

City of Cheyenne does not constitute any formal endorsement of a final drainage plan until final designs and details can be reviewed and approved. I also acknowledge that future final drainage design reports and details shall be required by the City prior to construction or acceptance of drainage facilities for the < subdivision or project name>.

<Developer/Property Owner>

_____ _____

Authorized Signature *Date*

d. ***Final Plan.*** Final drainage reports are primarily for projects in the Construction Plan or Site Plan review state. The intent of the Final Drainage Report is to outline final drainage design details for review by the City Engineer. The Final Drainage Report shall include all information to substantiate the final design. If no substantial changes are required to a Preliminary Drainage Report, the Final Drainage Report may be submitted as an amendment to the Preliminary Drainage Report. Final Drainage Reports shall be submitted to the City Engineer's Office on computer disk in PDF format.

The Final Drainage Report shall contain the following information:

1. All requirements of the Preliminary Drainage Report, with the exception that final design computations shall be included for all proposed drainage facilities.
2. Detailed Drainage/Grading and Site Plans including finalized:
   (a) Proposed storm sewer improvements locations and all details;
   (b) Proposed channel improvements with typical cross-sections and major flow limits;
   (c) Proposed culvert locations and all details;
   (d) Permanent drainage easements.
3. Comparison tables/graphs of pre-development and post-development runoff rates for major and minor storms events.
4. Detention area(s) summary table(s) and/or curve(s) showing the following:
   (a) Stage vs. Area;
   (b) Stage vs. Volume;
   (c) Stage vs. Discharge (or outflow).
5. The report shall include the following certification:

   "I, <Name of Developer/Property Owner> hereby certify that the drainage facilities <name of development> shall be constructed according to the design presented in this report. I understand that the City of Cheyenne does not and will not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that the City of Cheyenne reviews drainage plans but cannot, on behalf of <Name of Developer/Property Owner>, guarantee that final drainage design review will absolve <Name of Developer/Property Owner> and/or their successors and/or assigns, of future liability for improper design . I further understand that approval of the Final Plat and/or Final Site Plan does not imply approval of my engineer's drainage design.

<Developer/Property Owner>

_____ _____

Authorized Signature *Date*

3.2.5 Final Acceptance of Drainage Improvements.

A request for final acceptance of drainage improvements shall be made to the City Engineer. Final acceptance requires the submittal of construction drawings clearly labeled as “Record Drawings”, “As-built Drawings”, or “As-Constructed Drawings”. The drawings shall be made by a Wyoming Licensed Professional Engineer or Professional Land Surveyor and include the following notation:

> *"I hereby attest that the installed drainage facilities as shown on <construction plan name, date> have been constructed in accordance with the approved drainage design for the <name of development>. The stormwater drainage facilities installed at this location conform to the approved design plans. Stormwater detention facilities constructed for this project facility meet or exceed storage volumes requirements outlined in the <Final Drainage Report> dated <date of final report> by <firm preparing Final Drainage Report>. Detention pond volumes for <name of detention facility or number> is <volume>. Deviations from the approved plan include < outline list of changes >.”*

_____

Registered Professional Engineer/Land Surveyor
State of Wyoming No._____ (Affix Seal)
<Date>

3.2.6 Maintenance

a. ***Private Maintenance.*** All components of the drainage system constructed on private property shall be maintained by the property owner or a representative of the owner. Maintenance responsibilities shall be defined on final plats and site/construction plans. Such maintenance shall include periodic cleaning, weed and grass cutting, repairs to pipe and underground structures and all else which is reasonably expected of a publicly owned and operated utility system.

In the event the owner fails to inspect, report, or properly maintain the system within 30 days after written notice by the City of such deficiencies to the owner, the City may enter upon the property and take whatever steps it deems necessary to maintain or repair the system and bill the owner for such expense. However, if the owner’s failure to properly maintain the system could cause damage to property, loss of life or a violation of a NPDES MS4 Permit, the City may take immediate action, without notice to the owner, to maintain or repair the Facilities.

It is expressly understood and agreed that the City is under no obligation to maintain or repair the system.

b. ***Public Maintenance.*** The City shall maintain those components of drainage systems that are constructed within the City right-of-way or on land owned by the City. The City may maintain components of drainage facilities located on private property in areas within drainage easements when said systems are constructed to manage stormwater for a broad area that extends beyond the confines of the property where the facility is located.

3.2.7 Grading and Erosion Control Permit [Reserved]

APPENDIX F

SOLID WASTE MUNICIPAL CODE

8.44.030 General regulations.

A. Littering and Improper Disposal.

1. No person may throw, drop, or deposit refuse upon any street, alley, sidewalk, or any yard, or premises, public or private.
2. No person may place refuse upon another person's private property. No person shall place accumulations of household, business, or construction waste in containers or dumpsters owned or rented by other individuals, businesses, or government entities.
3. No person may place refuse in any street, alley, or other public place except in proper containers for collection or under express approval granted by the public works director. No person shall throw or deposit any solid waste in any stream or other body of water within the city.

B. The owner of the property where waste is generated is responsible for the disposal of the waste regardless of whether the owner resides on the property.

C. The owners or occupants of any store or other place of business situated within the city will exercise reasonable diligence at all times to keep their premises clean of refuse, such as wastepaper, wrapping paper, paper napkins, cartons, package containers, glass bottles, broken glass fragments, cups, cans, tobacco product waste, and other used or waste materials thrown or left on premises by its customers or any other person, and to take reasonable measures to prevent same from blowing to adjoining premises. If owners or occupants fail to keep their premises or adjoining premises clean, the city may arrange for cleanup and bill the owner for the service. Receptacles of sufficient size and number must be placed on the premises, accessible to customers of the business or any other person on the premises, for disposal of waste. No customer or other person shall dispose of refuse on a business property, except refuse generated on the property and then only in receptacles located on the property for such purposes.

D. No dirt, rubbish, or refuse of any kind may be thrown, swept, or pushed into the street, alley or sidewalk adjacent to any store or place of business by the owner, manager, or any employee or agent thereof. Each business establishment shall be held responsible for keeping adjacent property and sidewalks of such building free of any accumulation of dirt, paper, or rubbish which, when so removed, shall be taken up and deposited with other refuse from such establishment. The owner or manager of such business shall be held liable for any violation of this section.

E. Containers.

1. All solid waste must be placed in approved containers. When stored in the right-of-way adjacent to streets and alleys, waste must be kept in approved metal or plastic containers resistant to animals and wind. Plastic or paper bags containing refuse may not be placed on the street or alley prior to 4:00 p.m. of the day prior to the designated collection day.
2. Businesses with Manual Collection Service. Solid waste containers will be provided by the city for the premises. Non-approved containers set out with refuse or containing refuse will be considered part of the refuse and may be removed for disposal. Paper or other bags may be used as approved by the public works director. Containers or bags shall not exceed a weight of forty (40) pounds when full.
3. Residences or Businesses with Automated Collection Service. The city will provide customers with a standard collection container(s) compatible with automated

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collection equipment. Only containers provided by the city will be used for automated collection. The city is responsible for repair and replacement of containers damaged or worn as a result of normal use. The solid waste division may require customers to pay for repair or replacement of containers damaged or destroyed through customer negligence.

4. Every receptacle required by this chapter must be maintained by the customer in a sanitary condition and be cleaned as needed. If not, the solid waste division may clean the container and assess the appropriate fee.

5. Businesses with manual collection are responsible for damages caused by unsecured containers. Businesses are required to have a trash containment area to obstruct view and to secure containers.

6. Prior to placement of waste collection roll-off containers within the city limits, a commercial (private) hauler must provide to the city public works director, or designee, a written report containing the following: name of company, address of company, primary contact name, contact information (during and after business hours), and a description of roll-off containers including color scheme, number and size. Each container shall be clearly marked with the company's name and business phone prior to placement. Commercial (private) haulers shall provide the written report upon business startup and annually thereafter not later than January 31st of each year. Failure to provide this report could result in a suspension of roll-off container privileges for a period of up to one year. Failure to comply with container marking requirements of this paragraph could result in removal and disposal of unmarked/unreported containers.

F. Residents and businesses are responsible for controlling waste until it is picked up by the solid waste division. Receptacles must be kept closed except during the collection or deposit of garbage, trash, or refuse. The contents of all receptacles must be protected so that wind and animals cannot scatter the contents. All waste placed in containers (except yard waste and single stream recycle material) must be bagged to prevent litter from being scattered when the container is emptied or blown over. If waste is scattered by animals or the wind, the solid waste division may clean up the litter and charge the resident or business an appropriate fee.

G. Materials placed in recycling containers must not be bagged in plastic bags. Plastic bags contaminate the load. Recyclable materials should be placed loosely in receptacles. Shredded material or other small paper items may be placed in recyclable paper bags.

H. The provisions of this section do not prohibit any business or institution from using an approved large watertight container for the storage of garbage designed to be loaded mechanically into roll-off containers. These containers must be approved by the pubic works director and be compatible with city collection equipment. Only containers issued by the city will be used for automated collection.

I. Any unauthorized accumulation of solid waste on any premises is declared to be a nuisance and is prohibited.

J. No agent, officer, or employee of the city solid waste division, may interfere with, disturb, break, destroy, or trespass upon any property except as necessary in the work of collection and removal of solid waste. No agent, officer or employee of the city may remove or take any article or refuse for their own use. City collection personnel are not permitted to enter houses and buildings for the collection of solid waste without the prior knowledge and approval of the public works director or designated representative. No agent, officer or employee of the city may accept any money, property or other valuable consideration for the performance of solid

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waste collection services, except such salary and benefits as authorized by city ordinance or personnel policies.

(Ord. No. 3916, § 2, 3-28-11)

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APPENDIX G

CHEYENNE DETENTION BASINS, LAKES, AND WETLANDS

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