

February 27, 2018

Submitted via NET DMR on 2/28/2018

Attn: Jon Kenning
Montana Department of Environmental Quality
Water Protection Bureau
PO Box 200901
Helena, MT 59620-0901

RE: City of Bozeman Small MS4 2017 Annual Report (MTR040002)

Mr. Jon Kenning,

The City of Bozeman is pleased to submit the attached 2017 Phase II Small MS4 General Permit Annual Report for your review. In addition, the City of Bozeman hired Mrs. Andrea Surratt to serve as City Manager, and is the current signatory for MS4 related documents. Please update your records to reflect this change.

I am available if you have any questions.

Regards,



Kyle Mehrens, Stormwater Program Coordinator

Cc: Craig Woolard, Director of Public Works
Project File
ERF

Attachments: *Attachment A: 2017 Small MS4 Annual Report Form*
Attachment B: Additional Information
Attachment C: Stormwater Management Plan v.8
Attachment D: Small MS4 Outfalls
Attachment E: Construction Stormwater Permit Review Checklist
Attachment F: Construction Site Visit Inspection Form
Attachment G: Post-Construction Checklist Example
Attachment H: City of Bozeman Engineering Standards

 Montana Department of Environmental Quality WATER PROTECTION BUREAU		Agency Use		
		MTR04		
		Date Rec'd:		
		Amount Rec'd:		
		Check No.:		
		Rec'd By:		
FORM MS4-AR	MPDES Storm Water Small MS4 Annual Report Form			
	Reporting period is for the calendar year, January 1st through December 31st. Check one. Annual Report is due by March 1st of the following year.			
	☒ 2017	☐ 2018	☐ 2019	☐ 2020
Instructions: This Annual Report Form is to be completed by each permittee and co-permittee authorized to discharge storm water under the General Permit for Storm Water Discharges Associated with Small Municipal Separate Storm Water Sewer Systems (MS4s). All authorized permittees and co-permittees are required to complete this Annual Report Form for each calendar year reporting period. For co-permittees authorized under one permit authorization or for co-permittees with multiple authorizations, you are required to complete this form and submit separate required documents/information exclusively for your respective regulated Small MS4 area(s). This completed Annual Report Form must be electronically submitted to the Montana Department of Environmental Quality, Water Protection Bureau. Electronic submission is required through the web-based tool: NetDMR. Additional information is located on DEQ's website: http://deq.mt.gov/Water/WQINFO/ctss/netdmr.				
Small MS4 Authorization Number: MTR04 0002				
Small MS4 Classification		☒ Traditional	☐ Non-Traditional	
Small MS4 Name: City of Bozeman				
Small MS4 Mailing Address: P.O. Box 1230				
City, State, and Zip Code: Bozeman, MT 59771				
Small MS4 Contact Person (and Title): Kyle Mehrens, Program Coordinator				
Mailing Address: P.O. Box 1230				
City, State, and Zip Code: Bozeman, MT 59771				
Phone Number: (406)582-2270			E-mail address: kmehrens@bozeman.net	

Storm Water Management Team: Attach an organizational chart identifying a primary SWMP coordinator and the positions responsible for implementing each minimum measure.

Requested above chart:

☒ Attached

☐ Not Attached

Has the permittee established and executed a formalized mechanism for regular communication between storm water management team members?

☒ Yes

☐ No

Permittee's SWMP Resources:

How many FTEs does the permittee designate to the MS4 permit? 6.5 If needed, provide an explanation.

If more space is needed, submit on an additional page with corresponding reference or on a data storage device.

Answer the following five (5) questions on an additional page with corresponding reference or on a data storage device.

(1) What are the source(s) of funding for implementation of the MS4 permit and the estimated percentage of the total budget allocated from each source listed?

(2) Specific to the annual reporting calendar year, how did the permittee justify commitment of resources or budget allocations to the implementation of the MS4 permit to decision-makers and the public? Provide a summary of meetings and outcomes held with decision-makers and the public.

(3) Has the permittee demonstrated program effectiveness to obtain budget allocations for this annual reporting calendar year or previous years? Why or why not? If so, what program effectiveness metrics were presented?

(4) How was this annual reporting calendar year's approach to allocate resources different than the previous year's approach?

(5) Was the permittee successful in their request for budget allocations? Describe the outcome and factors that affected or resulted in that outcome.

Illicit Discharge Detection & Elimination:

Per the IDDE MCM requirement (Part II (3)(c.i)), has the permittee reviewed, and updated if needed, the storm sewer map during the calendar year?

☒ Yes

☐ No

Per the IDDE MCM requirement (Part II (3)(e.i)), has the permittee dry weather inspected and screened outfalls during the calendar year?

☐ Yes

☒ No

Fill in the blanks with numbers. The permittee has inspected 0 outfalls during this calendar year. Since authorization under the 2017 General Permit, the permittee has inspected 0 total outfalls out of the 594 total MS4 outfalls.

Per the Illicit Discharge Detection & Elimination MCM (Part II (3)(e.i)), the permittee will complete the requirement to inspect and screen all outfalls during dry weather by the end of the permit cycle.	☒ Yes	☐ No
Construction Site Storm Water Management: During the calendar year, how many construction storm water management plan reviews were completed (Part II (4)(b))? <u>38</u>		
During the calendar year, how many construction projects were inspected for their storm water management controls (Part II (4)(c))? <u>11</u>		
Pollution Prevention/Good Housekeeping for Permittee Operations:		
Has the permittee reviewed, and updated if needed, the inventory of permittee-owned/operated facilities and activities (Part II (6)(a.i))?	☒ Yes	☐ No
Has the permittee reviewed, and updated if needed, the map that identifies the locations of facilities and known locations of activities (Part II (6)(a.ii))?	☐ Yes	☒ No
Has the permittee conducted annual storm water pollution prevention training for permittee staff during the next permit year after development of each standard operating procedure (Part II (6)(a.v))?	☐ Yes	☒ No
Not applicable during calendar year 2017, 2018, and 2019. Check "No" during these years.		
Training: According to Part II (B) Training requirements, has the permittee conducted applicable training during the 1 st and 4 th calendar years?	☒ Yes	☐ No
Not required during calendar year 2018, 2019, and 2021. Check "No" during these years.		
According to Part II (B) Training requirements, has the permittee conducted applicable new employee training within 90 days of the hire date?	☒ Yes	☐ No
Special Conditions: Per Pre-TMDL Approval (Part III.A) requirements, attach the required information regarding identification of all outfalls that discharge to impaired waterbodies, the impaired waterbodies, and the associated pollutants of impairments. Summarize the BMPs implemented over the reporting period and a schedule of BMPs planned for the following year.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Special Conditions: Approved TMDLs (Part III.B) requirements per calendar year below.		
Calendar Year 2017: The permittee has attached a Sampling Plan that includes strategy rationale, monitoring frequency, monitoring parameters, and monitoring locations.		
☒ Attached	☐ Not Attached	☐ Not Applicable

Calendar Year 2017: The permittee has attached all outfalls that discharge to impaired waterbodies and the associated pollutants of impairment.		
☒ Attached	☐ Not Attached	☐ Not Applicable
Calendar Year 2018: The permittee has attached all outfalls that discharge to impaired waterbodies and the associated pollutants of impairment.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Calendar Year 2019: The permittee has attached all outfalls that discharge to impaired waterbodies and the associated pollutants of impairment.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Calendar Year 2020: The permittee has attached all outfalls that discharge to impaired waterbodies and the associated pollutants of impairment.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Calendar Year 2020: The permittee has attached the TMDL section of the SWMP that identifies the measures and BMPs it plans to implement, describes the MS4's impairment priorities and long term strategy, and outlines interim milestones for controlling the discharge of the pollutants of concern and making progress towards meeting the TMDL.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Calendar Year 2021: The permittee has attached all outfalls that discharge to impaired waterbodies and the associated pollutants of impairment.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Calendar Year 2021: The permittee has evaluated the TMDL section of the SWMP based on monitoring results. The section has been revised, if needed, and is attached.		
☐ Attached	☐ Not Attached	☒ Not Applicable
Monitoring: Per requirements in Part IV (B), has the permittee attached monitoring results, calculations, and evaluations?		
☒ Attached	☐ Not Attached	☐ Not Applicable

INSTRUCTIONS: The permittee will only fill out the Annual Report Attachments section below that corresponds to the calendar in which an Annual Report is being submitted for. Attach the requested documents/information.

2017 Annual Report Attachments (1 st Calendar Year)		
Public Education and Outreach:		
Per requirements a.i in the referenced MCM, attach the required information regarding key target audiences and associated pollutants.		
☒ Attached	☐ Not Attached	
Public Involvement and Participation:		
Per requirements a.i in the referenced MCM, attach the required information regarding the public involvement approach and schedule of each key audience.		
☒ Attached	☐ Not Attached	
Illicit Discharge Detection & Elimination:		
Per requirements a.i in the referenced MCM, attach the required information regarding categories of non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☒ Attached	☐ Not Attached	
Per requirements b.i in the referenced MCM, attach the required information regarding occasional non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☒ Attached	☐ Not Attached	
Per requirements f.i in the referenced MCM, attach the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.		
☒ Attached	☐ Not Attached	
Construction Site Storm Water Management:		
Per requirements a.iii in the referenced MCM, attach progress towards an Enforcement Response Plan and associated documents.		
☒ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements b.i in the referenced MCM, attach the construction storm water management plan review checklist.		
☒ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements b.iii in the referenced MCM, attach the construction storm water management plan review checklist.		
☐ Attached	☐ Not Attached	☒ Not applicable
Specific to Traditional MS4s and per requirements c.i in the referenced MCM, attach the construction storm water management inspection form or checklist.		
☒ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements c.ii in the referenced MCM, attach the construction storm water management inspection form or checklist.		
☐ Attached	☐ Not Attached	☒ Not applicable

Post-Construction Site Storm Water Management in New and Redevelopment		
Specific to Traditional MS4s and per requirements b.i in the referenced MCM, attach the post-construction storm water management plan review checklist.		
☒ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements b.ii in the referenced MCM, attach the post-construction storm water management plan review checklist.		
☐ Attached	☐ Not Attached	☒ Not applicable
Per requirements in b.iii in the referenced MCM, attach the performance standards and associated documents.		
☒ Attached	☐ Not Attached	

2018 Annual Report Attachments (2nd Calendar Year)		
Public Education and Outreach:		
Per requirements b.i in the referenced MCM, attach the required information regarding outreach messages.		
☐ Attached	☐ Not Attached	
Per requirements c.i in the referenced MCM, attach the required information regarding a description of formats, distribution channels and schedule for key target audiences.		
☐ Attached	☐ Not Attached	
Public Involvement and Participation:		
Per requirements a.ii in the referenced MCM, attach the required information regarding participation and key target audience feedback on approaches.		
☐ Attached	☐ Not Attached	
Illicit Discharge Detection & Elimination:		
Per requirements a.i in the referenced MCM, attach the required information regarding categories of non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Per requirements b.i in the referenced MCM, attach the required information regarding occasional non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements d.i in the referenced MCM, attach the adopted ordinance or other regulatory mechanism to prohibit illicit discharges.		
☐ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements d.ii in the referenced MCM, attach the summary of legal authority to prohibit illicit discharges.		
☐ Attached	☐ Not Attached	☐ Not applicable
Per requirements d.iii in the referenced MCM, attach the required summary of the cooperative agreements.		

☐ Attached	☐ Not Attached
Per requirements d.iv in referenced MCM, attach the Enforcement Response Plan and associated documents.	
☐ Attached	☐ Not Attached
Per requirements e.ii in referenced MCM, attach the list of high priority outfalls.	
☐ Attached	☐ Not Attached
Specific to Traditional MS4s and per requirements f.iii in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.	
☐ Attached	☐ Not Attached ☐ Not applicable
Specific to Non-Traditional MS4s and per requirements f.iv in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.	
☐ Attached	☐ Not Attached ☐ Not applicable
Post-Construction Site Storm Water Management in New and Redevelopment	
Specific to Traditional MS4s and per requirements c.i in the referenced MCM, attach the post-construction storm water management inspection form or checklist.	
☐ Attached	☐ Not Attached ☐ Not applicable
Specific to Non-Traditional MS4s and per requirements c.ii in the referenced MCM, attach the post-construction storm water management inspection form or checklist.	
☐ Attached	☐ Not Attached ☐ Not applicable
Per requirements in c.iii in the referenced MCM, attach the inventory of all new permittee-owned and private post-construction storm water management controls.	
☐ Attached	☐ Not Attached
Per requirements in c.vi in the referenced MCM, attach an inspection frequency protocol.	
☐ Attached	☐ Not Attached
Specific to Traditional MS4s and per requirements c.vii, attach the developed inspection program.	
☐ Attached	☐ Not Attached ☐ Not applicable
Pollution Prevention/Good Housekeeping for Permittee Operations	
Per requirements in a.iii in the referenced MCM, attach completed Standard Operating Procedures.	
☐ Attached	☐ Not Attached

2019 Annual Report Attachments (3 rd Calendar Year)		
Public Education and Outreach:		
Per requirements c.ii in the referenced MCM, attach the required information regarding outreach materials distributions.		
☐ Attached	☐ Not Attached	
Public Involvement and Participation:		
Per requirements a.ii in the referenced MCM, attach the required information regarding participation and key target audience feedback on approaches.		
☐ Attached	☐ Not Attached	
Illicit Discharge Detection & Elimination:		
Per requirements a.i in the referenced MCM, attach the required information regarding categories of non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Per requirements b.i in the referenced MCM, attach the required information regarding occasional non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Per requirements e.ii in referenced MCM, attach the list of high priority outfalls.		
☐ Attached	☐ Not Attached	
Per requirements e.iii in referenced MCM, attach the required summary of screening results.		
☐ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements f.iii in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.		
☐ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements f.iv in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.		
☐ Attached	☐ Not Attached	☐ Not applicable
Construction Site Storm Water Management:		
Specific to Traditional MS4s and per requirements a.i in the referenced MCM, attach the adopted ordinance or other regulatory mechanism to require construction storm water controls.		
☐ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements a.ii in the referenced MCM, attach the legal authority summary.		
☐ Attached	☐ Not Attached	☐ Not applicable
Per requirements a.iii in the referenced MCM, attach the adopted Enforcement Response Plan and associated documents.		
☐ Attached	☐ Not Attached	
Post-Construction Site Storm Water Management in New and Redevelopment		

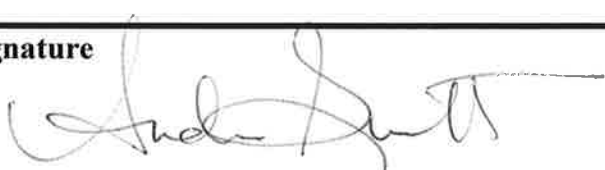
Per requirements in c.viii in the referenced MCM, attach findings and compliance actions regarding inspections of high priority post-construction storm water management controls.		
☐ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements c.ix, attach the findings and resulting actions regarding inspections of high priority privately-owned post-construction storm water management controls.		
☐ Attached	☐ Not Attached	☐ Not applicable
Pollution Prevention/Good Housekeeping for Permittee Operations		
Per requirements in a.iii in the referenced MCM, attach the completed Standard Operating Procedures.		
☐ Attached	☐ Not Attached	

2020 Annual Report Attachments (4th Calendar Year)		
Public Education and Outreach:		
Per requirements c.ii in the referenced MCM, attach the required information regarding outreach materials distributions.		
☐ Attached	☐ Not Attached	
Public Involvement and Participation:		
Per requirements a.ii in the referenced MCM, attach the required information regarding participation and key target audience feedback on approaches.		
☐ Attached	☐ Not Attached	
Illicit Discharge Detection & Elimination:		
Per requirements a.i in the referenced MCM, attach the required information regarding categories of non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Per requirements b.i in the referenced MCM, attach the required information regarding occasional non-storm water discharges or flows, associated pollutants, and local controls or conditions.		
☐ Attached	☐ Not Attached	
Per requirements e.ii in referenced MCM, attach the list of high priority outfalls.		
☐ Attached	☐ Not Attached	
Per requirements e.iii in referenced MCM, attach the required summary of screening results.		
☐ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements f.iii in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.		
☐ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements f.iv in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge		

Investigation and Corrective Action Plan and any associated documents.		
☐ Attached	☐ Not Attached	☐ Not applicable
Post-Construction Site Storm Water Management in New and Redevelopment		
Specific to Traditional MS4s and per requirements a.i in the referenced MCM, attach the adopted ordinance or other regulatory mechanism to require post-construction storm water controls.		
☐ Attached	☐ Not Attached	☐ Not applicable
Specific to Non-Traditional MS4s and per requirements a.ii in the referenced MCM, attach the legal authority summary.		
☐ Attached	☐ Not Attached	☐ Not applicable
Per requirements in a.iii in the referenced MCM, attach the Enforcement Response Plan and associated documents.		
☐ Attached	☐ Not Attached	
Per requirements in c.viii in the referenced MCM, attach findings and compliance actions regarding inspections of high priority post-construction storm water management controls.		
☐ Attached	☐ Not Attached	
Specific to Traditional MS4s and per requirements c.ix, attach the findings and resulting actions regarding inspections of high priority privately-owned post-construction storm water management controls.		
☐ Attached	☐ Not Attached	☐ Not applicable
Per requirements in d.i in the referenced MCM, attach a summary of the discussion outcomes.		
☐ Attached	☐ Not Attached	
Pollution Prevention/Good Housekeeping for Permittee Operations		
Per requirements in a.iii in the referenced MCM, attach the completed Standard Operating Procedures.		
☐ Attached	☐ Not Attached	

2021 Annual Report Attachments (5th Calendar Year)	
Public Education and Outreach:	
Per requirements c.ii in the referenced MCM, attach the required information regarding outreach materials distributions.	
☐ Attached	☐ Not Attached
Public Involvement and Participation:	
Per requirements a.ii in the referenced MCM, attach the required information regarding participation and key target audience feedback on approaches.	
☐ Attached	☐ Not Attached
Illicit Discharge Detection & Elimination:	
Per requirements a.i in the referenced MCM, attach the required information regarding categories of non-storm water discharges or flows, associated pollutants, and local controls or conditions.	

☐ Attached	☐ Not Attached
Per requirements b.i in the referenced MCM, attach the required information regarding occasional non-storm water discharges or flows, associated pollutants, and local controls or conditions.	
☐ Attached	☐ Not Attached
Per requirements e.ii in referenced MCM, attach the list of high priority outfalls.	
☐ Attached	☐ Not Attached
Per requirements e.iii in referenced MCM, attach the required summary of screening results.	
☐ Attached	☐ Not Attached
Specific to Traditional MS4s and per requirements f.iii in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.	
☐ Attached	☐ Not Attached ☐ Not applicable
Specific to Non-Traditional MS4s and per requirements f.iv in the referenced MCM, attach the summary of investigations conducted and corrective actions taken per the required Illicit Discharge Investigation and Corrective Action Plan and any associated documents.	
☐ Attached	☐ Not Attached ☐ Not applicable
Post-Construction Site Storm Water Management in New and Redevelopment	
Per requirements in c.viii in the referenced MCM, attach findings and compliance actions regarding inspections of high priority post-construction storm water management controls.	
☐ Attached	☐ Not Attached
Specific to Traditional MS4s and per requirements c.ix, attach the findings and resulting actions regarding inspections of high priority privately-owned post-construction storm water management controls.	
☐ Attached	☐ Not Attached ☐ Not applicable
Pollution Prevention/Good Housekeeping for Permittee Operations	
Per requirements in a.iii in the referenced MCM, attach completed Standard Operating Procedures.	
☐ Attached	☐ Not Attached
Attach any updates, changes, or improvements to the Small MS4 Storm Water Management Program per requirements in Part IV (E).	
☐ Attached	☐ Not Attached ☐ Not applicable

Annual Report Form Signature	
This Annual Report Form must be completed, signed, and certified as follows: • For a corporation, by a principal officer of at least the level of vice president; • For a partnership or sole proprietorship, by a general partner or the proprietor, respectively; or For a municipality, state, federal, or other public facility, by either a principal executive officer or ranking elected official.	
All Permittees Must Complete the Following Certification: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information; including the possibility of fine and imprisonment for knowing violations. [75-5-633, MCA]. <i>Certification of this form indicates conformance with the 2017 General Permit for Storm Water Discharge Associated with Small Municipal Separate Storm Sewer Systems and the required Annual Reporting upon receipt of permit coverage.</i>	
Name (Type or Print) Andrea Surratt	
Title (Type or Print) City Manager	Phone Number (406)582-2324
Signature 	Date Signed 2/27/18

Additional Information

Permit #MTR040002

Annual Report Information in Stormwater Management Plan (SWMP):

1. Stormwater Management Team Organizational Chart: Section 1.7
2. Budget: Section 2.2
3. Special Conditions: Section 8.0
4. Monitoring Results: Section 8.0
5. Public Education and Outreach Section: Section 3.0
6. Public Involvement and Participation: Section 3.0
7. Illicit Discharge Detection and Elimination: Section 4.0
8. Construction Site Management: Section 5.0

City of Bozeman and Montana State University Stormwater Management Plan



2017 - 2021 MS4 General Permit Term
Version 8

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1.0 Program Administration

Image 1.0.1: 2013 Colorado urban flooding. Source: theatlantic.com



Image 1.0.2: Failed stormwater pipe



1.1 Introduction

This Stormwater Management Plan (SWMP) describes the City of Bozeman (City) and Montana State University's (University) planned structural, programmatic, and administrative Best Management Practices (BMPs) required to comply with the Montana Department of Environmental Quality's (MDEQ) 2017-2021 Municipal Separate Storm Sewer System General Permit (MS4 General Permit). The City and University are collectively referred to as the MS4. The MS4 plans to engineer, implement, maintain, and enforce BMPs to the maximum extent practicable, with the overarching goal of improving the quality of stormwater discharges into the MS4's waterways.

The MS4 also refers to this SWMP as the Stormwater Master Plan. This SWMP is an iterative and evolving document. Updates and additions occur annually.

1.2 Strategic Vision

The MS4 manages stormwater discharging into Bozeman's waterways through tailored education, innovative solutions, enforcement response, and progressive infrastructure projects to achieve the following goals:

1. Protect and improve water quality
2. Facilitate regulatory compliance
3. Protect human and environmental health
4. Improve flood resiliency
5. Influence policies at local, state, and federal levels

1.3 Major Program Initiatives

The MS4 plans to complete the following initiatives during the MS4 General Permit term:

1. Develop a Stormwater Design Manual and update existing Municipal Ordinances.
2. Create a policy to enforce maintenance of stormwater basins in HOA subdivisions.
3. Evolve erosion and sediment control practices in the construction industry through training, inspections, and enforcement cases.
4. Formalize relationship between the City and University with a Memorandum of Understanding (MOU).
5. Establish a targeted water quality-monitoring program that tracks trends and measures BMP effectiveness to evaluate MS4 pollutant loading to receiving waterbodies.
6. Balance staffing with required workload and level of service goals.
7. Optimize operation and maintenance field activities to extend infrastructure asset life cycles.

1.4 Regulatory Overview

The United States Congress established the National Pollutant Discharge Elimination System (NPDES) as a part of the Clean Water Act (CWA) in 1972 to preserve and restore beneficial uses of United States' Waters. The U.S. Environmental Protection Agency (EPA) is the lead organization tasked with implementing and oversight of the CWA. In Montana, the MDEQ has assumed authority for developing water quality standards and issuing discharge permits, allowing for further state-scale interpretation, enactment, and enforcement of CWA requirements.

The NPDES program regulates water pollution through a series of permits focused on point sources, such as industrial facilities, wastewater plants, and stormwater discharges. The focus of this SWMP is the MS4 General Permit, which requires regulated entities to develop, implement, and maintain a

stormwater management program, adhering to requirements of the following six minimum control measures:

1. Public Education and Outreach
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Stormwater Management
5. Post-Construction Stormwater Management
6. Pollution Prevention and Good Housekeeping for Municipal Operations

In 2014, the MDEQ proposed a new and more comprehensive MS4 General Permit. The regulated entities of Montana expressed concern over its contained language and asked that the MDEQ postpone its issuance for two years. An MS4 Work Group formed, which included representatives from the regulated communities, MDEQ, EPA, and environmental groups. Representatives participated in monthly meetings and worked together to draft new MS4 General Permit language, resulting in the MS4 General Permit issued January 1, 2017.

1.5 Waterways

The MS4 contains hundreds of outfalls that discharge into ≈100 miles of waterways and irrigation ditches within its municipal boundary. Staff used the Draft 2016 Integrated Report available at the MDEQ's Clean Water Act Information Center, EPA-approved 2013 Lower Gallatin Planning Area TMDL document, and City GIS databases to compile the following information:

1. Baxter Creek
 - Total Outfalls: 11
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: None
2. Bozeman (aka Sourdough) Creek
 - Total Outfalls: 61
 - Approved TMDL: Yes
 - Impairments: E. Coli, Total Nitrogen, Sediment, Chlorophyll-a, and Alteration in streamside cover
 - MS4 Waste Load Allocation: TN = 0 lb/day; E. Coli = 0 cfu/day; sediment = 81 tons/year
3. Bridger Creek
 - Total Outfalls: 2
 - Approved TMDL: Yes
 - Impairments: Chlorophyll-a and Nitrate/Nitrite (Nitrite + Nitrate as N)
 - MS4 Waste Load Allocation: N/N = 0 lbs./day
4. East, West and Main Forks of Catron Creek
 - Total Outfalls: 80
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: None
5. Cattail Creek

- Total Outfalls: 42
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: None
6. East Gallatin River
- Total Outfalls: 16
 - Approved TMDL: Yes
 - Impairments: Total Nitrogen and Total Phosphorous
 - MS4 Waste Load Allocation: TN = 0 lbs./day; TP = 0 lbs./day
7. Farmers Canal
- Total Outfalls: 47
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: N/A
8. Figgins Creek
- Total Outfalls: 24
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: N/A
9. Flat Creek
- Total Outfalls: 11
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: N/A
10. Mandeville Creek
- Total Outfalls: 49
 - Approved TMDL: Yes
 - Impairments: Total Nitrogen and Total Phosphorous
 - MS4 Waste Load Allocation: TN = 0 lbs./day; TP = 0 lbs./day
11. Matthew Bird Creek
- Total Outfalls: 32
 - Approved TMDL: No
 - Impairments: None
12. Maynard Border Ditch
- Total Outfalls: 12
 - Approved TMDL: No
 - Impairments: None
 - MS4 Waste Load Allocation: N/A
13. Middle Creek Ditch
- Total Outfalls: 36

- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

14. Mill Ditch

- Total Outfalls: 0
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

15. Nash Spring Creek

- Total Outfalls: 2
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

16. Rocky Creek

- Total Outfalls: 1
- Approved TMDL: Yes
- Impairments: Alteration in Streamside Vegetative Cover, Other Anthropogenic Substrate Alterations, Physical Substrate Habitat Alterations, and Sedimentation/Siltation
- MS4 Waste Load Allocation: N/A

17. Story Ditch

- Total Outfalls: 11
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

18. West Gallatin Canal

- Total Outfalls: 30
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

19. Unnamed Irrigation Canals

- Total Outfalls: 9
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

20. Unnamed Tributaries

- Total Outfalls: 113
- Approved TMDL: No
- Impairments: None
- MS4 Waste Load Allocation: N/A

Waterways receiving stormwater discharges from the MS4 will benefit from the strategies outlined in this SWMP and the BMPs implemented throughout the MS4 General Permit term. The MS4 plans to

implement specific infrastructure and targeted programmatic efforts to address 303(d) listed water quality impairments to the maximum extent practicable given available resources. For purposes of this MS4 General Permit term, the MS4 designates Bozeman Creek as its highest priority waterway and Mandeville Creek as its second highest priority for pollution reduction efforts.

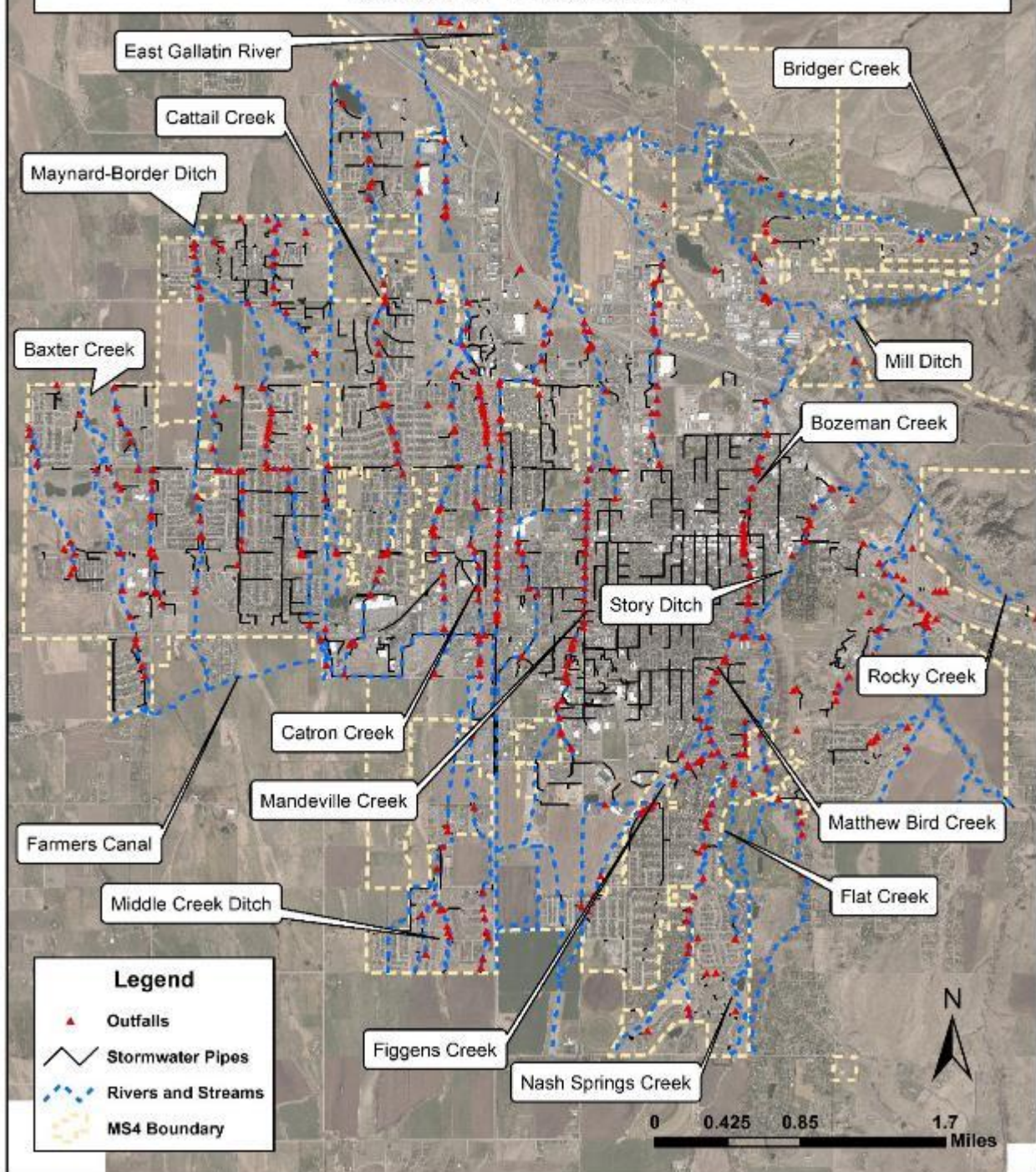
Bozeman Creek is the highest priority because of its total outfalls, known impairments, degraded state, and, most importantly, it is the only waterway with a non-zero MS4 Waste Load Allocation (WLA). According to the TMDL, Total Suspended Solids (*TSS, a measure of sediment concentrations in water*) contributions from the MS4 to Bozeman Creek require a 37% WLA, requiring a reduction of 81 tons/year.

Mandeville Creek is the second highest priority waterway because of its total outfalls, known impairments, shared responsibilities between co-permittees, and its degraded state. The MS4 has previously made investments to reduce loads to Mandeville Creek and plans to continue pollution reduction efforts as this MS4 General Permit term progresses.

Three other impaired waterways exist and will be the focus of targeted efforts as opportunities arise during this and future MS4 General Permit terms: (1) East Gallatin River, (2) Bridger Creek, and (3) Rocky Creek. The East Gallatin will benefit from BMPs implemented throughout the MS4.

Urban Waterways and Discharge Locations City of Bozeman Stormwater Division

Last Updated - January 1, 2017



Map 1.5.1: Bozeman's receiving waterways

1.6 Permittee

The City of Bozeman contains urbanized areas defined by the U.S Census Bureau's 2010 survey. ARM 17.30.1102(23)(b) designates the City of Bozeman as a small MS4, and the MS4 General Permit extends permit coverage for the entirety of the City's incorporated boundary. Montana DEQ considers the City of Bozeman to be a Traditional MS4 for purposes of the MS4 General Permit that is required to:

1. Prepare and submit a Notice of Intent (NOI) for authorization to discharge stormwater under the fourth generation Montana Pollution Discharge Elimination System (MPDES) General Permit for Stormwater Discharges Associated with Small MS4s.
2. Receive authorization to discharge stormwater from the MDEQ by January 1, 2017.
3. Prepare and submit Annual Reports to the MDEQ.
4. Develop, implement, and update a SWMP throughout the MS4 General Permit term.
5. Execute a Memorandum of Understanding (MOU) with the University, designating roles and responsibilities for the MS4 General Permit term.

On June 25, 2012, the City adopted Ordinance 1831 creating a stormwater utility, providing for the collection of rates and charges that generate revenue for the operation and maintenance of the City's stormwater system. Funding was initially allocated to inventory, map, and assess the condition of the City's stormwater infrastructure. This effort was in response to findings identified during a 2011 MDEQ audit of the MS4, which included one permit violation, 16 program deficiencies, and 23 recommendations for improvement.

On March 3, 2014, City staff presented the results of their inventory, mapping, and assessment effort to City Commissioners. Staff inventoried over ten thousand individual assets, many of which were found to be clogged, cracked, buried, or in general disrepair. Also, a program administration review identified significant problems and shortfalls. Commissioners directed the City to develop options for addressing the issues identified.

On April 21, 2014, the City presented three level of service options. Each level differed primarily on the timeline required to address known issues and the annual funding level. City Commissioners decided to implement a program, which included a total funding level of \$1.2 million annually for operations, maintenance, treatment upgrades, and deferred maintenance.

On February 23, 2015, the City adopted the new level of service and a rate model to collect service fees based on individual property's impact to the stormwater system.

On December 1, 2015, the City implemented the final piece of the new rate model allowing the Stormwater Utility to be fully funded and functional for the first time in its history.

The City's utility rate model includes the following components and funding allocations:

1. \$450,000 annually for deferred maintenance, which includes costs associated with the replacement of failed pipes, cleaning clogged infrastructure and upgrading old system components.
2. \$550,000 annually for operations and maintenance, which includes costs related to personnel, reoccurring system maintenance, supplies, and equipment.
3. \$200,000 annually for system enhancements, which includes costs associated with projects that provide stormwater treatment to remove pollutants of concern before discharging to receiving waterways.

The City's rate model has three distinct guiding principles:

1. Flat Charge - Charged evenly across the service area and pays for deferred maintenance costs. Properties with a water meter receive a flat monthly charge of \$3.23 per meter. Properties that have impervious area, but do not have a water meter also receive a flat monthly charge.
2. Variable Charge - Charged proportional to the amount of impervious area individual properties have. Impervious area does not allow water to soak into the ground during rain events creating stormwater runoff. Larger swaths result in an increased impact on public infrastructure and local waterways.
3. Utility Credit – Properties that have installed quantity and quality-based stormwater infrastructure controls receive a billing credit as these properties impact the stormwater system less than those without stormwater infrastructure.

The Stormwater, Building, GIS, and Finance Divisions work collaboratively to update the stormwater utility rate model. The workflow includes:

1. Developer submits development plans electronically to the Building Division
2. Stormwater Staff reviews and uploads site plan to group folder
3. GIS Staff checks folder and draws impervious area for new project
4. Finance Staff sends water meter notice to Stormwater Staff when the project is complete
5. Stormwater Staff reviews impervious area data and calculates ERU totals
6. Stormwater Staff provides Finance Staff with an ERU value and credit value
7. Finance Staff updates software and generates a bill for customers

1.7 Stormwater Management Team

The City spends approximately 10,000 hours annually developing and working on stormwater-related programs. Staff uses Cityworks Asset Management Software (Cityworks) to track daily work activities, providing data for analysis, reports, and resource allocation.

1. Staff
 - (1) Stormwater Program Coordinator (Primary SWMP Coordinator): Develops and manages the implementation of SWMP and MS4 General Permit compliance activities, administers environmental compliance programs, manages personnel, prepares budgets, develops policies, coordinates infrastructure projects, and maintains rate model databases. This position's primary permit responsibilities include:
 - Community Outreach and Education
 - Public Involvement and Participation
 - Construction-Site Management
 - Post-Construction Management
 - Illicit Discharge Detection and Elimination
 - Project Management
 - Good Housekeeping
 - Training
 - Water Quality Sampling and Analysis
 - (1) Stormwater Program Specialist: Develops and implements best practice solutions related to water quality compliance monitoring, BMP effectiveness research, and data analysis. This position's primary permit responsibilities include:
 - Water Quality Sampling and Analysis
 - Industrial Stormwater Permits (Water Reclamation Facility and Landfill)

- (1) Stormwater Program Technician: Provides support for SWMP implementation and MS4 General Permit compliance activities, environmental compliance programs, sampling, training, inspections, permit reviews, data collection, reporting, and equipment management. This position's primary permit responsibilities include:
 - Construction-Site Management
 - Post-Construction Management (inspection and maintenance)
 - Illicit Discharge Detection and Elimination
- (.5) Development Review Engineers: Reviews submitted development applications and ensure compliance with City Engineering Standards. Completes post-construction inspections to ensure contractors install infrastructure per approved design. This position's primary permit responsibility includes:
 - Post-Construction Management (site and subdivision plan review)
- (1) Stormwater Operations Foreman: Manages reoccurring stormwater infrastructure maintenance, structural inspections, repairs, and replacements.
- (2) Stormwater Operators: Completes stormwater infrastructure related work under the guidance and supervision of the Operations Foreman.

2. Future Additions

- Stormwater Program Technician: Provides support for environmental compliance programs, sampling, training, inspections, permit reviews, data collection, reporting, and equipment management.
- Internship: Completes short-term projects, such as stormwater sampling, outfall reconnaissance inventories, infrastructure mapping, and condition studies.

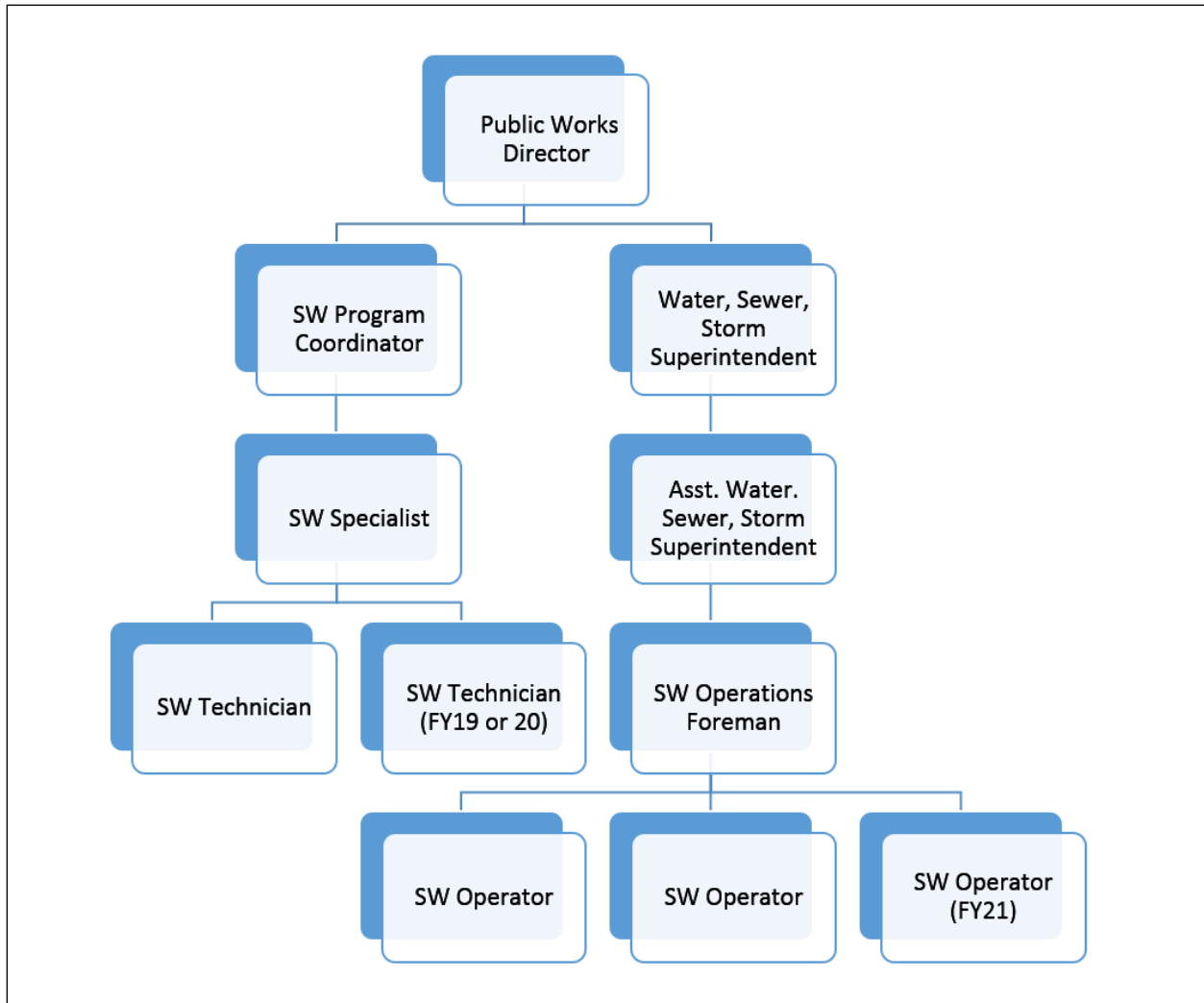


Figure 1.6.1: Staff structure

The following representatives make up the City's Stormwater Management Team (SWMT). Regular communication and coordination occur via recurring meetings, allowing for the exchange of necessary information:

1. Kyle Mehrens, Stormwater Program Coordinator (*Primary SWMP Coordinator*)
2. Frank Greenhill, Stormwater Program Specialist
3. Cody Flammond, Stormwater Program Technician (*Hazwoper Certification*)
4. Mike Dilbeck, Stormwater Operations Foreman

The following representatives are Subject Matter Experts (SMEs). SMEs provide guidance on specific issues, projects, plans, and policy changes upon request.

1. Craig Woolard P.E., Public Works Director
2. Brian Heaston P.E., Project Engineer
3. Shawn Kohtz P.E., Development Review Manager
4. Griffin Nielsen E.I., Development Review Engineer
5. Kellen Gamradt P.E., Project Engineer
6. Richard Hixson P.E., City Engineer

7. Jon Henderson, GIS Manager
8. John Alston, Water/Sewer/Storm Superintendent
9. Nick Pericich, Water/Sewer/Storm Assistant Superintendent
10. John Vandelinder, Streets Superintendent
11. Matt Workman, Streets Assistant Superintendent
12. Katherine Maines, Public Works Technician

1.8 Co-Permittee

The University is an educational facility designated as a Non-Traditional Phase II MS4 per ARM 17.30.1102(23)(d) and is integrated into the City's Program. The University is a co-permittee authorized to discharge under the City's MS4 General Permit. The University is required to:

1. Prepare and submit a Notice of Intent (NOI) for authorization to discharge stormwater under the fourth generation Montana Pollution Discharge Elimination System (MPDES) General Permit for Stormwater Discharges Associated with Small MS4s
2. Receive authorization to discharge stormwater from the MDEQ by January 1, 2017.
3. Develop and execute an MOU with the City, designating roles and responsibilities for the MS4 General Permit term.
4. Provide the City with annual reporting data and programmatic information.
5. Implement applicable content of this SWMP throughout the MS4 General Permit term subject to a Memorandum of Understanding.

In 2011, as a co-permittee, the University participated in the MDEQ audit of the City's Stormwater Program. The University based efforts through the permit cycle on the findings of that audit. The University has completely mapped its system; record keeping and compliance issues have been coordinated with the City; and BMPs have been instituted and documented.

In the current permit cycle, the University has done four projects of an acre or larger in size which have influenced stormwater quantity and quality. Additionally, one project specific to water quality was also done in this period. Because of these projects, MSU has reduced water quantity and improved water quality on 562,743 square feet (12.9 acres) of stormwater drainage area. Of this square footage, 78,035 (1.8 acres) is new construction, and the remaining square footage is improvements to conditions.

Current funding is not a line item but included in the general campus maintenance operations budget for Facilities Services. As allowable and necessary funding from Facilities Services Major Maintenance budget are allocated to specific stormwater improvement projects.

The University currently devotes approximately 640 hours annually to stormwater maintenance, management, and improvements and tracks work activities and labor using a work order system. Under the general guidance of the Engineering and Utilities Manager, the Environmental Service Manager coordinates and ensures MS4 General Permit compliance.

1. Current Staff
 - Engineering and Utility Manager: High-level directional and political support (*40 hours per year*)
 - Environmental Services Manager (Primary SWMP Coordinator): Overall program coordination. Administers and supports environmental compliance programs; manages support personnel; identifies and advocates for infrastructure projects; conducts sampling, training, inspections, permit reviews, data collection, and reporting; manages reoccurring infrastructure maintenance, structural inspections, repairs, and replacements (*300 hours/year*)

- Support Staff and Contracted Services: Groundskeepers, laborers, plumbers, and street sweeping (300 hours/year)

The following representatives make up the University's stormwater management team. Regular communication occurs, allowing for the exchange of necessary information:

- Megan Sterl, Engineering and Utility Manager
 - a. Program Administration
- EJ Hook, Environmental Services Manager (*Primary SWMP Coordinator*)
 - a. Community Outreach and Education
 - b. Public Involvement and Participation
 - c. Construction-Site Management
 - d. Post-Construction Management
 - e. Illicit Discharge Detection and Elimination
 - f. Project Management
 - g. Good Housekeeping
 - h. Training

1.9 Additional Regulatory Responsibilities

The following MPDES permits also fall under the purview of the MS4:

1. General Permit for Stormwater Discharges Associated with Construction Activity (MTR100000): Construction projects that disturb one acre, or more of land must obtain a stormwater discharge authorization from the MDEQ. The MS4 implements a Construction Management Program detailed in SWMP Sec. 5.0
2. Multi-Sector General Permit for Discharges Associated with Industrial Activity (MTR000000): The MS4's Water Reclamation Facility (WRF) and Landfill obtain authorizations to discharge stormwater from their facilities. MS4 Staff assist WRF and Landfill personnel with required inspections, BMP development, training, reporting, and records keeping.
3. General Permit for Construction Dewatering (MTG070000): The Water and Sewer Division completes main break repairs and preventative maintenance in high groundwater areas, both requiring dewatering activities. Pumped water is land applied whenever possible to avoid any potential impacts from this activity and the need for permit coverage.
4. General Permit for Disinfected Water and Hydrostatic Testing (MTG770000): The Water and Sewer Division flow hydrants to flush the water distribution pipe network and test hydrants.

1.10 Affiliations

The MS4 works with the following partners, but does not share any specific permitting responsibilities:

1. Montana Stormwater Association (MSWA): An organization formed in 2016 comprised of representatives from the regulated Phase II MS4s in Montana. The MSWA provides a unified voice for state scale policy changes, rules, issues, and initiatives. The MSWA meets as necessary to cover relevant topics and plans to formalize in the next five years, including the development of a mission statement, budget, and structure. The MS4 intends to be a lead contributor.
2. National Municipal Stormwater Alliance (NMSA): An organization formed in 2015 comprised of MS4 regulated entities nationwide. The NMSA provides a unified voice for national scale policy

changes, rules, issues, and initiatives. The NMSA meets annually at the WEFTech Conference. The MS4 plans to increase its participation in the next five years.

3. Gallatin Local Water Quality District: A Gallatin County agency that provides contract-based water quality sampling and education services for the MS4.
4. Montana State Extension Water Quality: A University Extension agency that provides contract-based water quality sampling and education services for the MS4.
5. Montana Water Environment Association (MWEA): A Montana organization that represents water, wastewater, and stormwater professionals. MWEA is a member of the Water Environment Federation (WEF), which has over 34,000 members worldwide. As of 2016, the MWEA is forming a Stormwater Board, intended to educate and provide technical assistance for members of Montana. These efforts align closely with WEF's efforts on the national scale, raising the bar of technical, infrastructure, policy, and science surrounding stormwater at the national level. The MS4 plans to help develop and serve on the Stormwater Board once created.
6. Greater Gallatin Watershed Council: An educational organization working to improve waterway health throughout the Gallatin Valley.

1.11 Memorandum of Understanding

The MS4 does not have a formalized MOU that outlines specific roles and responsibilities at this time; however, the MS4 does work collaboratively on various programs and initiatives. Leadership in both organizations support and recognize the value of the MS4's close relationship. Specific efforts include:

1. Participation in monthly meetings
2. Monthly payment of City Stormwater Utility fees by MSU
3. Inclusion of MSU's primary SWMP Coordinator at Bozeman Stormwater Team meetings
4. Joint level of service analysis, performance tracking, and reporting
5. Cooperative project development and implementation, such as S. 11th treatment unit
6. Collaborative infrastructure operation procedures and pollution response
7. Shared inspection forms, training, methodologies, and program documentation
8. Collective sampling and evaluation

The MS4's goal is to have an MOU in place but plans to develop and troubleshoot the draft contents over the next few years to ensure a sufficient document once formalized.

1.12 Annual Report

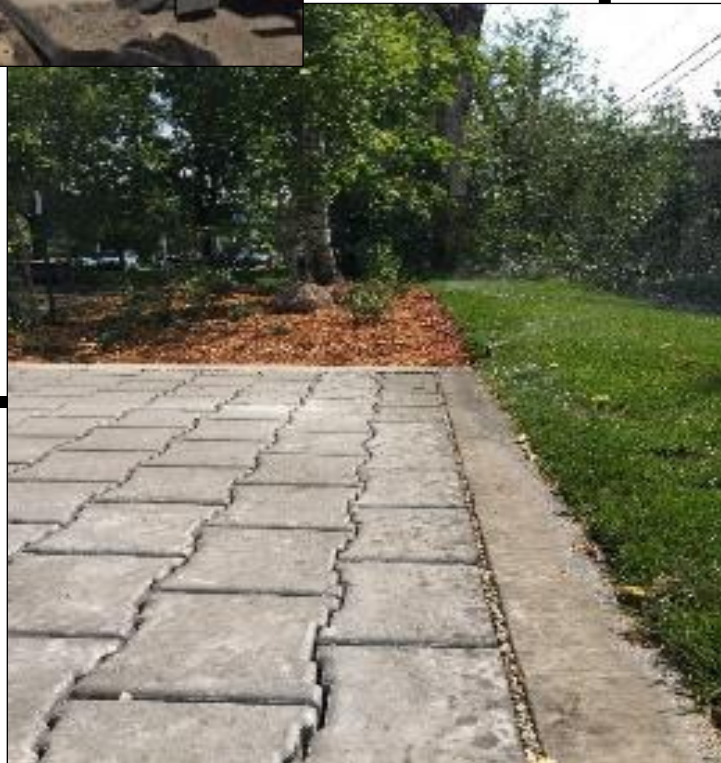
The MS4 submits an individual Annual Report Form, this SWMP, and relevant documents to the MDEQ by March 1st each year of the MS4 General Permit term.

2.0 Performance Performance

Image 2.0.1: Stormwater treatment unit installation



Image 2.0.2: Permeable pavers



2.1 Introduction

The City Commission sets the MS4's annual operating and capital budgets. The following sections detail the MS4's current and future investment strategies, projects, performance tracking mechanisms, and pollutant reduction totals.

2.2 Budget

1. City: FY18 Approved Budget (July 1, 2017, through June 30, 2018)
 - Source: Municipal Enterprise Fund
 - Rate Model Type: Impervious Area
 - Percent Allocation: 100%
 - Resource Justification: Budget approval process completed June 26, 2017
 - Program Effectiveness: Effective, see SWMP Sec. 2.6
 - Resource Allocation Variation: Addition of one administrative FTE (Specialist)
 - Success Determination: Successful, the MS4 has either met performance goals or successfully acquired resources to lessen deficits.
 - Staff: 6.5 FTEs
 - Budget: \$1,488,360
 - Salaries and Benefits: \$451,548
 - Operating Budget: \$161,466
 - Capital: \$650,000
 - Debt Service: \$225,346
 - Transfers: \$0.00
2. MSU: FY18 Approved Budget (July 1, 2017, through June 30, 2018)
 - Source: Facility's Budget
 - Rate Model Type: Part of Facilities Services Major maintenance budget
 - Percent Allocation: 100%
 - Resource Justification: Budget approval process completed June 29, 2017
 - Program Effectiveness: Effective, see SWMP Sec. 2.6
 - Resource Allocation Variation: Addition of approximately \$25,000 for College and 11th stormwater improvement project
 - Success Determination: Successful, the MS4 has either met performance goals or successfully acquired resources to lessen deficits.
 - Staff: 0.3 FTEs
 - Budget: \$124,000
 - Salaries and Benefits: n/a
 - Operating Budget: \$124,000
 - Capital: n/a
 - Debt Service: n/a
 - Transfers: n/a

2.3 TMDL Action Plan

The MS4 allocates \$650,000 per year towards structural and treatment infrastructure projects to improve the integrity of the stormwater collection network, expand system conveyance, and meet water quality requirements. The MS4 plans to target pollutants of concern for its impaired waterbodies by taking the following project identification and prioritization strategy:

1. Mitigate major impacts through industry standard structural treatment technologies, such as mechanical separation, confirmed to achieve 80% TSS removal under certain conditions through independent certification programs. This step allows the MS4 to “triage” the system, installing effective, maintainable, and economical treatment systems near stormwater discharge points for the MS4’s large urban drainage areas currently lacking treatment before discharge.
2. Develop and implement operation and education-based programs and initiatives, such as street sweeping, infrastructure cleaning, and targeted community outreach, that target pollutants of concern for the MS4’s impaired waterbodies. This step allows the MS4 to reduce the pollutants of concern by implementing economic and sustainable administrative and operational activities.
3. Collect and analyze stormwater runoff, in-stream water quality, BMP effectiveness, and long-term monitoring data using an array of industry standard gages and equipment to plan future investments, education-based initiatives, and infrastructure operations. This step allows the MS4 to monitor its pollutants of concern reductions, impaired waterbody improvement, and investment and program self-evaluation.
4. Enhance pollutant reductions using targeted green infrastructure and low impact development projects, such as boulevard bio-retention swales and dispersion, verified to achieve 100% TSS removal through the process of capture and infiltration of the water quality event (2-year storm). This step allows the MS4 to “fine-tune” the stormwater system to optimize treatment efficiencies in larger urban watersheds and treat stormwater in smaller urban watersheds not suitable for larger projects.

The MS4 prepares a five-year Capital Improvement Plan (CIP) that outlines future capital projects. The CIP process occurs annually, is open for public comment, approved by the City Commission, and incorporated into the fiscal year operating budget. Staff accounts for the following when preparing CIPs:

1. **Urban Watershed Priority:** The MS4 has two distinct regions of development. Urban areas built before 1980 and after 1980. Areas constructed before 1980 contain direct discharge urban watersheds that include infrastructure collection and conveyance systems that discharge stormwater into receiving water bodies without treatment or volume control. The MS4 classifies those that exceed 30-acres as high-priority and targets them for regional treatment projects.

Areas built after 1980 contain indirect discharge urban watersheds, which include infrastructure collection and conveyance systems that discharge stormwater into receiving water bodies after it travels through post-construction BMPs, such as stormwater basins. The majority of post-construction BMPs are owned and maintained by Home Owner Associations or private companies. The MS4, through its Post-Construction Program, educates, inspects, and enforces maintenance of these BMPs. Staff classifies indirect discharge urban watersheds as low-priority.
2. **Development and Land Use:** Development types and land-use occurring in urban watersheds affects stormwater pollution levels. The MS4 accounts for expected pollutant types and influent concentrations. For example, an urban watershed that includes industrial activities contains high levels of TSS, metals, and oils from the activities and properties that exist. Examples of

contributing land uses activities include gravel staging areas, equipment storage areas, and refueling stations. Residential urban watersheds contain high levels of nutrients, Total Sediment Solids, and E.coli. Example contributors include lawns and pets.

3. Waterway Impairments: Treatment projects that target total suspended sediment reductions in stormwater discharges to Bozeman and Mandeville Creeks constitute the majority of CIP expenditures.
4. Budget Constraints: Alignment of projects, so annual expenditures are equal to utility income.
5. Other Projects: Combining planned projects with other MS4 initiatives, such as road reconstructions, reduces costs.

2.4 Capital Projects

The MS4 plans to complete the following approved capital projects:

1. Mechanical Separation Units - Downtown Stormwater Treatment Phase 2
 - ID: STRM13
 - Year: FY19
 - Budget: \$350,000
 - Description: This project includes the installation of four (4) stormwater mechanical separation units near the following intersections: N. Black and E. Main, N. Bozeman and E. Main, N. Rouse and E. Main, and Westridge and Overbrook. Staff proposes to target these locations because the roads, parking lots, yards, driveways, and drainage systems contained within their urban watersheds have a direct connection to Bozeman and Matthew Bird Creeks, meaning no removal of stormwater pollutants currently occurs.
 - Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.
 - Advantages of Approval: The four (4) units will treat stormwater flowing from 162 urban acres, collecting an estimated 12 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore Bozeman and Matthew Bird Creeks' aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
 - Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
 - Additional Funding Sources: None
2. Boulevard Infiltration Structures – Downtown Stormwater Treatment Phase 2
 - ID: STRM36

- Year: FY19
- Budget: \$50,000
- Description: This project includes the installation of two (2) stormwater boulevard infiltration structures near the intersection of N. 11th and W. Dickerson. Staff proposes to target this location because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watershed have a direct connection to Mandeville Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the small size of the drainage basin targeted.
- Advantages of Approval: The two (2) structures will divert, capture, and infiltrate stormwater flowing from seven (7) urban acres, collecting over two (2) tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore Mandeville Creek's aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

3. Pipe Replacement – N. 4th (W. Cottonwood to W. Peach)

- ID: New
- Year: FY19
- Budget: \$50,000
- Description: This project includes the construction of 150' of 30" reinforced concrete pipe near the intersection of N. 4th and W. Peach, replacing a conveyance ditch and linking two existing pipe sections. Staff proposes to target this location because the ditch is clogged and reverse graded due to significant degradation. Staff secured an easement from the property owner in FY17 to facilitate the construction of this project and improve land records.
- Alternatives Considered: Staff assessed the potential of rehabbing the conveyance ditch currently in place; however, decided to proceed with a pipe project after reviewing long-term maintenance cost and private property concerns.
- Advantages of Approval: The pipe will convey stormwater originating from a 58-acre urban watershed, reducing flood risk for adjacent properties and improving water quality by mitigating past issues stemming from erosion and illegal dumping.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance annually, including the removal of collected debris using existing pipe flushing

equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.

- Additional Funding Sources: None

4. Administrative Staff Vehicle

- ID: New
- Year: FY19
- Budget: \$35,000
- Description: This project includes the purchase of a new field work and inspection vehicle for Stormwater Division Administrative Staff, accommodating transportation needs for a new Specialist Position hired in FY18. The Stormwater Division has three administrative personnel who currently have one truck, and access to two shared Public Works cars. An additional truck is necessary for Staff to complete pollution event mitigation activities, sampling equipment transport, work within the public-right-of-way, and field inspections.
- Alternatives Considered: Staff assessed the potential of sharing existing vehicles; however, determined that scheduling conflicts would present themselves frequently, affecting the Division's ability to achieve level of service goals.
- Advantages of Approval: The purchase of an additional vehicle will allow Stormwater Division Staff to complete daily work activities timely, effectively, and safely.
- Additional Operating Cost in the Future: Staff will budget for annual preventative maintenance completed by a mix of internal and external services, ensuring the vehicle stays in good working order.
- Additional Funding Sources: None

5. Mechanical Separation Unit – College and S. 11th

- ID: Montana State University Project
- Year: FY19
- Budget: \$150,000
- Description: This project includes the installation of a stormwater mechanical separation unit near the intersection of College and S. 11th. Staff proposes to target this location because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watersheds have a direct connection to Mandeville Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.
- Advantages of Approval: The unit will treat stormwater flowing from 60 urban acres, collecting over 3.6 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public

safety, help restore Mandeville Creeks' aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.

- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

6. Annual Pipe Rehabilitation and Drainage Projects

- ID: STRM13
- Year: FY19
- Budget: \$65,000
- Description: An annual program that provides funding for the design and construction of various pipe rehabilitation, drainage, and treatment projects that improve the structural integrity and conveyance capacity of the City's stormwater infrastructure network. Unplanned funds allow Staff to respond to infrastructure needs that arise from reoccurring system inspection and partner with other Public Works' projects, such as local SID street reconstructions when approved.
- Alternatives Considered: Staff assessed the potential of Stormwater Operations Personnel completing all pipe rehabilitation and drainage projects; however, this approach would significantly reduce resources applied towards critical reoccurring infrastructure maintenance.
- Advantages of Approval: The allocation of unplanned funds allows Staff to be proactive in the repair and replacement of stormwater infrastructure that has or is likely to fail, increasing system efficiency and reducing City liability.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance of projects as required.
- Additional Funding Sources: None

7. Annual Inlet Replacement Program

- ID: New
- Year: FY19
- Budget: \$100,000
- Description: An annual program that provides funding for the replacement of under sized and degraded stormwater inlets throughout the downtown core in coordination with the Street and Engineering Divisions' ADA pedestrian ramp installation program.
- Alternatives Considered: Staff assessed the potential of Stormwater Operations Personnel completing inlet replacements; however, this approach would significantly reduce resources applied towards critical reoccurring infrastructure maintenance.

- Advantages of Approval: Upgrading inlets to the City's current standard will reduce localized flooding and improve stormwater treatment through increased sump depth.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance annually, including the removal of collected debris using existing inlet vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

8. Mechanical Separation Units - Downtown Stormwater Treatment Phase 3

- ID: STRM34
- Year: FY20
- Budget: \$300,000
- Description: This project includes the installation of three (3) stormwater mechanical separation units near the following intersections: N. Rouse and E. Peach, N. Tracy and W. Main, and Langhor and Westridge. Staff proposes to target these locations because the roads, parking lots, yards, driveways, and drainage systems contained within their urban watersheds have a direct connection to Bozeman and Matthew Bird Creeks, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.
- Advantages of Approval: The three (3) units will treat stormwater flowing from 258 urban acres, and collect over 16 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore Bozeman and Matthew Bird Creeks' aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

9. Boulevard Infiltration Structures – Downtown Stormwater Treatment Phase 3

- ID: STRM49
- Year: FY20
- Budget: \$50,000
- Description: This project includes the installation of two (2) stormwater boulevard infiltration structures near the intersection of N. 11th and W. Alderson. Staff proposes to target this location

because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watershed have a direct connection to Mandeville Creek, meaning no removal of stormwater pollutants currently occurs.

- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the small size of the drainage basin targeted.
- Advantages of Approval: The two (2) structures will divert, capture, and infiltrate stormwater flowing from eight (8) urban acres and collect over two (2) tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore Mandeville Creek's aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

10. Mechanical Separation Units - Downtown Stormwater Treatment Phase 4

- ID: STRM31
- Year: FY21
- Budget: \$300,000
- Description: This project includes the installation of three (3) stormwater mechanical separation units near the following intersections: N. Rouse and E. Tamarack, S. Black and E. Cleveland, and S. Bozeman and E. Cleveland. Staff proposes to target these locations because the roads, parking lots, yards, driveways, and drainage systems contained within their urban watersheds have a direct connection to Bozeman and Matthew Bird Creeks, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.
- Advantages of Approval: The three (3) units will treat stormwater flowing from 278 urban acres and collect over 17 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore Bozeman and Matthew Bird Creeks' aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming

equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.

- Additional Funding Sources: None

11. Boulevard Infiltration Structures – Downtown Stormwater Treatment Phase 4

- ID: New
- Year: FY21
- Budget: \$50,000
- Description: This project includes the installation of two stormwater boulevard infiltration structures near the intersection of S. Black and E. Garfield. Staff proposes to target this location because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watershed have a direct connection to Matthew Bird Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the small size of the drainage basin targeted.
- Advantages of Approval: The two (2) structures will divert, capture, and infiltrate stormwater flowing from 14 urban acres and collect over two (2) tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

12. Mechanical Separation Units - Downtown Stormwater Treatment Phase 5

- ID: STRM38
- Year: FY22
- Budget: \$300,000
- Description: This project includes the installation of three (3) stormwater mechanical separation units near the following intersections: N. 4th and W. Peach, N. 11th and W. Koch, and N. 9th and W. Villard. Staff proposes to target these locations because the roads, parking lots, yards, driveways, and drainage systems contained within their urban watersheds have a direct connection to Mandeville Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or

pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.

- Advantages of Approval: The three (3) units will treat stormwater flowing from 255 urban acres and collect over 15 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

13. Boulevard Infiltration Structures – Downtown Stormwater Treatment Phase 5

- ID: New
- Year: FY22
- Budget: \$50,000
- Description: This project includes the installation of two stormwater boulevard infiltration structures near the intersection of N. Montana and E. Beall. Staff proposes to target this location because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watershed have a direct connection to Bozeman Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the small size of the drainage basin targeted.
- Advantages of Approval: The two (2) structures will divert, capture, and infiltrate stormwater flowing from eight (8) urban acres and collect over two (2) tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

14. Mechanical Separation Units - Downtown Stormwater Treatment Phase 6

- ID: New
- Year: FY23

- Budget: \$300,000
- Description: This project includes the installation of three (3) stormwater mechanical separation units near the following intersections: S. 17th and W. Babcock, Blackmore and Terrace, and S. Tracy and E. Kagy. Staff proposes to target these locations because the roads, parking lots, yards, driveways, and drainage systems contained within their urban watersheds have a direct connection to Mandeville and Matthew Bird Creeks, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the large size of the drainage basins targeted.
- Advantages of Approval: The three (3) units will treat stormwater flowing from 100 urban acres and collect over 6 tons of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.
- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

15. Boulevard Infiltration Structures – Downtown Stormwater Treatment Phase 6

- ID: New
- Year: FY23
- Budget: \$50,000
- Description: This project includes the installation of two stormwater boulevard infiltration structures near the intersection of N. Broadway and E. Mendenhall. Staff proposes to target this location because the roads, parking lots, yards, driveways, and drainage systems contained within its urban watershed have a direct connection to Bozeman Creek, meaning no removal of stormwater pollutants currently occurs.
- Alternatives Considered: Staff has not identified any alternative stormwater treatment approaches with comparable maintenance requirements, construction footprints, and/or pollutant removal efficiencies, especially considering the small size of the drainage basin targeted.
- Advantages of Approval: The two (2) structures will divert, capture, and infiltrate stormwater flowing from four (4) urban acres and collect over one (1) ton of sediment, litter, oil, and metals annually. Pollutant removal will improve public safety, help restore aquatic habitat, decrease infrastructure degradation, and provide the City a measurable step towards municipal stormwater discharge permit compliance.

- Additional Operating Cost in the Future: Stormwater Operations Personnel will complete maintenance semi-annually, including the removal of collected debris using existing vacuuming equipment. Once collected, Staff will temporarily store and dry debris at the City's Stormwater Waste Management Facility before hauling to the landfill for final disposal.
- Additional Funding Sources: None

16. Stormwater Facility Plan Update

- ID: New
- Year: FY20
- Budget: \$150,000
- Description: This project includes hiring a contractor to update the City of Bozeman's Stormwater Facility Plan, which was last revised in 2007. The City has made significant stormwater programmatic, operational, and administrative changes over the past ten years in response to evolving environmental regulations, growth, and aging infrastructure. An updated Stormwater Facility Plan will assist Staff in identifying high-priority infrastructure deficiencies, future needs, and determine the City's regulatory standing with MS4 General Permit regulations.
- Alternatives Considered: Staff will continue implementing recommendations provided in the 2007 Stormwater Facility Plan.
- Advantages of Approval: A Stormwater Facility Plan will provide Staff a framework, action plan, and third party professional oversight that will assist the City in achieving its programmatic goals, which include complying with environmental regulations, improving waterway health, protecting public safety, and managing infrastructure.
- Additional Operating Cost in the Future: None
- Additional Funding Sources: None

2.5 Completed Capital Projects

The MS4 has completed the following projects to date:

1. City Hall Patio Permeable Paver Project
 - Purpose: LID/Green infrastructure pilot project and community education
 - Type: Pave Drain Permeable Pavers
 - Expected Treatment Efficiency: 100% TSS Reduction
 - Treatment Area: ≈1,000 square feet
 - Cost: \$15,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Summer 2017
 - Co-Benefits: Progress towards WLA
2. Inlet Replacements
 - Purpose: Reduce sediment to Bozeman Creek and flood control
 - Type: Standard inlet with 9" sump

- Expected Treatment Efficiency: Unknown
 - Treatment Area: 23 inlets
 - Cost: \$100,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: Progress towards WLA
3. Pipe Replacements (S. Black and S. Bozeman)
 - Purpose: Flood control
 - Type: 15" SDR
 - Expected Treatment Efficiency: n/a
 - Treatment Area: 600'
 - Cost: \$60,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: n/a
 4. Mechanical Separation Unit Installation – N. Rouse and E. Griffin
 - Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (6' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈ 14 Acres
 - Cost: \$100,000 (MDT Project)
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: Progress towards WLA
 5. Mechanical Separation Unit Installation - N. Rouse and Bridger Center
 - Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (5' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈12 Acres
 - Cost: \$75,000 (MDT Project)
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: Progress towards WLA
 6. Mechanical Separation Unit Installation – S. Rouse and E. Olive
 - Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (5' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈9 Acres
 - Cost: \$50,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: Progress towards WLA
 7. Mechanical Separation Unit Installation – Perkins and E. Peach

- Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (4' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈ 22 Acres
 - Cost: \$25,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2017
 - Co-Benefits: Progress towards WLA
8. Stormwater Operations Disposal Facility
- Purpose: Sediment dewatering and storage
 - Type: Asphalt pad with ecology block bays
 - Expected Treatment Efficiency: n/a
 - Treatment Area: n/a
 - Cost: \$400,000
 - Discharge Location: Lined wastewater pond
 - Date of Completion: Fall 2017
 - Co-Benefits: Facilitates pollutant reduction totals
9. Midtown Streetscape Project
- Purpose: Flood control, water quality improvement, economic benefit
 - Type: Basalite permeable pavers and Stratavault soil cells
 - Expected Treatment Efficiency: 100% TSS Reduction
 - Treatment Area: ≈ 600 square feet
 - Cost: Unknown, Economic Development Project
 - Discharge Location: Conveyance Ditch
 - Date of Completion: Winter 2017
 - Co-Benefits: Aesthetic value
10. Mechanical Separation Unit Installation - S. Rouse and E. Lincoln
- Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (5' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈ 32 Acres
 - Cost: \$50,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2016
 - Co-Benefits: Progress towards WLA
11. Mechanical Separation Unit Installation - N. 11th and W. Lamme
- Purpose: Reduce sediment load to Mandeville Creek
 - Type: Contech CDS (4' Diameter)
 - Expected Treatment Efficiency: 80% TSS Reduction
 - Treatment Area: ≈ 7 Acres
 - Cost: \$25,000
 - Discharge Location: Mandeville Creek
 - Date of Completion: Fall 2016
 - Co-Benefits: Located adjacent to High School and includes educational signage

12. Mechanical Separation Unit, Underground Infiltration Basin, Wash Pad, and Paving Project – Shops Complex
 - Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (4' Diameter), ADS StormTech, and Inlet Sumps
 - Expected Treatment Efficiency: 80% TSS Reduction for Mechanical Separation Unit and 100% for Underground Infiltration Basin
 - Treatment Area: ≈2 Acres
 - Cost: \$360,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Fall 2016
 - Co-Benefits: Progress towards WLA
13. Mechanical Separation Unit Installation – N. Wallace and E. Tamarack
 - Purpose: Reduce sediment load to Bozeman Creek
 - Type: Contech CDS (8' Diameter)
 - Expected Treatment Efficiency: 80% TSS
 - Treatment Area: ≈100 Acres
 - Cost: \$75,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: November 2016
 - Co-Benefits: Progress towards WLA
14. Underground Infiltration Basin – N. 7th and Baxter
 - Purpose: Reduce localized flooding; reduce sediment load to Mandeville Creek
 - Type: Perforated gravity main embedded in aggregate for storage
 - Expected Treatment Efficiency: 100% TSS
 - Treatment Area: ≈9 Acres
 - Cost: \$20,000
 - Discharge Location: Mandeville Creek
 - Date of Completion: Summer 2016
 - Co-Benefits: Joint water conservation and stormwater LID pilot project
15. Underground Infiltration Basin – Plum and Avocado
 - Purpose: Reduce localized flooding; reduce sediment load to East Gallatin;
 - Type: ADS StormTech
 - Expected Treatment Efficiency: 100% TSS
 - Treatment Area: ≈14 Acres
 - Cost: \$50,000
 - Discharge Location: Subsurface
 - Date of Completion: Fall 2016
 - Co-Benefits: Resolved localized flooding issue
16. Backwater Slough – Story Mill Park
 - Purpose: Reduce sediment load in Bozeman Creek
 - Type: Constructed wetland
 - Expected Treatment Efficiency: 100% TSS
 - Treatment Area: Entire Bozeman Creek Watershed

- Cost: \$100,000
 - Discharge Location: Bozeman Creek
 - Date of Completion: Summer 2015
 - Co-Benefits: Nutrient uptake, flood mitigation, and wetland restoration
17. Bozeman Creek Meander Construction – Bogert Park
- Purpose: Stream restoration; improve streamside vegetative cover; reduce sediment load due to streambank erosion; flood control
 - Type: Excavated meander and pool addition; inset floodplain construction
 - Expected Treatment Efficiency: Unknown
 - Treatment Area: Entire Bozeman Creek Watershed
 - Cost: Unknown
 - Discharge Location: Bozeman Creek
 - Date of Completion: Spring 2017
 - Co-Benefits: Education, fish habitat, stream bank stabilization, and flood control
18. Meander the Mandeville Construction Phase 1 – Bozeman High School
- Purpose: Stream restoration; improve streamside vegetative cover; flood control
 - Type: Construction of meanders, riffles, and pools
 - Expected Treatment Efficiency: Unknown
 - Treatment Area: Entire Mandeville Creek Watershed
 - Cost: Unknown
 - Discharge Location: Mandeville Creek
 - Date of Completion: 2016
 - Co-Benefits: Education, fish habitat, stream bank stabilization, and flood control
19. LID Infiltration Galleries – University Field House
- Purpose: Reduce sediment load to Mandeville Creek
 - Type: LID Infiltration Galleries
 - Expected Treatment Efficiency: 100% TSS Reduction
 - Treatment Area: 2.4 Acres
 - Cost: \$75,000
 - Discharge Location: Mandeville Creek
 - Date of Completion: 2016
20. Mechanical Separation Unit Installation – University Field House
- Purpose: Reduce sediment load to Mandeville Creek
 - Type: Hydro International Downstream Defender and Sediment Separator
 - Expected Treatment Efficiency: 80% TSS removal
 - Treatment Area: 3 Acres
 - Cost: \$70,000
 - Discharge Location: Mandeville Creek
 - Date of Completion: Fall 2015
21. Underground Infiltration – Jabs and Wilson Halls
- Purpose: Reduce sediment load to Mandeville Creek
 - Type: Underground Infiltration Gallery
 - Expected Treatment Efficiency: 100% TSS Reduction

- Treatment Area: 3.9 Acres
- Cost: n/a
- Discharge Location: Subsurface
- Date of Completion: 2016

22. Gravity Main Install – 15th and Babcock

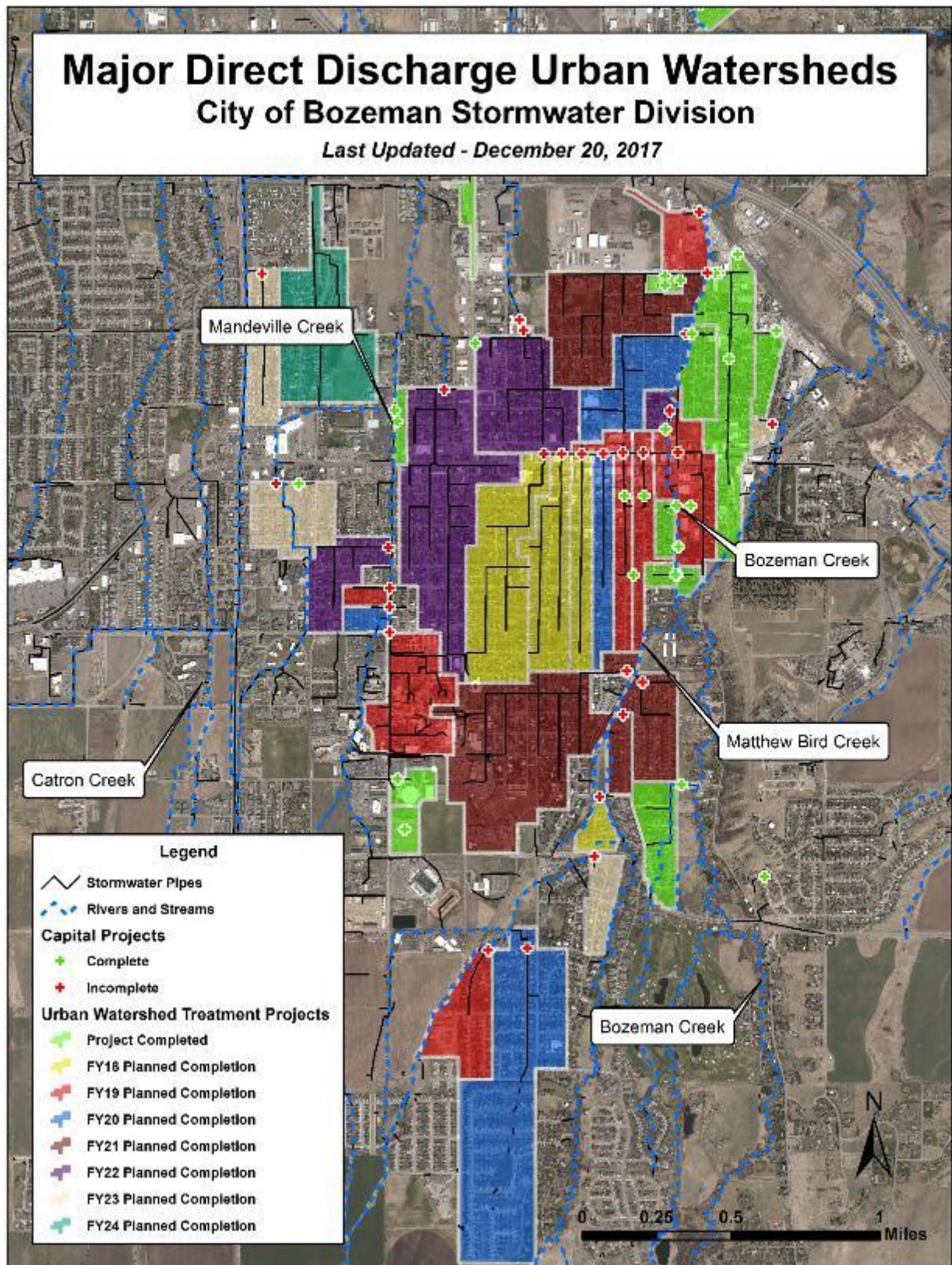
- Purpose: Eliminate localized flooding issue
- Type: Construction of underground stormwater main
- Expected Treatment Efficiency: None
- Treatment Area: None
- Cost: ≈\$30,000
- Discharge Location: Mandeville Creek
- Date of Completion: Fall 2015

23. Wallace Street Reconstruction and Stormwater System Improvements

- Purpose: Eliminate localized flooding issue and provide treatment
- Type: Construction of 3,000 feet of underground stormwater mains and new inlets
- Expected Treatment Efficiency: None
- Treatment Area: None
- Cost: ≈\$200,000
- Discharge Location: Bozeman Creek
- Date of Completion: 2016

24. Story Street Reconstruction and Stormwater System Improvements

- Purpose: Eliminate localized flooding issue and provide treatment
- Type: Construction of underground stormwater mains, new inlets, and oil/sand separators
- Expected Treatment Efficiency: Unknown
- Treatment Area: 10 Acres
- Cost: ≈\$200,000
- Discharge Location: Bozeman Creek
- Date of Completion: 2015



Map 2.3.1: Planned stormwater treatment projects

2.6 Pollutant Reduction Totals

The MS4 tracks pollutant reduction totals using a variety of methods and data tracking mechanisms, including:

1. Total Suspended Solids (Sediment)

- **Treatment Unit Maintenance:** The MS4 calculates tonnage totals by measuring the depth of sediment within each unit before cleaning. The MS4 subtracts a top of sediment depth measurement from a total depth measurement. The MS4 then calculates a volume of sediment (cubic feet) using dimension information for each unit. Finally, the MS4 converts the volume to tons by using an assumed sand weight ratio of .056 Tons = 1 Cubic Foot of Sand.

⊕ 2017: 22.6 Tons

- Bozeman Creek Watershed: 16.3 Tons
- Mandeville Creek Watershed: 5.0 Tons
- East Gallatin: 1.3 Tons
- Citywide (Excluding Above): 0 Tons

- **Infrastructure Maintenance:** The MS4 calculates tonnage totals by conservatively estimating the depth of sediment vacuumed out of manholes and inlets before cleaning. The MS4 multiplies the area of each assets sump by an assumed 1/2 full depth measurement. Then, the MS4 multiplies the volume by the total assets maintained for that calendar year. Finally, the MS4 converts the volume to tons by using an assumed sand weight ratio of .056 Tons = 1 Cubic Foot of Sand.

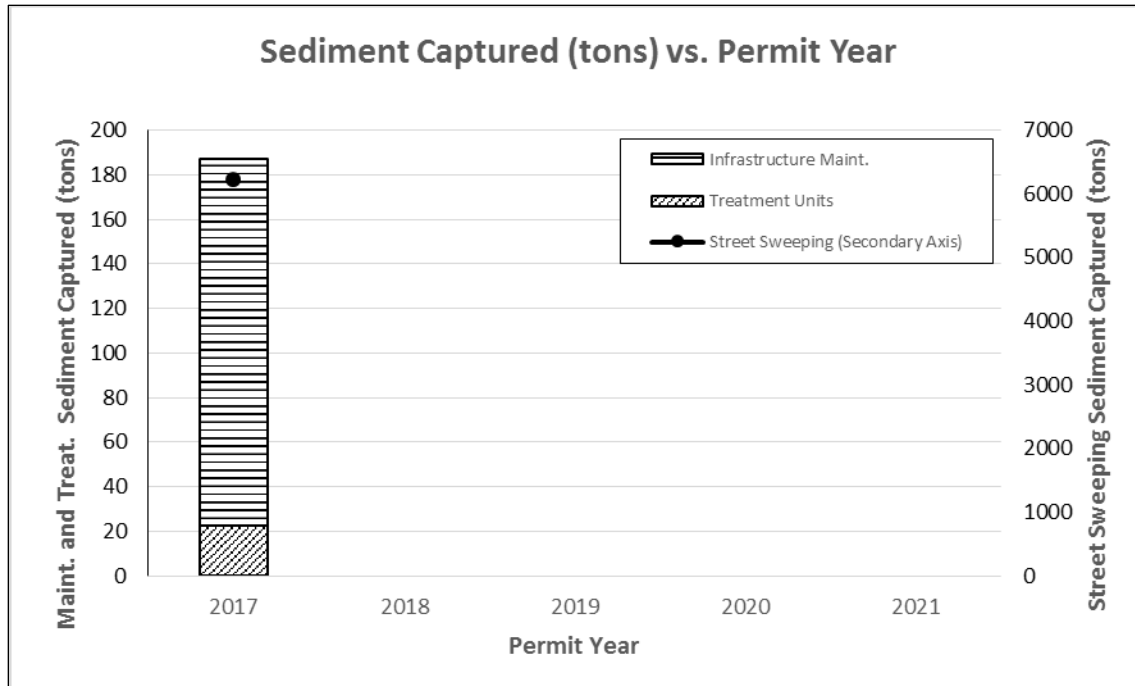
⊕ 2017: 164.7 Tons

- City Citywide: 117.7 Tons
- MSU Campus: 46.9 Tons

- **Street Sweeping:** The MS4 calculates tonnage totals for reoccurring, spring, and fall Street sweeping operations. Streets Division personnel track cubic yard totals for each of the activities, which is then stored in Cityworks and reported on. The MS4 converts yards to tons using an assumed weight ratio of 1.5 Tons = 1 Cubic Yard of Sand for reoccurring and spring street sweeping. The MS4 converts yards to tons using an assumed weight ratio of .18 Tons = 1 Cubic Yard of Leaves for fall street sweeping.

⊕ 2017: 6,232 Tons

- City Citywide: 6,108 Tons
- MSU Campus: 124 Tons



Graph 2.6.1: Sediment capture totals

2.7 Performance Measures

The MS4 utilizes performance measures to determine the effectiveness of implemented programs, best management practices, and infrastructure projects. The MS4 updates the following performance measures annually:

1. Inlets Cleaned: Stormwater inlets serve two primary purposes: (1) mitigate flood risk by collecting runoff from the MS4's streets, parking lots, alleyways, and other hard surfaces, reducing flooding, and (2) treat stormwater by capturing sediment, trash, and other pollutants in their nine-inch sumps. The MS4 maintains inlets year-round and documents operation totals, such as the number cleaned, labor hours accumulated, budget spent, and weight of material removed.
 - ⊕ Performance Measure: Clean 20% of inlets annually
 - ⊕ Calculation Type: Total assets (includes duplicate effort)
 - ⊕ Data Source: Infrastructure Maintenance Performance Measure
 - 2017: 23.5% (675 maintained inlets/2,877 total inlets)
 - City: 19.6% (521 maintained inlets/2,652 total inlets)
 - MSU: 68.4% (154 maintained inlets/225 total inlets)
2. Pipes Cleaned: Stormwater pipes serve two primary purposes: (1) convey stormwater collected by inlets to their point of discharge, and (2) capture sediment, trash, and other pollutants that fall out of suspension, requiring reoccurring maintenance to remain functional. The MS4 maintains stormwater pipes year-round, documenting operation totals, such as the length of pipe cleaned, labor hours accumulated, budget spent, and weight of material removed.
 - ⊕ Performance Measure: Clean 20% of pipes annually
 - ⊕ Calculation Type: Total assets (mains and laterals, includes duplicate effort)
 - ⊕ Data Source: Infrastructure Maintenance Performance Measure

- *2017: 18.0% (17.0 maintained miles/94.3 total miles)*
 - *City: 21.6% (16.7 maintained miles/77.4 total miles)*
 - *MSU: 1.8% (.3 maintained miles/16.9 total miles)*
- 3. **Manholes Cleaned:** Stormwater manholes serve two primary purposes: (1) allow for maintenance access to underground infrastructure, and (2) treat stormwater by capturing sediment, trash, and other pollutants in their sumps, requiring reoccurring maintenance to remain effective. The MS4 maintains manholes year-round, documenting operation totals, such as the number of manholes cleaned, labor hours accumulated, budget spent, and weight of material removed.
 - ⊕ Performance Measure: Clean 20% of manholes annually
 - ⊕ Calculation Type: Total assets (includes duplicate effort)
 - ⊕ Data Source: Infrastructure Maintenance Performance Measure
 - *2017: 30.3% (376 maintained manholes/1,240 total manholes)*
 - *City: 23.8% (255 maintained manholes/1,073 total manholes)*
 - *MSU: 72.5% (121 maintained manholes/167 total manholes)*
- 4. **Infrastructure Repairs:** Infrastructure repairs or “spot repairs” serve two primary purposes: (1) fix known pipe failures and restrictions to ensure the adequate flow of stormwater, and (2) repairs open sections of pipe where scouring of subgrade soils occur, mitigating the chance of a road failure and sediment load contribution. The MS4 completes infrastructure repairs year-round, documenting operation totals, such as the number of repairs, labor hours accumulated, and budget spent.
 - ⊕ Performance Measure: Indicator measure
 - ⊕ Calculation Type: Total repairs
 - ⊕ Data Source: Performance Measures Spreadsheet
 - *2017: 22 Repairs*
 - *City: 17 Repairs*
 - *MSU: 5 Repairs*
- 5. **Stormwater Mains Inspected:** Stormwater main inspections serves two primary purposes: (1) allows staff to identify structural, and maintenance needs for underground infrastructure, and (2) ensure no cross connection or illegal pipe connections exist. The MS4 inspects pipes year-round, documenting operation totals, such as labor hours accumulated and budget spent.
 - ⊕ Performance Measure: Inspect 20% of stormwater mains annually
 - ⊕ Calculation Type: Total assets (mains and laterals, includes duplicate effort)
 - ⊕ Data Source: Infrastructure Maintenance Performance Measure
 - *2017: 10.4% (9.8 inspected miles/94.3 total miles)*
 - *City: 12.0% (9.31 inspected miles/77.4 total miles)*
 - *MSU: 3.0% (.5 inspected miles/16.9 total miles)*
- 6. **Sediment Prevented from Discharging into Waterways:** Sediment is the MS4’s primary pollutant of concern. Significant efforts are completed and tracked annually to reduce the amount entering local waterways. The MS4 plans to maintain existing and implement new improvements, increasing totals annually.
 - ⊕ Performance Measure: 81 tons per year (Lower Gallatin TMDL WLA)

- ⊕ Calculation Type: Total tons (excludes street sweeping and spring and fall cleanups)
 - ⊕ Data Source: Treatment Unit Totals Document
 - *2017: 187 Tons*
7. Urban Acres Treated: Over 1,500 acres of the MS4 contains aged conveyance infrastructure that discharges stormwater directly into waterways without treatment or flood control. A primary component of the MS4's Stormwater Program is to retrofit or install enhancement improvements that bring these areas up to current water quality and, when applicable, quantity standards. Example projects include the installation of mechanical separation units, regional pond facilities, and green infrastructure.
- ⊕ Performance Measure: Indicator measure
 - ⊕ Calculation Type: Acres/total acres
 - ⊕ Data Source: Treatment Unit Totals Document
 - *2017: 81/192 Acres*
8. Construction Site Inspections: The MS4 tracks the totals and types of compliance inspections completed annually. Three separate construction site permits types exist and are subject to review: Less than One (1) Acre, Greater than One (1) Acre, and Single-Family Residential.
- ⊕ Performance Measure: Inspect 20% per year
 - ⊕ Calculation Type: Percentage of total inspections, does not include multiple visits or occupancy inspections
 - ⊕ Data Source: Less and Over One (1) Acre count from Construction Folder, SFR calculated using meter activations in GIS
 - *2017: 4.2% (19 inspections/450 projects)*
 - *City: 2.4% (14 inspections/445 projects)*
 - *MSU: 100% (5 inspections/5 projects)*
9. Illicit Discharges Resolved: Illicit discharge events can threaten public safety and environmental health and pose difficulties to MS4 infrastructure operations and maintenance. The MS4 responds to a variety of illicit discharge events, ranging from minimal to severe on an annual basis.
- ⊕ Performance Measure: Indicator measure
 - ⊕ Calculation Type: Total events
 - ⊕ Data Source: Performance Measures Spreadsheet
 - *2017: 5 Events*
 - *City: 3 Events*
 - *MSU: 2 Events*
10. Impervious Area Added to Utility Billing Database: The MS4 utilizes ERUs as its mechanism to generate impervious area based stormwater utility rates. A single ERU totals 2,700 square feet of impervious area or the equivalent of the total area of a rooftop and driveway found on a typical single-family residential lot. The MS4 updates ERUs as the MS4 adds new impervious area through residential, multi-family, and commercial building construction and new roads. ERUs function as growth and workload indicators for the time it takes to maintain the totals.
- ⊕ Performance Measure: Indicator measure
 - ⊕ Calculation Type: Total acres

- ⊕ Data Source: GIS calculation for multi-family and commercial, assumed 1 ERU for SFR properties with a total based on the construction performance measure (excludes public right-of-way)

- 2017: 91.3 Acres (*multi-family and commercial = 60.8 acres, residential = 30.5 acres*)

11. Stormwater Basin Inspections: HOAs are responsible for the maintenance of stormwater basins within their subdivisions via Maintenance Agreements created during the development process. Historically, HOA maintenance of basins has been severely lacking, resulting in the degradation of the majority of the MS4's HOA ponds. Degraded ponds can result in negative water quality impacts and flooding. The MS4 has initiated a new process as of 2016 to educate, inspect, and report on the condition of stormwater basins to improve their management.

- ⊕ Performance Measure: Inspect 20% per year

- ⊕ Calculation Type: Percentage of total

- ⊕ Data Source: GIS calculation

- 2017: 8.7% (*38 stormwater basins/439 total stormwater basins*)

- City: 2.0% (*8 stormwater basins inspected/409 total stormwater basins*)

- MSU: 100% (*30 stormwater basins inspected/30 total stormwater basins*)

3.0 Public Education and Involvement



Image 3.0.1: Construction field academy



Image 3.0.2: Dog waste station with educational signage

3.1 Strategy

The MS4 educates audiences on stormwater-related issues to reduce the public's contribution of pollutants to waterbodies using the following strategies:

1. **Passive Engagement (Education):** Involves creating and distributing educational messages targeting pollutant-generating activities. Strategies include:
 - Audio and visual
 - Website
 - Utility bill inserts
 - Internet and radio advertisements
 - Brochures
 - Magazine articles
 - Educational signage
 - Vehicle wraps
2. **Active Engagement (Involvement):** Includes holding customized interpersonal interactions with various audiences targeting pollutant-generating activities. Strategies include:
 - Presentations
 - Meetings
 - Trainings
 - Tours
 - Events

3.2 Key Audiences

The MS4 targets the following audiences because majorities within each group complete activities that do not conform to best practice procedures, such as proper erosion control, fertilizer application, and stormwater basin maintenance.

1. **Residents**
 - Pollutant(s): E.coli, nutrients, and sediment
 - Activity: Yard maintenance and dog waste collection
 - Rationale: Large cumulative impact, opportunity for source reduction, and foundation for cultural shift
 - Outreach Strategy: Passive Engagement and Active Engagement
2. **Home Owner Associations (HOAs) and Property Management Companies**
 - Pollutant(s): Nutrients, sediment, and flood control (downstream erosion)
 - Activity: Stormwater basin maintenance
 - Rationale: Responsible for majority of post-construction features, lack of education regarding maintenance methods
 - Outreach Strategy: Passive and Active Engagement
3. **Construction Industry**
 - Target Pollutant(s): Sediment, floatables, oil and grease, and concrete waste
 - Targeted Activity: Construction
 - Rationale: Lack of education regarding erosion, sediment, and pollutant control, high growth rate, large industry, entrenched business practices

- Outreach Strategy: Passive and Active Engagement

3.3 Ongoing Initiatives

The MS4 completes initiatives to engage, educate, and change the behavior of its key target audiences. Also, the MS4 evaluates and collects feedback from its audiences, using it to improve existing practices and identify future opportunities. Ongoing initiatives include:

1. Educational Stormwater Video: Seven-minute video directed and produced by Jon Catton in the fall (made public on November 13) of 2017. The video describes the MS4's Program, the context for why stormwater is important, and ways residents/property owners can make a difference. Residents view the video on the City's website.
 - Key Audience: Residents
 - Targeted Pollutant(s): E.coli, nutrients, and sediment
 - Strategy: Passive Engagement
 - Treatment Area: Citywide
 - Performance: Total views, watch time, and average view duration tracked annually using YouTube Analytics.
 - 2017: 179 views, 722 minutes watch time, and 4:02 average view duration
2. Dog-Waste Collection Campaign: Campaign devoted to educating residents about the importance of dog waste collection and disposal. Outreach includes one (1) utility bill insert sent to ratepayers annually and maintenance of strategic signage placed in high dog use areas.
 - Key Audience: Residents
 - Targeted Pollutant(s): E.coli
 - Strategy: Passive Engagement
 - Treatment Area: Citywide
 - Performance: Tonnage tracked annually by calculating the total amount of dog waste collected by the Parks Division at all city-owned stations. One bag (containing numerous individual bags) weighs 10 lbs. on average, which Staff multiplies by the number of bags collected in a given year and divides by 2,000 lbs. to arrive at tons.
 - 2017: 19.5 tons
3. Contractor Training: Training designed to educate contractors on proper selection and use of Best Management Practices. The MS4 holds trainings regularly, including six (6) or more different classes tailored to various education levels, construction activities, and inspection procedures. Further, the MS4 maintains a Construction Program that includes permits, processes, and materials tailored to this group further described in Section 5.0.
 - Key Audience: Contractors
 - Targeted Pollutant(s): Sediment, floatables, oil and grease, and concrete waste
 - Strategy: Active and Passive Engagement
 - Treatment Area: Citywide
 - Performance: Attendance tracked annually.
 - 2017: 268 Attendees
4. HOAs and Property Management Company Training: Tailored outreach, educating HOA Boards and management representatives on the proper function and maintenance of stormwater basins. The City participates in site tours, board meetings, and annual assemblies upon request,

or in situations when Staff identifies an issue. The MS4 maintains a Post-Construction Program that includes processes and materials tailored to this group further described in Section 6.0.

- Key Audience: Home Owner Associations and Property Management Companies
- Targeted Pollutant(s): Nutrients, sediment, flood control (downstream erosion)
- Strategy: Active and Passive Engagement
- Treatment Area: Citywide
- Performance:

➤ 2017: 0 annual meeting(s), 0 board meeting(s), 1 site tour(s)

5. Vehicle Decal Wraps: Educational signage installed on the MS4's Vactor truck and street sweeper demonstrating the connection between the urban terrestrial landscape and waterways. Both vehicles drive hundreds of miles annually, subjecting thousands of residents to their messages. The MS4 maintains, repairs, and replaces wraps as necessary.

- Key Audience: Residents
- Targeted Pollutant(s): E.coli, nutrients, and sediment
- Strategy: Passive Engagement
- Treatment Area: Citywide
- Performance:

➤ 2017: No tracking mechanism

6. Website: Publically accessible site that includes a variety of information, spanning from what stormwater is, how to report a pollution event, rate model information, post-construction design standards, and more. Address: www.bozeman.net/stormwater. The MS4's new web management system went live July of 2017, and Staff updates content on a regular basis.

- Key Audience: Residents, Home Owner Associations, and Contractors
- Targeted Pollutant(s): E.coli, nutrients, and sediment
- Strategy: Passive Engagement
- Treatment Area: Citywide
- Performance: Total unique page views tracked by Google Analytics annually

➤ 2017: 677 views

7. Project WET Stormwater Curriculum: Class exercises administered by 4th, 5th, and 6th-grade teachers in local schools educating students on stormwater-related issues. Project WET is a non-profit organization that provides action-oriented water education programs for students and teachers worldwide. Project WET utilizes customized, and location-specific lesson plans and activities to teach young learners. The MS4 is working with Project WET to integrate the developed lessons into the Bozeman Public Schools Next Generation Science Standards. The program has trained hundreds of students to date, yielding an average pre and post-assessment score increase of 120%. Address: <http://www.projectwet.org/bozeman>

- Key Audience: Residents
- Targeted Pollutant(s): E.coli, sediment, nutrients, and trash
- Strategy: Passive Engagement
- Treatment Area: Entire MS4
- Performance: Total student participants

➤ 2017: 492 students

8. General Outreach: Presentations, trade show booths, conferences, community events, and advertisement developed by Staff and applied in various settings focused on providing general stormwater information to the public.
 - Key Audience: Residents
 - Targeted Pollutant(s): E.coli, sediment, and nutrients
 - Strategy: Active Engagement
 - Treatment Area: Entire MS4
 - Performance: Total events
 - 2017: 15 (*Green Drinks Event, MSU Class Presentations, GLWQD Board Presentation, (2) MSAWWA Conference Presentation, SWMBIA Home Show Booth, Environment Summit Community Event, Water Works Art Initiative, Gallatin Watershed Sourcebook, Breaking Ground Advertisement*)

3.4 Future Initiatives

The MS4 seeks educational partnership opportunities with local non-profits, internships, and town/gown (University) opportunities whenever feasible, and if the evaluation (SWMP Sec. 8.0) of the MS4's efforts yield results necessitating further improvement. The ongoing initiatives detailed above are the MS4's primary objectives. Additionally, the MS4 may pursue the following as resources and collaborative opportunities arise:

1. Adopt a Curb/Storm Inlet Campaign: Development of an adoption program pairing residents with a local street inlet adjacent to their property. The MS4 would provide bags, and ask residents to collect debris on a reoccurring basis throughout the spring, fall, and summer. The MS4 would then pick up the bags at a determined interval, weigh, and dispose of as necessary.
2. Outreach Effectiveness Study: Collaborative effort with a professor to measure the effectiveness of various outreach initiatives occurring within a selected residential watershed. The MS4 would compare collected data with a control watershed of similar character.
3. Community Education Video Series: Development of a multifaceted video library that would bring to life many of the concepts presented in the MS4's static educational materials, such as how to properly fertilize, pick up dog waste, install rain barrels, etc.

4.0 Illicit Discharge Detection and Elimination



Image 4.0.1: Bentonite slurry spill



Image 4.0.2: Illicit connection confirmation through dye test

4.1 Response Action Plan

Strategy: The MS4 responds to and resolves illicit discharge events, which vary in scope, public health threat, and environmental risk. The MS4 uses professional judgment and the following protocol to assess event priority, formulate a response, and, if necessary, pursue enforcement in cases where a party completes a repeat, blatant, or knowing violation of Bozeman Municipal Code Section 40.04.200.

Protocol: The MS4 subjects all suspected illicit discharge to the following:

1. Assign event coordinator
2. Investigate complaint to determine pollutant type and severity (*pictures, site visit, phone correspondence*)
3. Implement one of the following responses:
 - Tier 1 Event
 - Threat Level: Minimal impact to public safety and environment
 - Team: MS4 staff
 - Timeline: Initiate response within 5-days
 - Resolution: MS4 operations staff and/or contracted restoration firm
 - Pollutant Disposal: Public - Disposal Facility, private - varies
 - Reporting: Internal report
 - Examples: Leaking vehicles, dripping grease dumpster, and minor construction site violations
 - Tier 2 Event
 - Threat Level: Moderate impact to public safety and environment
 - Team: MS4 Staff
 - Timeline: Initiate response within 24-hours
 - Resolution: MS4 operations staff and/or contracted restoration firm
 - Pollutant Disposal: Public - Disposal Facility, private - varies
 - Reporting: Internal report
 - Examples: Carpet cleaning process water discharge, sanitary overflow, camper waste disposal, homeless camp cleanup, floor drain and illicit sanitary connections, non-hazardous chemical spills, and moderate to severe construction violations
 - Tier 3 Event
 - Threat Level: Immediate threat to human health and environment
 - Team: MS4 operations staff and emergency services
 - Timeline: Immediate response
 - Resolution: Fire, MS4 operations, and/or restoration firm
 - Pollutant Disposal: Public - Disposal Facility, private - varies
 - Reporting: Internal report and DEQ Notification
 - Example: Hazardous chemical spills
4. Eliminate discharge by whatever means necessary
5. Notify appropriate agencies
6. Prepare and file event report
7. Assess penalty(s) to responsible party(s) (*based on: staff time accrued and remediation costs*)

High Priority Determination: The MS4 considers all illicit discharge events to be high-priority if the assigned Event Coordinator deems them a Tier 1, 2, or 3 Event, no matter their location within City limits.

Annual Total:

1. 2017 Events (Identified by or reported to the MS4)

▪ Significant Events:

- Tier 1 Event: Ellis Apartments - Leaking vehicle
 - Pollutant: Oil
 - Local Control: Bozeman Municipal Code (*report available upon request*)
 - Resolved: Yes, owner cleaned up oil
- Tier 1 Event: Crystal Bar - Illicit roof drain
 - Pollutant: Wash water
 - Local Control: Bozeman Municipal Code (*report available upon request*)
 - Resolved: Yes, owner disconnected sink from roof drain
- Tier 2 Event: Lindley Park - Homeless camp clean up
 - Pollutant: Trash, human waste, and drug paraphernalia
 - Local Control: Bozeman Municipal Code (*report available upon request*)
 - Resolved: Yes, restoration firm cleaned up debris
- Tier 1 Event: NAC Construction Site Fueling Spill
 - Pollutant: Diesel Fuel (<25 gallons)
 - Local Control: MSU Safety and Risk Management (*report available upon request*)
 - Resolved: Yes, MSU Facility Services
- Tier 1 Event: Stadium Tractor Hydraulic Oil Spill
 - Pollutant: Hydraulic Oil (<25 gallons)
 - Local Control: MSU Safety and Risk Management (*report available upon request*)
 - Resolved: Yes, MSU Facility Services
- Non-Significant Events:
 - Emergency Main Break Dewatering
 - Pollutant: Sediment
 - Local Control: Treatment system design and purchase in progress
 - Operations Planned Dig Dewatering
 - Pollutant: Sediment
 - Local Control: Treatment system design and purchase in progress
 - Fire Hydrant Flushing
 - Pollutant: Residual chlorine
 - Local Control: Dechlorinating procedure managed by the Water and Sewer Division
 - Crawl Space Sump Pump Discharges
 - Pollutant: n/a

- Local Control: Slab on grade requirement when building in high groundwater areas

Illicit Discharge Events Resolved					
	2017	2018	2019	2020	2021
Tier 1 Events	4				
Tier 2 Events	1				
Tier 3 Events	0				
Total	5				

Chart 4.1.1: Illicit discharge events

4.2 Outfall Reconnaissance Inventory (ORI)

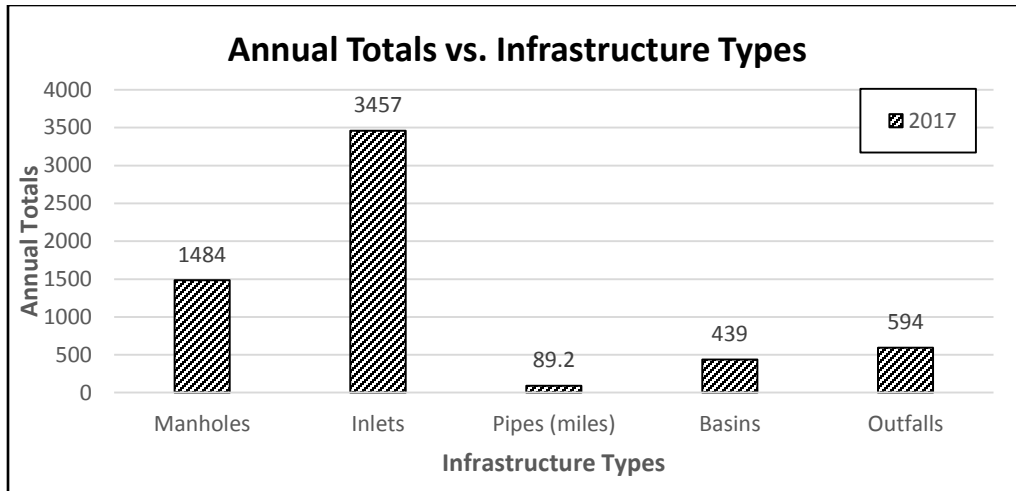
The MS4 General Permit requires the MS4 to prioritize and inspect outfalls detailed in SWMP Sec. 1.5 during the Permit Term to ensure no illicit discharges exist. The MS4 completed the following:

1. 2017 ORI Inspection Total
 - Inspected: 0 (0%)
 - Total: 594
 - High-Priority Inspected: TBD
 - High-Priority Total: TBD

4.3 Infrastructure Map

The MS4 collects and updates stormwater infrastructure spatial data annually using GPS and GIS technology. The Montana DEQ and public can access the stormwater system map by visiting the following link: <https://gisweb.bozeman.net/Html5Viewer/?viewer=infrastructure>

1. 2017 Infrastructure Totals *(includes public, private, and MSU assets)*
 - Manholes: 1,484
 - Inlets: 3,457
 - Underground Pipes (laterals and mains): 89.2 miles
 - Stormwater Basins: 439
 - Outfalls: 594



Graph 4.3.1: Infrastructure totals

5.0 Construction Site Management

Image 5.0.1: Compliant single-family residential property



Image 5.0.2: Inlet sump clogged with construction debris



5.1 Strategy

The MS4 adheres to the following strategy:

1. **Make Positive Contact:** Ensure initial interactions with contractors are positive, allowing for the clear articulation of program goals, expectations, procedures, and regulations.
2. **Provide Educational Opportunities:** Offer educational opportunities focused on providing construction industry personnel with the tools and thought processes necessary for compliance.
3. **Complete Permit Reviews:** Hold pre-submittal meetings, conduct stormwater permit adequacy reviews, and, if necessary, hold stormwater permit preparers accountable through denial and resubmittal before allowing contractors to obtain building permits.
4. **Confirm Compliance through Inspections:** Conduct compliance inspections to ensure contractors implement and maintain stormwater permits. Utilize enforcement proceedings as necessary.

5.2 Ongoing Initiatives

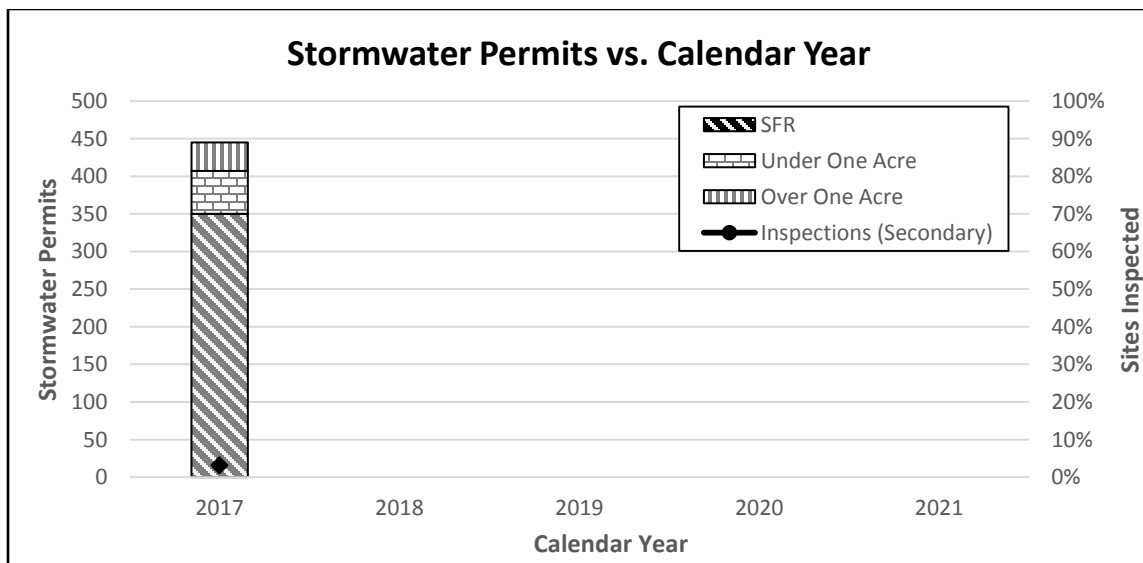
The MS4 requires contractors to comply with regulations detailed in the Bozeman Municipal Code and the City of Bozeman Best Management Practice (BMP) Manual for Construction Sites. The MS4 implements a program grounded in the following protocol to invoke industry compliance:

1. **Training (*optional*):** Classes held regularly for construction industry professionals, including Introduction to Stormwater Management, Construction Site BMP Field Academy, Stormwater Pollution Prevention Plan (SWPPP) Administrator, SWPPP Administrator Re-Certification, SWPPP Preparer, Construction Dewatering, and Compliance Evaluation Inspector.
2. **Permit Pre-submittal Meeting (*optional*):** Initial meeting where parties discuss minimum expectations, project details, and specific concerns.
3. **Permit Review:** Adequacy reviews for all permits, tracking steps using Cityworks PLL permit management software. Stage repeats until the applicant submits an adequate permit.
4. **Inspection:** Inspections based on the following prioritization:
 - **Priority Site:** Goal is to inspect one per week or 20% of total per year.
 - Complaint Driven (*internal or external*); or
 - Field Observation; or
 - Compliance History
 - **High-Priority Site:** Goal is to inspect per frequency outlined in the MS4 Permit.
 - Greater than One (1) Acre; and
 - Direct Discharge to Bozeman Creek
5. **Notice of Violations and Inspection Report:** Documents Bozeman Municipal Code violations, required corrective actions, schedule to remedy, and potential penalties if not resolved, including one or more of the following:
 - **Cease and Desist Order and Notice to Clean:** The MS4 issues if the contractor does not implement corrective actions within required timeframes. The MS4 hires a third party contractor to clean the right-of-way road surface and underground infrastructure with the cost borne by the violator.
 - **Civil Action:** The MS4 issues when contractors are guilty of repeat or knowing violations.

- Criminal Charges: The MS4 issues when contractors are guilty of egregious repeat or knowing violations.
6. Notice of Penalty: Same as Notice of Violations, but also includes a description of assessed penalties. The MS4 repeats protocols three, four, and five as necessary until the contractor resolves corrective actions.

2017 Totals:

- Construction Projects: 445 (*City*)
 - Single-Family Residential: 350
 - Less than One (1) Acre: 57
 - Greater than One (1) Acre: 38
- Plan Reviews: 445 (*City*)
 - Single-Family Residential: 350
 - Less than One (1) Acre: 57
 - Greater than One (1) Acre: 38
- Site Inspections: 14 or 3.1% (*City*)
 - Single-Family Residential: 8
 - Less than One (1) Acre: 0
 - Greater than One (1) Acre: 11
- Training Classes: 11
 - Attendees: 268



Graph 5.2.1: Stormwater permits

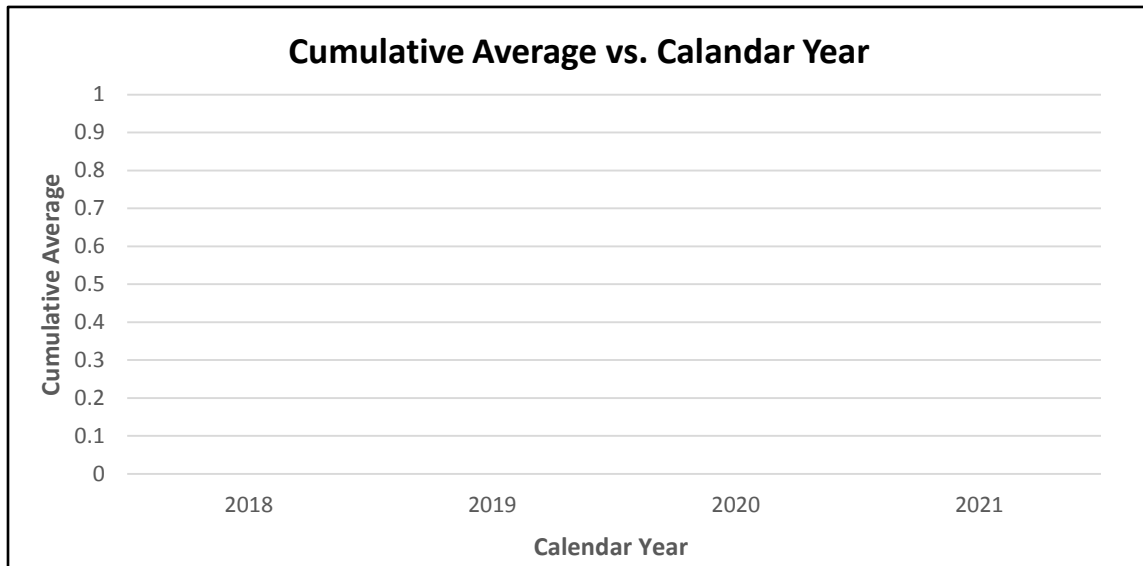
5.3 Performance

The MS4 conducts program performance evaluation through an annual broad-based condition analysis of active construction sites after spring snowmelt. The MS4 randomly selects 50 active construction sites, completes a drive-by inspection for each, and records one of the following observations:

1. Good Condition (2 points): Sites that exhibit adequate BMP implementation and are compliant with regulations
2. Moderate Condition (1 point): Sites that exhibit inadequate BMP implementation, and are slightly compliant with regulations
3. Poor Condition (0 points): Sites that exhibit no BMP implementation, and are not compliant with regulations

The MS4 compiles the collected data and updates the following:

1. 2017 Total:
 - Good Condition Sites (total sites x 2 points): n/a
 - Moderate Condition Sites (total sites x 1 point): n/a
 - Poor Condition Sites (total sites x 0 points): n/a
 - Cumulative Average (total points/total sites): n/a
 - Trend (*increasing or decreasing*): n/a



Graph 5.3.1: Construction program performance

The MS4 analyzes the data by comparing annual averages and uses the results to evaluate, communicate, and determine the need for future initiatives and stricter policy to improve construction industry compliance.

5.4 Future Initiatives

The MS4's Construction Program continues to improve, requiring the implementation of the following initiatives:

1. Inspection Percentage: The MS4 inspected 4.2% of active construction sites in 2017, 15.8% percent below its goal of 20%. Factors influencing this low rate include an extraordinary growth rate, entrenched industry, and limited staff. However, the MS4 will see a significant improvement in the percentage in 2018, primarily due to a new Stormwater Program Technician position hired late in 2017.

2. **New Single-Family Residential Permit:** Single-family construction represents the majority of projects occurring within the City. Also, homebuilders' current adherence to Bozeman Municipal Code and its contained regulations is low, resulting in hundreds of non-compliant sites annually. The MS4 will implement a new single-family residential permit in 2018 for homebuilders with the goal of further raising awareness.
3. **Occupancy and Infrastructure Refusal:** The MS4's enforcement protocol is efficient at (1) mitigating pollution coming from a non-compliant construction site, and (2) penalizing responsible parties for their lack of attention to pollution controls. However, the MS4's enforcement protocol is not valid at ensuring the responsible party pays the debts accrued by the City for these efforts.

Current Bozeman Municipal Code allows the MS4 to lien debts against property but has found that the timing of this process is challenging. To resolve, the MS4 plans to work with their attorneys to tie the occupancy process to enforcement action. The MS4 is confident that withholding occupancy will increase the construction industry's compliance with MS4 standards.

4. Explore the use of flocculants.

5.5 Documents

The MS4 utilizes the following documents *(available upon request)*:

1. **General Documents:**
 - Bozeman Municipal Code: Article 4
 - City of Bozeman Best Management Practice (BMP) Manual for Construction Sites v.6
2. **Single-Family Construction:**
 - Single-Family Residential Drainage Certification
 - Construction Stormwater Site Inspection Form: Sites Less than One (1) Acre
3. **Projects Less than One Acre:**
 - Construction Stormwater Permit: Sites Less than One (1) Acre
 - Construction Stormwater Permit Review Checklist: Sites Less than One (1) Acre
 - Construction Stormwater Site Inspection Form: Sites Less than One (1) Acre
 - Request for Final Occupancy (RFO) Form
4. **Projects Greater than One Acre:**
 - MDEQ Construction General Permit
 - MDEQ Construction General Permit Notice of Intent (NOI)
 - MDEQ Construction Stormwater Pollution Prevention Plan (SWPPP)
 - Construction Stormwater Permit Review Checklist: Sites Greater than One (1) Acre
 - Construction Stormwater Site Inspection Form: Sites Greater than One (1) Acre
 - Request for Final Occupancy (RFO) Form

6.0 Post Construction

Image 6.0.1: Overgrown stormwater basin



Image 6.0.1: Dredged stormwater basin

6.1 Ongoing Initiatives

The MS4 requires new and redevelopment projects exceeding one (1) acre to infiltrate the first ½ inch of stormwater runoff and meet the MS4's 10-year storm volume control requirement, maintaining pre-development runoff patterns and pollutant loading post project build out. Developers use an array of strategies to meet MS4 standards, including traditional and LID-based stormwater control measures, such as stormwater basins, permeable pavers, and bioretention systems.

The MS4 regulates and documents compliance with development requirements through its site plan application and review process, which the Engineering and Community Development Divisions manage. The longstanding process, professional staff responsible, and required documentation ensure developers construct projects by MS4 regulations.

1. 2017 Totals:

- Development Project Reviews: 262

Also, the MS4 educates Home Owner Associations (HOA), private property owners, and Property Management Companies, jointly known as parties, on how to complete maintenance on a reoccurring basis, including the following protocol:

1. Inventory and Condition: As of 2018, the majority of parties do not understand that they own stormwater assets, requiring annual inspection and maintenance. The MS4 works to educate parties on the inventory and condition of their systems through a variety of reports, walking tours, and presentations.
2. Plan and Funding: The MS4 recommends that parties plan and forecast workloads for a minimum of fifteen years, allowing for an adequate budget. Further, the MS4 suggests that parties develop a stable funding mechanism through either a special assessment or increase in HOA fees, allowing a stable framework to achieve set goals. In some cases, parties are not qualified to develop these plans, especially considering the complexity and cost of civil projects. In those situations, the MS4 suggests hiring a professional consultant well versed in civil and environmental design.
3. Complete Maintenance: Typically, parties utilize three primary maintenance activities, including:
 - Vegetation clearing or vacuuming (1-2 years)
 - Minor debris removal and stabilization (2-5 years)
 - Dredging and reshaping (5-10 years)

Maintenance and rehabilitation costs grow exponentially over time if not responsibly achieved. As such, the MS4 works hard to educate parties on the snowball effect that can result and the need to manage their assets proactively.

As of early 2018, the MS4 does not have an enforcement strategy developed and plans to continue an education based approach for the near future with the broad goals of determining:

1. An effective strategy and support structure, allowing HOAs and private owners to succeed in managing their assets.
2. If the MS4s has unrealistic expectations, requiring a new strategy where MS4 takes a larger role, including assuming maintenance responsibility, implementing a SID policy, or establishing an enforcement protocol.

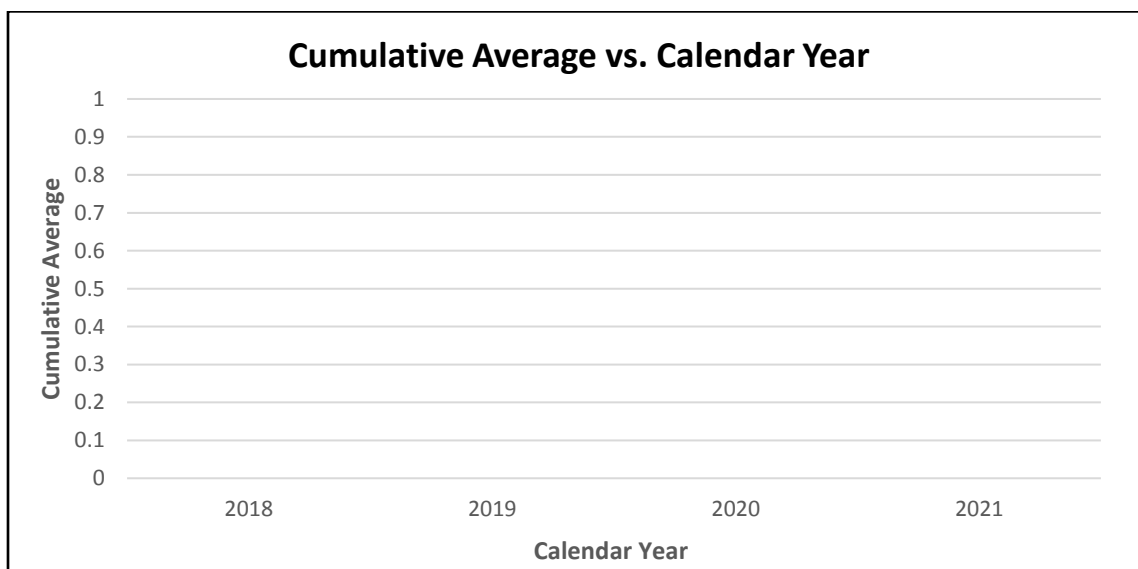
6.2 Performance

The MS4 conducts program performance evaluation through an annual broad-based condition analysis of stormwater post-construction measures features during the first week in September. The MS4 randomly selects 50 measures, completes a drive-by inspection for each, and records one of the following observations:

1. Good Condition (2 points): Sites that exhibit adequate maintenance history, and are functioning as designed
2. Moderate Condition (1 point): Sites that exhibit inadequate maintenance history, and are moderately functioning as designed
3. Poor Condition (0 points): Sites that exhibit no maintenance history, and are not functioning as designed

The MS4 compiles the collected data and updates the following:

1. 2017 Total:
 - Good Condition Sites (total sites x 2 points): n/a
 - Moderate Condition Sites (total sites x 1 point): n/a
 - Poor Condition Sites (total sites x 0 points): n/a
 - Cumulative Average (total points / total sites): n/a
 - Trend (*increasing or decreasing*): n/a



Graph 6.2.1: Post-construction program performance

The MS4 analyzes the data by comparing annual averages and uses the results to evaluate, communicate, and determine the need for future initiatives and stricter policy to improve stormwater basin condition.

6.3 Future Initiatives

The MS4's Post-Construction Program continues to improve and evolve, requiring the implementation of the following initiatives:

1. New Drainage Design Standards: The MS4 developed current standards in 2004. In 2008, the MS4 completed a Facility Plan, which evaluated requirements, identified shortfalls, and provided recommendations for improvement. The MS4 has not implemented the changes proposed in 2008 and is working to bring standards in line with the Facility Plan's recommendations, requiring significant political, internal, and external conversations. Most notable changes include:

- Increasing design storm from 10-year to 25, 50, or 100-year
- Requiring detention downtown for redevelopment projects that do not exceed one acre
- Aligning language to work jointly with the content of the Montana Post-Construction Stormwater BMP Guidance Manual
- Redeveloping rainfall curves to represent modern rainfall intensity and distribution

The MS4 plans to solicit proposals during the summer of 2018, with the goal of proposing the new standard to the City Commission and, if found agreeable, implementing late fall.

2. HOA Policy Questions: Two significant policy-level issues exist that require City Commission guidance, including:
 - Subdivisions that have defunct HOAs and thus lack the money to maintain stormwater basins. *Possible solution: The MS4 would hire and oversee maintenance of the features. Once complete, the MS4 would develop a special improvement district surrounding the contributing properties and bill the selected for the costs accrued. This approach would require a significant increase in the MS4's staffing level.*
 - HOAs that decide to not maintain their post-construction features after repeated requests by the City. *Possible solution: The MS4 would take control of all HOA-owned features and maintain as needed. The approach would require a significant increase in the MS4's utility and staffing levels.*

6.4 Documents

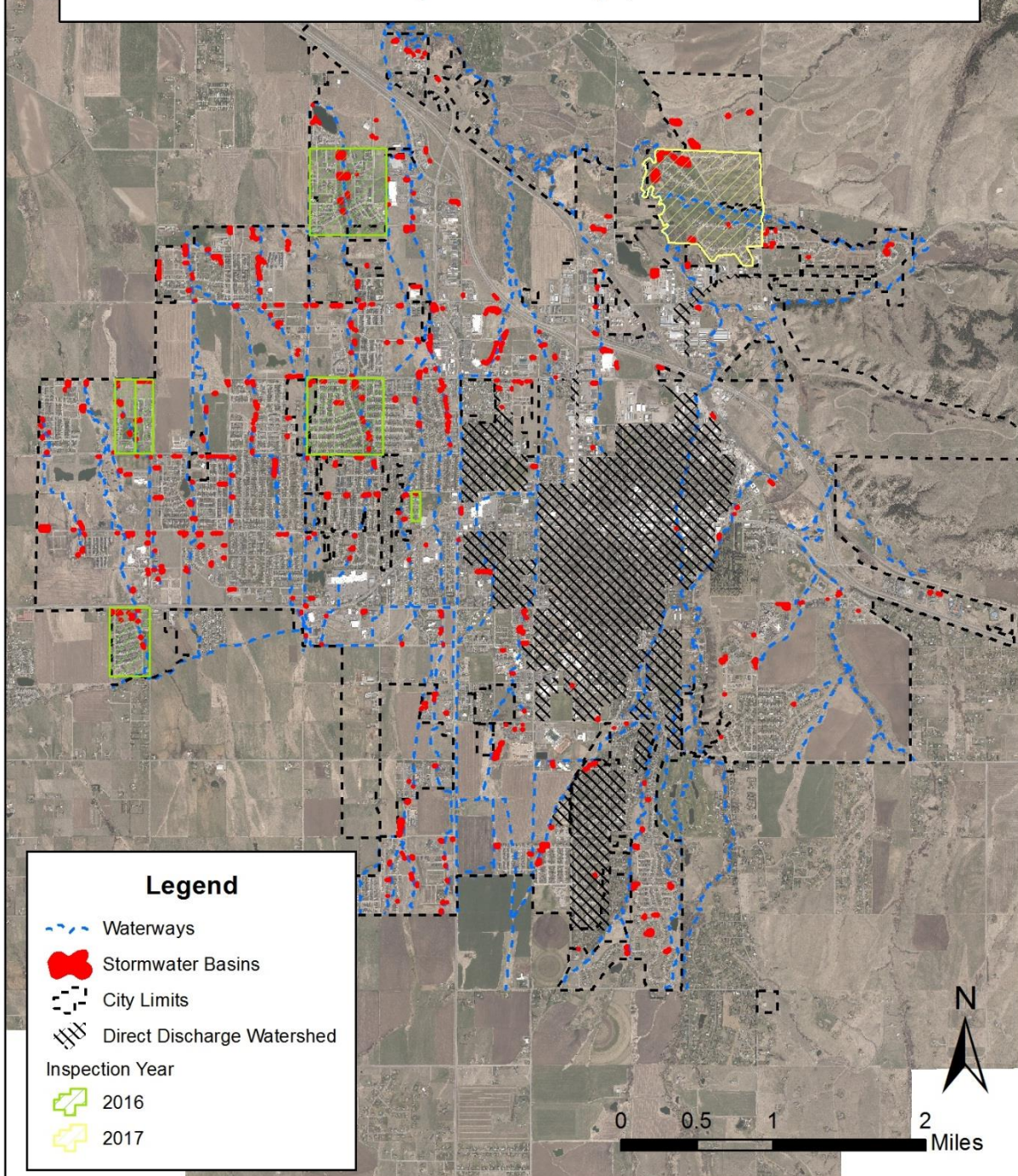
The MS4 utilizes the following documents (*available upon request*):

1. Stormwater Basin Maintenance:
 - Stormwater Basin Maintenance Guide
 - Stormwater Basin Inspection Form
2. Post-Construction Design
 - City Engineering Division Design Standards and Specifications Policy
 - Montana Post-Construction Stormwater BMP Design Guidance Manual
 - Development Review Documents (Plan Review Checklist): Planning Division Staff Report, Engineering Review Letter, and DRC Memo

Stormwater Basin Inspection Program

City of Bozeman Stormwater Division

Last Updated - February 9, 2018



Map 6.4.1: Stormwater basin inspection frequency

7.0 Good Housekeeping

Image 7.0.1: Street sweeping debris pile



Image 7.0.2: Sediment management facility



7.1 Ongoing Initiatives

The MS4 has dedicated stormwater operation and maintenance employees who complete over 6,000 hours of work annually. Further, the MS4's Streets, GIS, and Solid Waste Divisions provide resources towards work activities that have a direct benefit for water quality. Specific activities include:

1. Pipe repair, replacement, inspection, and maintenance
2. Inlet repair, replacement, inspection, and maintenance
3. Manhole repair, adjustment, inspection, and maintenance
4. Spring leaf and debris pickup
5. Fall leaf and debris pickup
6. Waterway Cleanup
7. Infrastructure mapping
8. City solid waste cleanup
9. Street sweeping

The MS4 owns various facilities, where staff works to mitigate pollutant sources, including:

1. High-Priority:

- East Gallatin Storage Area
 - Use: Storage area for sediment, millings, street sweepings, and other materials used during the daily operation of numerous MS4 divisions
 - Control Measures: None
 - Pollutants of Concern: Sediment, oils and greases, and floatables
 - Responsible Party: Public Works and Parks Directors
- University Shops Facility
 - Use: Staging, storage, and office property that supports numerous MSU divisions
 - Control Measures: None
 - Pollutants of Concern: Sediment, fuels, oils and greases, and metals
 - Responsible Party: MSU Environmental Services Manager
- City Shops Complex
 - Use: Staging, storage, and office property that supports numerous City divisions
 - Control Measures: Underground storage and mechanical separation
 - Pollutants of Concern: Sediment, fuels, oils and greases, and metals
 - Responsible Party: Public Works Director

2. Low-Priority:

- Bozeman Sediment Management Facility
 - Use: Stormwater debris collection and drying
 - Control Measures: Fully contained, no connection to state surface waters
 - Pollutants of Concern: None
 - Responsible Party: Public works Director
- Water Reclamation Facility
 - Use: Treatment plant that is regulated under the MDEQ's Stormwater Industrial Permit
 - Control Measures: Numerous stormwater basins and dry wells
 - Pollutants of Concern: Oil and grease and fuels

- Responsible Party: Public Works Director
- **Water Treatment Plant**
 - Use: Potable water treatment plant
 - Control Measures: Numerous stormwater basins
 - Pollutants of Concern: None
 - Responsible Party: Public Works Director
- **Parks**
 - Use: Numerous parks exist citywide with varying sizes and amenities
 - Control Measures: Varied
 - Pollutants of Concern: TSS, total nitrogen, phosphorous, and E.coli
 - Responsible Party: Parks Director
- **Vehicle Maintenance Facility**
 - Use: Facility that supports the storage and maintenance of equipment for all municipal operations
 - Control Measures: Stormwater basin
 - Pollutants of Concern: Sediment, oils and greases, and metals
 - Responsible Party: Public Works Director
- **Closed Landfill**
 - Use: Facility that is no longer supporting the disposal of solid waste, but does house the Solid Waste Division and is permitted under the MDEQ's Stormwater Industrial Permit
 - Control Measures: Numerous stormwater basins, swales, and berms
 - Pollutants of Concern: Sediment, oils and greases, and metals
 - Responsible Party: Public Works Director
- **Snow Storage Area**
 - Use: Location that houses snow throughout winter
 - Control Measures: Vegetated buffer and grading
 - Pollutants of Concern: Sediment, oils and greases, floatables, and metals
 - Responsible Party: Public Works Director

The MS4 completes an array of maintenance and operation activities annually to facilitate community health and safety. The MS4 identifies and develops solutions for the following activities:

1. **High-Priority:**
 - **Sanitary sewer breaks and overflows**
 - Contaminant: Pathogens and floatables
 - Responsible Party: Public Works Director
2. **Low-Priority:**
 - **Diesel wash-down of asphalt paving equipment**
 - Contaminant: Fuels
 - Responsible Party: Public Works Director
 - **Water main breaks**

- Contaminant: TSS
 - Responsible Party: Public Works Director
- Concrete Washout
 - Contaminant: pH
 - Responsible Party: Public Works Director
- Curb-cut slurry capture, collection, and disposal
 - Contaminant: pH
 - Responsible Party: Public Works Director
- Roadway traction sand, salt, and chemical application rates and techniques
 - Contaminant: pH and TSS,
 - Responsible Party: Public Works Director
- Facility and vehicle chemical transport, storage, and transfer
 - Contaminant: Varied
 - Responsible Party: Public Works Director
- Solid waste collection and disposal
 - Contaminant: Floatables and oils and greases
 - Responsible Party: Public Works Director
- Fueling and preventative maintenance of vehicles
 - Contaminant: Oils and greases and fuels
 - Responsible Party: Public Works Director
- Equipment and vehicle washing
 - Contaminant: Oils and greases, fuels, TSS, and metals
 - Responsible Party: Public Works and Parks Directors
- Trenching and excavation
 - Contaminant: TSS
 - Responsible Party: Public Works Director
- Fertilizer application rates and locations
 - Contaminant: Total nitrogen and phosphorous
 - Responsible Party: Parks Director

7.2 Training

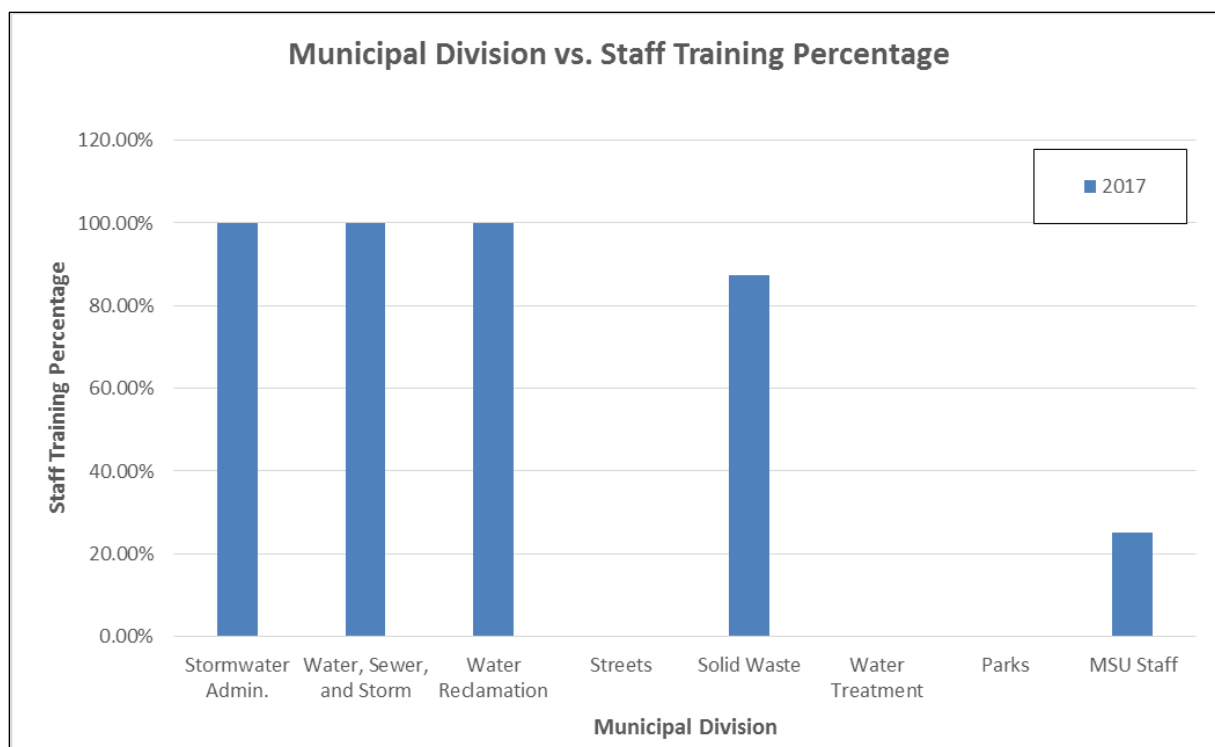
Professional Staff: The MS4 trains its professional Staff tasked with implementing portions of the Stormwater Management Plan.

1. Construction Site and Post Construction Feature Compliance Inspection Staff: The MS4 receives external training when available, and all team members hold responsibility in not only knowing how to implement procedures but also how to identify issues and improve workflows.

- 2017: Frank Greenhill and EJ Hook, 301 Compliance Evaluation Inspections Training held by Altitude Training Associates and sponsored by the MDEQ and City of Bozeman on October 17 and 18.
2. Post-Construction Feature Design Review Staff: The City's Engineering Division is responsible for the review and approval of site plans to ensure projects align with approved standards. Shawn Kohtz P.E., and Griffin Nielsen E.I., are the primary reviewers and individually receive 40-hours or more of Civil Engineering training every two years to maintain their Montana licenses, of which a portion is specific to stormwater. The primary SWMP coordinator communicates and works with the engineers on a daily basis to ensure proper function of the MS4.
 3. Stormwater Management Team (listed in SWMP Sec. 1.5): Stormwater Staff lead monthly meetings for the Stormwater Team, which include permit requirement discussions, Streets Division updates, Storm/Water/Sewer updates, capital project updates, responsibilities, MSU updates, budget updates, identified issues, solutions, and general discussion regarding the operation of the MS4.
 - 2017: 8 meetings

Internal Operations: The MS4 trains employees with the goal of increasing awareness and reducing stormwater pollutants generated from internal operations. The MS4 utilizes an online-based application (Proprofs) to hold interactive training for field supervisors and employees that includes the following content:

1. Stormwater Division Overview Video (7 minutes) - "Stormwater in Bozeman: The Big Picture"
 - Broad view of Bozeman's stormwater system
 - Information about the importance of mitigating stormwater pollution
 - Team member introduction
2. Facility Operations Training Videos: "Rain Check"
 - Notes and FYIs
 - Quiz questions
 - Detailed Best Management Practices related to the following activities:
 - Good Housekeeping and Spill Prevention
 - Spill Control and Response
 - Vehicle Fueling
 - Vehicle and Equipment Maintenance
 - Vehicle and Equipment Washing
 - Materials Management
 - Waste Management
 - Landscaping



Graph 7.2.1: Staff training totals

7.3 Future Initiatives

The MS4's Good Housekeeping Program continues to improve and evolve, requiring the implementation of the following initiatives:

1. **Operation and Maintenance Plan:** The MS4 works to collect and utilize data whenever possible to inform programmatic decision. The development of a Plan will further assist MS4 staff in conducting annual operations of its infrastructure, increasing effectiveness, reducing liability, and ensuring performance measures maintain accuracy. Numerous area require consideration, including:
 - High-Priority Areas
 - Individual vs. Actual Maintenance Frequency
 - Geographic Distribution of System
 - Asset Classifications
 - Public vs. Private Ownership
 - Inaccessible Assets

8.0 Sampling and Evaluation

Image 8.0.1: In-stream sampling equipment



Image 8.0.2: Stormwater runoff nutrient analysis



8.1 Introduction

The MS4 conducts sampling, collects data, and evaluates program performance to:

1. Monitor stormwater and surface water quality over time
2. Evaluate effectiveness of infrastructure and administrative investments
3. Generate data that advises policy, capital, and operational decisions
4. Provide a data-driven performance metric easily communicated to the public

The MS4 implements four protocols annually, including:

1. Urban Runoff Monitoring
2. In-Stream Wet Weather Monitoring
3. Sediment Reduction Monitoring
4. Long-Term Monitoring

Area

The MS4 is located in Gallatin County, Montana, and has a population of 61,953 as of 2016 (*City population 45,250, MSU population, 16,703*). The MS4's primary land-use type is residential and commercial, with isolated industrial areas. Other notable geographical details include:

1. Elevation: 4820 ft.
2. Climate: Cold continental, with warm and dry summers, cold and dry winters
3. Average Temperature: 44.6°F
4. Average Precipitation: 18.4 inches (*MSU rain gauge*)

Numerous waterways originate within or pass through the MS4, with a northerly flow direction. Peak flows occur in May and June, coinciding with the months of highest precipitation and snowmelt.

Bozeman Creek, a.k.a. Sourdough Creek, originates in the Gallatin Mountains south of the MS4. Flowing north, Bozeman Creek enters the MS4 at E. Kagy Boulevard and continues until its confluence with the E. Gallatin River at E. Griffin Dr. The Montana DEQ determined that Bozeman Creek contained various impairments from natural and anthropogenic sources when preparing the 2013 Lower Gallatin Planning Area TMDL.

Bozeman Creek Impairment Information			
Probable Cause	Probable Sources	Associated Uses	TMDL
Alteration in stream-side or littoral vegetative cover	Agricultural grazing, crop production	Aquatic Life	No
Chlorophyll-a	Agricultural grazing and crop production, residential districts, municipal area	Primary Contact and Recreation	No
E.coli	Septic tanks, urban runoff, storm sewers, pet waste, livestock	Primary Contact and Recreation	Yes
Nitrogen (Total)	Agricultural grazing and crop production, residential districts, municipal area	Aquatic Life, Primary Contact, and Recreation	Yes
Sediment	Natural sources, unpaved roads/trails, urban runoff, storm sewers, municipal area	Aquatic Life	Yes

Chart 8.1.1: Bozeman Creek Impairment Information

Mandeville Creek, a small spring feed watercourse, originates south of Bozeman. Flowing north, Mandeville Creek enters the MS4 at Alder Creek Dr. and continues until its confluence with the E. Gallatin River. The Montana DEQ determined that Mandeville Creek contained various impairments from anthropogenic sources when preparing the 2013 Lower Gallatin Planning Area TMDL.

Mandeville Creek Impairment Information			
Probable Cause	Probable Sources	Associated Uses	TMDL
Nitrogen (Total)	Municipal point source discharges, residential districts, municipal area	Aquatic Life, Primary Contact, and Recreation	Yes
Phosphorous (Total)	Municipal point source discharges, residential districts, municipal area	Aquatic Life, Primary Contact, and Recreation	Yes

Chart 8.1.2: Mandeville Creek Impairment Information

Regulatory Requirements

The MS4 General Permit requires that the MS4 perform sampling, testing, and reporting of stormwater discharges annually, including:

1. Monitor stormwater discharges based on residential and industrial land-use types
 - See SWMP Sec. 8.2 Urban Runoff Monitoring
2. Assess in-stream water quality impacts of stormwater discharges to Bozeman and Mandeville Creeks (Option 2)
 - See SWMP Sec. 8.3 In-Stream Wet-Weather Monitoring and SWMP Sec. 8.5 Long-Term Trend Monitoring.
3. Conduct TMDL-related monitoring to evaluate the effectiveness of best management practices (BMPs) implemented to reduce pollutant loading from the MS4 to impaired waters (Option 2)
 - See SWMP Sec. 8.4 Sediment Reduction Monitoring
4. Self-evaluate results relative to long-term medians
 - See SWMP Sec. 8.6 Evaluation

8.2 Urban Runoff Monitoring

The MS4 collects urban runoff samples from representative watersheds to characterize pollutant loading occurring from various land-use types before system treatment, such as stormwater basins, sumps, infiltration galleries, and mechanical separation. In general, urban runoff pollutant concentrations are variable and dependent on numerous environmental conditions, such as precipitation cycles, wind, tree cover, and human activities.

Methods and Sites

The MS4 has a network of four monitoring locations: two within residential drainage basins and two within commercial/industrial drainage basins, including:

1. Site: RES_01
 - Location: Near the intersection of S. Bozeman Ave. and E. Garfield St.
 - Land-use: Residential
 - Drainage Basin: Seven acres
 - Inlet ID: I.F06.00082
 - Latitude: 45.667143
 - Longitude: -111.034474
 - Inlet ID: I.F06.00083
 - Latitude: 45.667143
 - Longitude: -111.034724
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two samples per year
2. Site: IND_01
 - Location: Near Commercial Dr. cul-de-sac (west)
 - Land-use: Commercial and Industrial
 - Drainage Basin: 10 acres
 - Inlet ID: I.E01.00184
 - Latitude: 45.703061
 - Longitude: -111.030112
 - Inlet ID: I.E01.00185
 - Latitude: 45.703164
 - Longitude: -111.030428
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two samples per year
3. Site: RES_02
 - Location: MSU Campus near the intersection of S. 12th Ave. and W. Garfield St.
 - Land-use: Residential
 - Drainage Basin: Four acres
 - Inlet ID: I.H06.00329
 - Latitude: 45.666911
 - Longitude: -111.054301
 - Inlet ID: I.H06.00259
 - Latitude: 45.666970
 - Longitude: -111.054226

- Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
- Frequency: Two samples per year

4. Site: IND_02

- Location: MSU Campus near the intersection of S. 6th Ave. and W Garfield St.
- Land-use: Industrial
- Drainage Basin: Two acres
- Inlet ID: I.G06.00603
 - Latitude: 45.664409
 - Longitude: -111.044957
- Inlet ID: I.G06.00630
 - Latitude: 45.664409
 - Longitude: -111.044942
- Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
- Frequency: Two samples per year

The MS4 collects urban runoff samples from storm sewer inlets at each site using Thermo-Scientific Nalgene Samplers (Samplers). Before runoff events, Staff installs each Sampler at the selected inlet grate and positions it to collect the first flush of urban runoff. Once full, the Sampler closes itself prohibiting additional collection or dilution of the original sample.

Analysis

The MS4 collects, transfers, packages, and ships samples to a certified laboratory, which analyzes the following parameters:

- Total Suspended Solids (TSS), mg/L
- Chemical Oxygen Demand (COD), mg/L
- Total Phosphorus, mg/L
- Total Nitrogen, mg/L
- pH, standard units
- Copper, mg/L
- Lead, mg/L
- Zinc, mg/L
- Oils and Greases, mg/L

The MS4 estimates flow, in gallons per minute (gpm), using the Rational Formula where:

$$Q = CiA \quad \text{Equation 1}$$

- Q is peak runoff rate (*cfs converted to gpm*)
- C is the runoff coefficient (*C-Factor, Bozeman Engineering Standards*)
- i is rainfall intensity (*in./hr., MSU Rain Gage*)
- A is the drainage area (*acres*)

Sampling Location Runoff Coefficients (C-Factors)		
Location Name	Primary Land Use	Runoff Coefficient (C-Factor)
RES_01	Low to Medium Density Residential	0.35
RES_02	Dense Residential	0.50
IND_01	Industrial	0.80
IND_01	Industrial	0.80

Chart 8.2.1: Sampling location runoff coefficients C-factors

	TSS (mg/L)	Oil and Grease (mg/L)	Total Nitro. (mg/L)	Phosp. (mg/L)	Zinc (mg/L)	Lead (mg/L)	Copper (mg/L)	COD	PH
RES_01: 2017 (1)	203	2	6.2	0.908	0.116	0.0052	0.022	251	6.7
RES_01: 2017 (2)	368	0	12	1.23	0.179	0.0073	0.03	175	6.97
RES_01: 2018 (1)									
RES_01: 2018 (2)									
RES_01: 2019 (1)									
RES_01: 2019 (2)									
RES_01: 2020 (1)									
RES_01: 2020 (2)									
RES_01: 2021 (1)									
RES_01: 2021 (2)									
RES_01 Median	285.5	1	9.1	1.07	0.15	0.01	0.03	213.00	6.84
RES_02: 2017 (1)	-	-	-	-	-	-	-	-	-
RES_02: 2017 (2)	-	-	-	-	-	-	-	-	-
RES_02: 2018 (1)									
RES_02: 2018 (2)									
RES_02: 2019 (1)									
RES_02: 2019 (2)									
RES_02: 2020 (1)									
RES_02: 2020 (2)									
RES_02: 2021 (1)									
RES_02: 2021 (2)									
RES_02 Median	-	-	-	-	-	-	-	-	-
IND_01: 2017 (1)	149	4	17.3	1.38	0.578	0.016	0.044	292	7
IND_01: 2017 (2)	1820	0	11.68	1.32	0	3.35 !	0.0867	151	6.92
IND_01: 2018 (1)									
IND_01: 2018 (2)									
IND_01: 2019 (1)									
IND_01: 2019 (2)									
IND_01: 2020 (1)									
IND_01: 2020 (2)									
IND_01: 2021 (1)									
IND_01: 2021 (2)									
IND_01 Median	984.5	2	14.49	1.35	.289	0.016	0.0654	221.5	6.96
IND_02: 2017 (1)	-	-	-	-	-	-	-	-	-
IND_02: 2017 (2)	-	-	-	-	-	-	-	-	-
IND_02: 2018 (1)									
IND_02: 2018 (2)									
IND_02: 2019 (1)									
IND_02: 2019 (2)									
IND_02: 2020 (1)									
IND_02: 2020 (2)									
IND_02: 2021 (1)									
IND_02: 2021 (2)									
IND_02 Median	-	-	-	-	-	-	-	-	-

Chart 8.2.2: Monitoring Results

! = Indicates suspected analysis error. Not included in median calculations

Evaluation

The MS4 enters monitoring results into a local spreadsheet and stores analysis reports for safe record upon receipt. Further, the MS4 analyzes the data using the following Scoring Matrix (Matrix) and protocol to interpret, evaluate, and communicate the results. The Matrix includes scores ranging from 0 to 4-points, representing a set increase from EPA benchmarks provided in previous MS4 General Permits.

For example, the TSS Benchmark is 125 mg/L. As such, the 3-Point range is two times that amount (250), the 2-Point range is three times that amount (375), etc.

Urban Runoff Monitoring: Scoring Matrix					
	4-Points	3-Points	2-Points	1-Point	0-Points
TSS (mg/L)	0 – 125	126 - 250	251 - 375	376 - 500	> 500
Oil and Grease (mg/L)	0 - 10	11 - 20	21 - 30	31 - 40	> 41
Total Nitrogen (mg/L)	0 - 2.0	2.1 - 4.0	4.1 - 6.0	6.1 - 8.0	> 8.0
Phosphorus (mg/L)	0 - .41	.42 - .82	.83 - 1.23	1.24 - 1.65	> 1.65
Zinc (mg/L)	0 - .20	.21 - .40	.41 - .60	.61 - .80	> .80
Lead (mg/L)	0 - .10	.11 - .20	.21-.30	.31 - .40	> 40
Copper(mg/L)	0 - .04	.041 - .08	.081 - .12	.121 - .160	> .160
COD	0 - 80	81 - 160	161 - 240	241 – 320	> 320
PH (High End)	7.6 - 9.0	9.1 - 10.0	10.1 - 11.0	11.1 -12.0	12.1 - 14.0
PH (Low End)	6.0 - 7.5	5.0 - 5.9	4.0 - 4.9	3.0 - 3.9	1.0 - 3.0

Chart 8.2.3: Urban Runoff Monitoring: Scoring Matrix

The MS4 relates results to the Matrix and then populate the appropriate Urban Runoff Monitoring charts with the corresponding point totals.

For example, a 2018 RES_01 sample contained 135 mg/L of TSS. The MS4 assigns and populates the Urban Runoff Monitoring: RES_01 chart TSS box with 3-points. The same approach applies to all sites and parameters.

Urban Runoff Monitoring: RES_01								
	2018		2019		2020		2021	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.2.4: Urban Runoff Monitoring: RES_01

Urban Runoff Monitoring: IND_01								
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.2.5: Urban Runoff Monitoring: IND_01

Urban Runoff Monitoring: RES_02								
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.2.6: Urban Runoff Monitoring: RES_02

Urban Runoff Monitoring: IND_02								
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.2.7: Urban Runoff Monitoring: IND_02

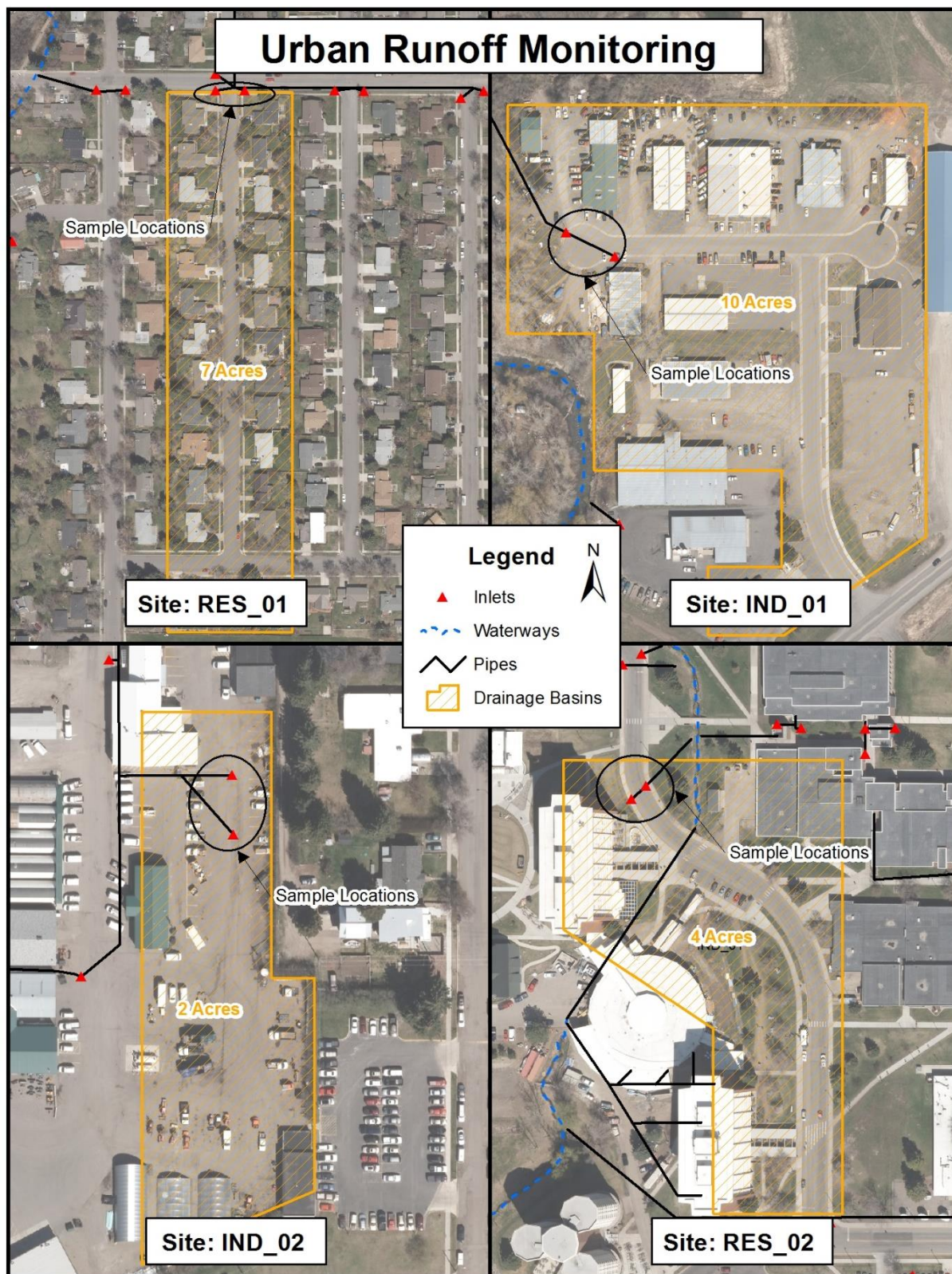
The MS4 sums the individual scores to obtain an Event Point Total.

The MS4 sums both Event Scores to obtain an Annual Point Total.

The MS4 calculates a Final Score by transferring and summing the Annual Points in the Urban Runoff Monitoring: Results chart. The MS4 divides the Total Points by the Possible Points to calculate the Final Score. The MS4 transfers the Final Score to SWMP Sec. 8.6.

Urban Runoff Monitoring: Results				
	2018	2019	2021	2022
RES_01 Annual Points				
IND_01 Annual Points				
RES_02 Annual Points				
IND_02 Annual Points				
Total Points:				
Possible Points:	288	288	288	288
Final Score (decimal):				

Chart 8.2.8: Urban Runoff Monitoring: Results



Map 8.2.9: Urban Runoff Monitoring

8.3 In-Stream Wet-Weather Monitoring

The MS4 conducts In-Stream Wet-Weather Monitoring to analyze impacts of urban runoff to Bozeman and Mandeville Creeks during wet weather. Combined, the Creeks receive urban runoff from over 1,700 acres of dense development at over 100 individual discharge points or outfalls. Non-point source pollution sources exist upstream of the MS4 as identified in the Lower Gallatin Planning Area TMDL. This approach allows the MS4 to take sole responsibility for and mitigate the impacts stemming from urban runoff.

Methods and Sites

The MS4 monitors two (2) locations on Bozeman Creek and two (2) locations on Mandeville Creek. Each Creek has one (1) station upstream and one (1) downstream of the MS4 boundary. Sample sites include:

1. Site: UPS_01
 - Location: Bozeman Creek upstream of MS4, near Kagy Blvd.
 - Latitude: 45.657248
 - Longitude: -111.028584
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two (2) samples per year
2. Site: DWS_01
 - Location: Bozeman Creek downstream of MS4, near Gold Ave.
 - Latitude: 45.699668
 - Longitude: -111.027347
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two (2) samples per year
3. Site: UPS_02
 - Location: Mandeville Creek upstream of MS4, near Campus Blvd.
 - Latitude: 45.656506
 - Longitude: -111.05803
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two (2) samples per year
4. Site: DWS_02
 - Location: Mandeville Creek downstream of MS4, near E. Baxter Ln.
 - Latitude: 45.697742
 - Longitude: -111.051959
 - Parameters: TSS, COD, TP, TN, pH, Copper, Lead, Zinc, Oils and Greases, and Flow
 - Frequency: Two (2) samples per year

The MS4 collects in-stream samples using Thermo-Scientific Nalgene Samplers (Sampler). Before rain events, Staff mounts each Sampler to a metal post driven into the creek bed and positions it to collect a sample as soon as the water levels rise one-half to three-quarters of an inch. The Sampler closes itself and does not allow additional collection or dilution of the original sample once full.

Analysis

The MS4 collects, transfers, packages, and ships samples to a certified laboratory, which analyzes the following parameters:

1. Total Suspended Solids (TSS), mg/L

2. Chemical Oxygen Demand (COD), mg/L
3. Total Phosphorus, mg/L
4. Total Nitrogen, mg/L
5. pH, standard units
6. Copper, mg/L
7. Lead, mg/L
8. Zinc, mg/L
9. Oils and Greases, mg/L

The MS4 determines Bozeman Creek's stream-flow using real-time data collected from the Bozeman Creek gaging station. The MS4 estimates flow for Mandeville Creek using historical data collected by Gallatin Local Water Quality District since no permanent gauging station exists.

	Monitoring Results								
	TSS (mg/L)	Oil and Grease (mg/L)	Total Nitro. (mg/L)	Phosp. (mg/L)	Zinc (mg/L)	Lead (mg/L)	Copper (mg/L)	COD	PH
UPS_01: 2017 (1)	7	0	0.406	0.0847	0.0054	0.0005	0.0036	11.6	8.18
UPS_01: 2017 (2)	14	0	0	0.022	0	0	0	15	8.1
UPS_01: 2018 (1)									
UPS_01: 2018 (2)									
UPS_01: 2019 (1)									
UPS_01: 2019 (2)									
UPS_01: 2020 (1)									
UPS_01: 2020 (2)									
UPS_01: 2021 (1)									
UPS_01: 2021 (2)									
UPS_01 Median	10.5	0	0.203	0.0534	0.0027	0.0002	0.0018	13.3	8.14
UPS_02: 2017 (1)	-	-	-	-	-	-	-	-	-
UPS_02: 2017 (2)	-	-	-	-	-	-	-	-	-
UPS_02: 2018 (1)									
UPS_02: 2018 (2)									
UPS_02: 2019 (1)									
UPS_02: 2019 (2)									
UPS_02: 2020 (1)									
UPS_02: 2020 (2)									
UPS_02: 2021 (1)									
UPS_02: 2021 (2)									
UPS_02: Median	-	-	-	-	-	-	-	-	-
DWS_01: 2017 (1)	10	0	0.547	0.0879	0.007	0.0006	0.0036	15.3	8.2
DWS_01: 2017 (2)	134	0	1.8	0.264	0.03	0.006	0.006	42	8.1
DWS_01: 2018 (1)									
DWS_01: 2018 (2)									
DWS_01: 2019 (1)									
DWS_01: 2019 (2)									
DWS_01: 2020 (1)									
DWS_01: 2020 (2)									
DWS_01: 2021 (1)									
DWS_01: 2021 (2)									

DWS_01: Median	72	0	1.1735	0.1760	0.0185	0.0033	0.0048	28.65	8.15
DWS_02: 2017 (1)	-	-	-	-	-	-	-	-	-
DWS_02: 2017 (2)	-	-	-	-	-	-	-	-	-
DWS_02: 2018 (1)									
DWS_02: 2018 (2)									
DWS_02: 2019 (1)									
DWS_02: 2019 (2)									
DWS_02: 2020 (1)									
DWS_02: 2020 (2)									
DWS_02: 2021 (1)									
DWS_02: 2021 (2)									
DWS_02 Median	-	-	-	-	-	-	-	-	-

Chart 8.3.1: Monitoring Results

Evaluation

The MS4 enters data into a local spreadsheet and stores analysis reports for safe record upon receipt. Further, the MS4 analyzes the data using the following Scoring Matrix (Matrix) and protocol to interpret, evaluate, and communicate the results. The Matrix includes points ranging from 0 to 4-points, which relate to percent change of pollutants between the upstream and downstream sites.

For example, a percent change of 0-20% equals 4-points, 21-40% equals 3-points, 41-60% equals 2-points, 61-80% equals 1-point, and 81- >100% equals 0-points.

Percent change is determined using the following formula:

$$\% \Delta = ((Y_2 - Y_1) / Y_1) * 100 \quad \text{Equation 2}$$

For example, TSS: $((200-150)/150) \times 100 = 33.3\%$, resulting in a score of 3-points.

In-Stream Wet-Weather Monitoring: Scoring Matrix					
	4-Points	3-Points	2-Points	1-Point	0-Points
TSS (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Oil/Grease (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Total Nitrogen (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Phosphorus (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Zinc (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Lead (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
Copper (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
COD (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)
PH (% Δ)	(<0) – (20)	(21) – (40)	(41) – (60)	(61) – (80)	(81) – (>100)

Chart 8.3.1: In-Stream Wet-Weather Monitoring Scoring Matrix

The MS4 relates results to the Matrix and then populates the appropriate Urban Runoff Monitoring charts with the corresponding scores.

For example, a 2018 Bozeman Creek UPS_01 and DWS_01 TSS percent change equaled 35%. The MS4 assigns and populates the In-Stream Wet-Weather Monitoring: Bozeman Creek UPS_01 and DWS_01 chart TSS box with 3-points. The same approach applies to all sites and parameters.

In-Stream Wet-Weather Monitoring: Bozeman Creek UPS_01 and DWS_01								
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.3.2: In-Stream Wet-Weather Monitoring: Bozeman Creek UPS_01 and DWS_01.

In-Stream Wet-Weather Monitoring: Mandeville Creek UPS_02 and DWS_02								
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TSS								
Oil and Grease								
Total Nitrogen								
Phosphorus								
Zinc								
Lead								
Copper								
COD								
PH								
Event Points:								
Annual Points:								

Chart 8.3.3: In-Stream Wet-Weather Monitoring: Mandeville Creek UPS_02 and DWS_02.

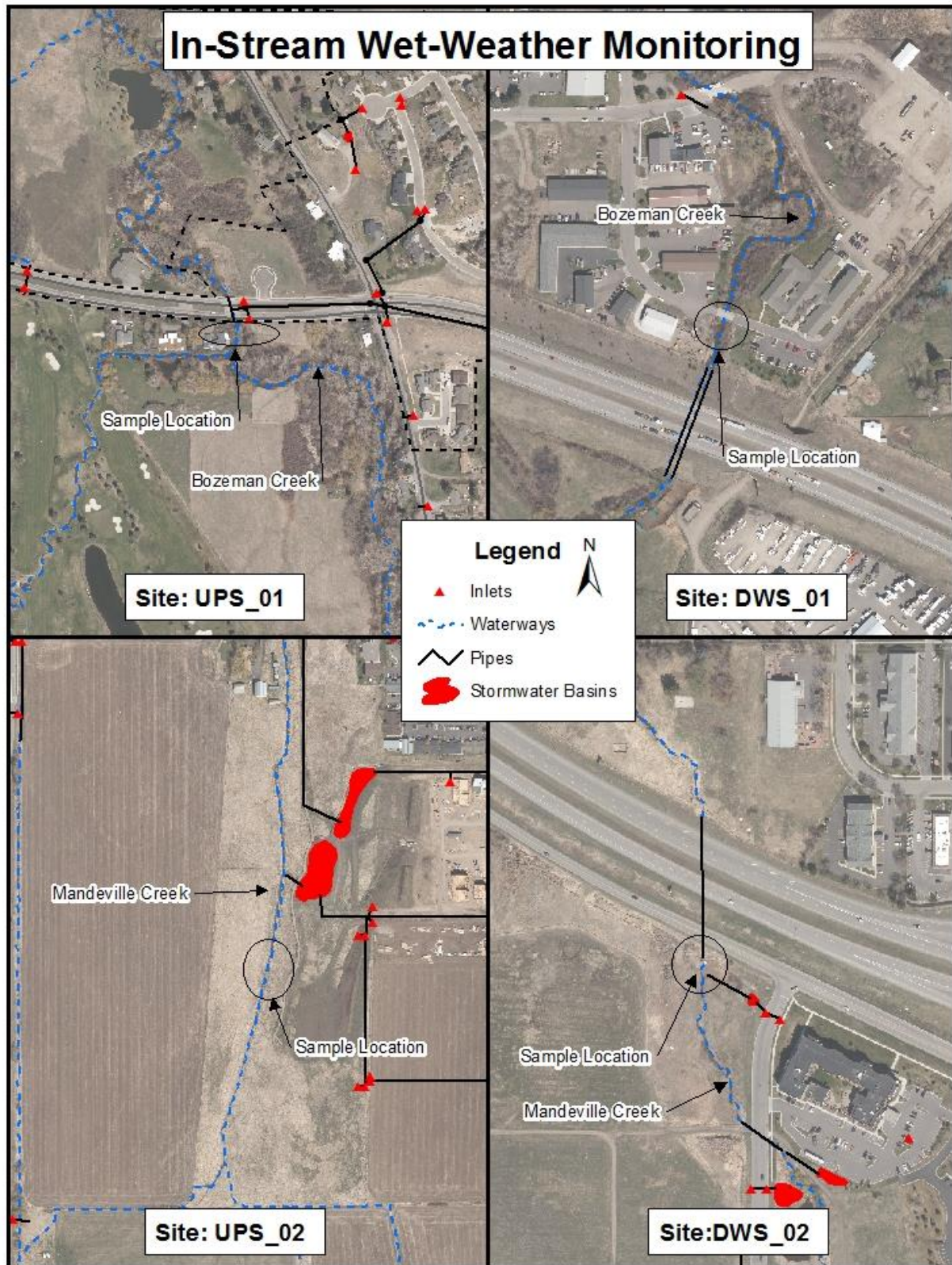
The MS4 sums the individual scores to obtain an Event Point Total.

The MS4 sums both Event Scores to obtain an Annual Point Total.

The MS4 calculates a Final Score by transferring and summing the Annual Points in the In-Stream Wet-Weather Monitoring: Results chart. The MS4 divides the Total Points by the Possible Points. The MS4 transfers the Final Score to SWMP Sec. 8.6.

In-Stream Wet-Weather Monitoring: Results				
	2018	2019	2021	2022
Bozeman Creek Annual Points				
Mandeville Creek Annual Points				
Total Points:				
Possible Points:	144	144	144	144
Final Score (decimal):				

Chart 8.3.4: In-Stream Wet-Weather Monitoring: Results



Map 8.3.4: In-Stream Wet-Weather Monitoring

8.4 Sediment Reduction Monitoring

The MS4 conducts Sediment Reduction Monitoring to comply with the Montana DEQ's sediment load reduction requirements detailed in the 2013 Lower Gallatin Planning Area TMDL. The MS4 tracks tons captured in BMPs detailed in SWMP Sec. 2.3 TMDL Action Plan.

Bozeman Creek Sediment Waste Load Reduction				
Sediment Source	Estimated Load	Waste Load Allocation	Required Load Reduction	Required Load Reduction
Municipal Storm Sewer	218 tons/year	137 tons/year	37%	81 tons/year **DEQ Imposed**

Chart 8.4.1: 2013 Lower Gallatin Planning Area TMDL - Bozeman Creek Sediment Waste Load Reduction

Mandeville Creek Sediment Waste Load Reduction				
Sediment Source	Estimated Load	Waste Load Allocation	Required Load Reduction	Load Reduction Goal
Municipal Storm Sewer	None	None	None	10 tons/year **Self Imposed**

Chart 8.4.2: 2013 Lower Gallatin Planning Area TMDL Mandeville Creek Sediment Waste Load Reduction

Methods and Sites

The MS4 calculates sediment capture twice per year from its BMPs described in SWMP Sec. 2.3 Pollutant Reduction Totals.

Analysis

The MS4 analyzes the following parameter:

1. Total Sediment Captured (tons)

Evaluation

The MS4 enters data into a local spreadsheet for safe record upon receipt. Further, the MS4 incorporates the data into the following Scoring Matrix (Matrix) to interpret, evaluate, and communicate the results. The Matrix includes scores ranging from 0 to 4-points, which relate to total annual sediment capture.

For example, a load reduction for Bozeman Creek of ≥ 81 tons equals 4-points, 60 – 80 tons equals 3-points, 40 – 59 tons equals 2-points, 20 – 39 tons equals 1-point, and 0 – 19 equals 0-points.

Sediment Reduction Monitoring: Scoring Matrix (Bozeman Creek)					
	4-Points	3-Points	2-Points	1-Point	0-Points
Sediment Captured (tons)	≥ 81	60 – 80	40 – 59	20 – 39	0 – 19

Chart 8.4.3: Sediment Reduction Monitoring: Scoring Matrix (Bozeman Creek)

Sediment Reduction Monitoring: Scoring Matrix (Mandeville Creek)					
	4-Points	3-Points	2-Points	1-Point	0-Points
Sediment Captured (tons)	≥ 10	7.5 – 9.9	5.0 – 7.4	2.5 – 4.9	0 – 2.4

Chart 8.4.4: Sediment Reduction Monitoring: Scoring Matrix (Mandeville Creek)

The MS4 relates results to the Matrix and then populate the Sediment Reduction Monitoring: Results chart with the corresponding scores. The MS4 weighs Bozeman Creek more heavily than Mandeville Creek because of DEQ's imposed reduction requirements.

For example, the MS4 captured 40 tons of sediment within the Bozeman Creek watershed in 2018. The MS4 assigns and populates the Sediment Reduction Monitoring: Results chart Bozeman Creek Annual Points box with 2-points.

The MS4 calculates a Final Score by summing the weighted Annual Points in the Sediment Reduction Monitoring: Results chart and dividing by the Possible Points to calculate the Final Score. The MS4 transfers the Final Score to SWMP Sec. 8.6.

Sediment Reduction Monitoring: Results				
	2018	2019	2021	2022
Bozeman Creek Annual Points	x 1.5			
Mandeville Creek Annual Points	x .5			
Total Points:				
Possible Points:	8	8	8	8
Final Score (decimal):				

Chart 8.4.5: Sediment Reduction Monitoring: Results.

8.5 Long-Term Trend Monitoring

Macroinvertebrate community assemblages are predictable, shifting from expected taxa to an increase in sediment-tolerant taxa because of sedimentation. The MS4 conducts a macroinvertebrate biological index sampling effort using the Observed/Expected Model (O/E) to assess macroinvertebrate community structure.

Methods and Sites:

The MS4 monitors benthic macroinvertebrates on Bozeman and Mandeville Creeks at the In-Stream Wet-Weather Monitoring Sites (SWMP Sec. 8.3). The MS4 derives macroinvertebrate biological index monitoring protocols from MDEQ Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrate Communities Standard Operating Procedures (*two samples taken per location per year*).

Analysis

The MS4 collects and preserves macroinvertebrate samples and then delivers to an accredited lab, which completes the analysis of the following parameters:

1. Taxonomic Sorting and Identification
2. Species Abundance
3. Species Diversity

The MS4 enters data into the Utah State University's Western Center for Monitoring and Assessment of Freshwater Ecosystems O/E model to calculate O/E ratios.

	Monitoring Results		
	Observed	Expected	O/E Ratio
UPS_01: 2017 (1)	-	-	-
UPS_01: 2017 (2)	-	-	-
UPS_01: 2018 (1)			
UPS_01: 2018 (2)			
UPS_01: 2019 (1)			
UPS_01: 2019 (2)			
UPS_01: 2020 (1)			
UPS_01: 2020 (2)			
UPS_01: 2021 (1)			
UPS_01: 2021 (2)			
UPS_01 Median			
UPS_02: 2017 (1)	-	-	-
UPS_02: 2017 (2)	-	-	-
UPS_02: 2018 (1)			
UPS_02: 2018 (2)			
UPS_02: 2019 (1)			
UPS_02: 2019 (2)			
UPS_02: 2020 (1)			
UPS_02: 2020 (2)			
UPS_02: 2021 (1)			
UPS_02: 2021 (2)			
UPS_02: Median			
DWS_01: 2017 (1)	-	-	-

DWS_01: 2017 (2)	-	-	-
DWS_01: 2018 (1)			
DWS_01: 2018 (2)			
DWS_01: 2019 (1)			
DWS_01: 2019 (2)			
DWS_01: 2020 (1)			
DWS_01: 2020 (2)			
DWS_01: 2021 (1)			
DWS_01: 2021 (2)			
DWS_01: Median			
DWS_02: 2017 (1)	-	-	-
DWS_02: 2017 (2)	-	-	-
DWS_02: 2018 (1)			
DWS_02: 2018 (2)			
DWS_02: 2019 (1)			
DWS_02: 2019 (2)			
DWS_02: 2020 (1)			
DWS_02: 2020 (2)			
DWS_02: 2021 (1)			
DWS_02: 2021 (2)			
DWS_02 Median			

Chart 8.5.1: Monitoring Results

Evaluation

The MS4 enters data into a local spreadsheet and stores analysis reports for safe record upon receipt. Further, the MS4 analyzes the data using the following Scoring Matrix and protocol to interpret, evaluate, and communicate the results. The Scoring Matrix includes scores ranging from 0 to 4-points, which relate to percent change in O/E ratios between the upstream and downstream sites for each creek.

For example, an O/E ratio percent change of 0-(-20%) equals 4-points, -21-(-40%) equals 3-points, -41-(-60%) equals 2-points, -61-(-80%) equals 1-point, and >-80% equals 0-points.

Percent change is determined using Equation 2 found in SWMP Sec. 8.3.

For example, an upstream Bozeman Creek sample has an O/E ratio of 1.1, and the downstream sample has an O/E ratio of 0.8. The MS4 finds the difference and divides by the original to arrive at a percentage $((0.8 - 1.1)/1.1) \times 100 = -30\%$, resulting in a score of 3-points.

Long-Term Trend Monitoring: Scoring Matrix					
	4-Points	3-Points	2-Points	1-Point	0-Points
O/E Ratio (% Δ)	>0 – (-20)	-21 – (-40)	-41 – (-60)	-61 – (-80)	-81 – (-100)

Chart 8.5.2: Long-Term Trend Monitoring: Scoring Matrix

The MS4 relates results to the Matrix and then populates the Long-Term Trend Monitoring: Results chart with the corresponding scores.

The MS4 calculates a Final Score by summing the Event Points in the Long-Term Trend Monitoring: Results chart and dividing by the Possible Points. The MS4 transfers the Final Score to SWMP Sec. 8.6.

	Long-Term Trend Monitoring: Results							
	2018		2019		2021		2022	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Bozeman Creek Event Points								
Mand. Creek Event Points								
Total Points:								
Possible Points:	16		16		16		16	
Final Score (decimal):								

Chart 8.5.3: Long-Term Trend Monitoring: Results

8.6 Evaluation

The MS4 calculates a Final Grade to determine the overall effectiveness of its programs and initiatives detailed in SWMP Sec. 1.0 to 7.0.

The MS4 transfers scores from each protocol (8.2 to 8.5) to the Programmatic Evaluation: Final Points chart. The MS4 utilizes a weighted sum calculation to make the four scores comparable to each other.

Programmatic Evaluation: Final Points (2018)				
	Final Scores	Weight	Weighted Total	Weighted Total (%)
Urban Runoff Monitoring		.25		
In-Stream Wet-Weather Monitoring		.25		
Sediment Reduction Monitoring		.25		
Stream Health Monitoring		.25		
Final Weighted Total (%):				

8.6.1: Programmatic Evaluation: Final Points (2018)

Programmatic Evaluation: Final Points (2019)				
	Final Scores	Weight	Weighted Total	Weighted Total (%)
Urban Runoff Monitoring		.25		
In-Stream Wet-Weather Monitoring		.25		
Sediment Reduction Monitoring		.25		
Stream Health Monitoring		.25		
Final Weighted Total (%):				

8.6.2: Programmatic Evaluation: Final Points (2019)

Programmatic Evaluation: Final Points (2020)				
	Final Scores	Weight	Weighted Total	Weighted Total (%)
Urban Runoff Monitoring		.25		
In-Stream Wet-Weather Monitoring		.25		
Sediment Reduction Monitoring		.25		
Stream Health Monitoring		.25		
Final Weighted Total (%):				

8.6.3: Programmatic Evaluation: Final Points (2020)

Programmatic Evaluation: Final Points (2021)				
	Final Scores	Weight	Weighted Total	Weighted Total (%)
Urban Runoff Monitoring		.25		
In-Stream Wet-Weather Monitoring		.25		
Sediment Reduction Monitoring		.25		
Stream Health Monitoring		.25		
Final Weighted Total (%):				

8.6.4: Programmatic Evaluation: Final Points (2021)

The MS4 relates the Final Weighted Total (%) to the following equally distributed ranges (100-percent scale) and their associated Final Grades:

1. Final Grade A: 80% - 100%
2. Final Grade B: 60% - 79%
3. Final Grade C: 40% - 59%
4. Final Grade D: 20% - 39%
5. Final Grade F: 0% - 19%

The MS4 populates the Stormwater Division Report Card with a Final Grade for the corresponding year.

Stormwater Division Report Card			
2018 Final Grade	2019 Final Grade	2020 Final Grade	2021 Final Grade
X	X	X	X

8.6.5: Stormwater Division Report Card

Discussion

The MS4 utilizes its empirical knowledge, performance measures, and monitoring data to continually evaluate and optimize its programmatic workloads detailed in this SWMP. Also, the MS4 compares its Final Grades to the criteria below and, as necessary, works to implement the following improvement strategies:

1. Grade = A: No stormwater impact to receiving waters. Maintain administrative programs, level of service goals, development policies, and capital strategies detailed in SWMP Sec. 2.3. Reduce system treatment budget levels.
2. Grade = B: Low stormwater impact to receiving waters. Maintain administrative programs, level of service goals, development policies, system enhancement funding, and capital strategies detailed in Section SWMP Sec. 2.3.
3. Grade = C: Moderate stormwater impact to receiving waters. Maintain operation service goals, system enhancement funding, and capital strategies detailed in Section SWMP Sec. 2.3. Increase administrative programs and development policies.
4. Grade = D: Significant stormwater impact to receiving waters. Increase administrative programs, level of service goals, development policies, system enhancement funding, and capital strategies detailed in Section SWMP Sec. 2.3.
5. Grade = F: Major stormwater impact to receiving waters. Increase administrative programs, level of service goals, development policies, system enhancement funding, and capital strategies detailed in Section SWMP Sec. 2.3.

2017 Result: The MS4 did not document sampling efforts using the scoring matrices described above because Staff had not developed the evaluation. Implementation begins with the first sampling event of 2018.

Preliminary analysis of available 2017 data indicates that the developed evaluation methodology is effective at tracking program performance. The MS4 expects a positive trend over the Permit Term as Staff implements the content of this SWMP.

City of Bozeman Small MS4 Outfalls (Last Updated on 12/21/2017)

Outfall ID	Facility ID	Latitude	Longitude	Receiving Waterway	Drainage Pattern
<i>Notes - Latitude and Longitude values are in Decimal Degrees. Indirect Discharge refers to Outfalls with retention or detention ponds upstream. Direct Discharge refers to Outfalls with no retention or detention ponds upstream. Bold outfalls discharge to impaired waterbodies. See SWMP Section 8.0 for listed impairments.</i>					
1	OF.F10.00475	45.6383769585	-111.0392414550	Tributary - SWWW_00030	Indirect Discharge
2	OF.F10.00476	45.6389300284	-111.0393867130	Tributary - SWWW_00030	Indirect Discharge
3	OF.F10.00044	45.63870449760	-111.0336303610	Nash Spring Creek	Indirect Discharge
4	OF.F10.00639	45.64192646170	-111.0371276000	Middle Creek Ditch	Indirect Discharge
5	OF.F10.00640	45.64198542750	-111.0360113880	Middle Creek Ditch	Indirect Discharge
6	OF.G10.00452	45.63695180090	-111.0442887310	Middle Creek Ditch	Indirect Discharge
7	OF.F09.00479	45.6449057100	-111.0337144060	Flat Creek	Indirect Discharge
8	OF.F09.00481	45.6449059913	-111.0336853340	Flat Creek	Indirect Discharge
9	OF.F09.00062	45.6485698672	-111.0387064790	Mathew Bird Creek	Indirect Discharge
10	OF.F09.00633	45.64497851540	-111.0382183280	Mathew Bird Creek	Indirect Discharge
11	OF.F09.00065	45.64650325590	-111.0395412210	Mathew Bird Creek	Indirect Discharge
12	OF.F09.00060	45.6436941871	-111.0394094260	Mathew Bird Creek	Direct Discharge
13	OF.F09.00061	45.6443822863	-111.0392719880	Mathew Bird Creek	Direct Discharge
14	OF.F09.00064	45.6474842077	-111.0392303390	Mathew Bird Creek	Direct Discharge
15	OF.G09.00029	45.6473346886	-111.0515194680	Figgins Creek	Indirect Discharge
16	OF.G09.00030	45.6480578224	-111.0511359350	Figgins Creek	Indirect Discharge
17	OF.G09.00031	45.6481346986	-111.0510402780	Figgins Creek	Indirect Discharge
18	OF.G09.00032	45.6485687635	-111.0507493160	Figgins Creek	Indirect Discharge
19	OF.G09.00033	45.6486969317	-111.0507536790	Figgins Creek	Indirect Discharge
20	OF.H09.00459	45.6477323673	-111.0523002270	Middle Creek Ditch	Indirect Discharge
21	OF.E08.00402	45.6505008476	-111.0255749300	Bozeman Creek	Direct Discharge
22	OF.E08.00405	45.65502199470	-111.0257237890	Bozeman Creek	Direct Discharge
23	OF.E08.00404	45.65397809430	-111.0256094650	Bozeman Creek	Direct Discharge
24	OF.E08.00406	45.65594065900	-111.0259535360	Bozeman Creek	Direct Discharge
25	OF.E08.00403	45.6512062011	-111.0261825420	Bozeman Creek	Direct Discharge
26	OF.F08.00063	45.6501546628	-111.0375384410	Mathew Bird Creek	Indirect Discharge
27	OF.F08.00069	45.6529819484	-111.0374621470	Mathew Bird Creek	Direct Discharge
28	OF.F08.00067	45.65242989510	-111.0379981630	Mathew Bird Creek	Direct Discharge
29	OF.F08.00068	45.6551143519	-111.0372960060	Mathew Bird Creek	Direct Discharge
30	OF.F08.00070	45.6545748170	-111.0371937020	Mathew Bird Creek	Direct Discharge
31	OF.F08.00072	45.6557252277	-111.0369476740	Mathew Bird Creek	Direct Discharge
32	OF.F08.00071	45.6557421551	-111.0368181630	Mathew Bird Creek	Direct Discharge
33	OF.F08.00073	45.6565840924	-111.0364830430	Mathew Bird Creek	Direct Discharge
34	OF.G08.00037	45.6564320267	-111.0440012050	Figgins Creek	Indirect Discharge
35	OF.G08.00451	45.6565645172	-111.0494415450	Middle Creek Ditch	Indirect Discharge
36	OF.G08.00684	45.6557339603	-111.0451607840	Figgins Creek	Indirect Discharge
37	OF.G08.00036	45.6562162000	-111.0440544840	Figgins Creek	Indirect Discharge
38	OF.G08.00040	45.6562692808	-111.0440384680	Figgins Creek	Indirect Discharge
39	OF.G08.00035	45.6567849089	-111.0435367800	Middle Creek Ditch	Direct Discharge
39	OF.G08.00035	45.6567849089	-111.0435367800	Figgins Creek	Direct Discharge
40	OF.G08.00034	45.6559691774	-111.0448765520	Figgins Creek	Indirect Discharge
41	OF.G08.00039	45.6564631431	-111.0437284530	Figgins Creek	Indirect Discharge

42	OF.G08.00038	45.6561926945	-111.0444047030	Figgins Creek	Indirect Discharge
43	OF.I08.00182	45.6509952132	-111.0697076340	Middle Creek Ditch	Indirect Discharge
44	OF.I08.00181	45.6528854982	-111.0690230930	Middle Creek Ditch	Indirect Discharge
45	OF.I08.00180	45.6542144272	-111.0684330710	Middle Creek Ditch	Indirect Discharge
46	OF.I08.00179	45.6546653404	-111.0685592150	Middle Creek Ditch	Indirect Discharge
47	OF.I08.00178	45.6562632786	-111.0652573570	East Fork Catron Creek	Indirect Discharge
48	OF.D07.00322	45.6620657273	-111.0168967960	Tributary - SWWW_00039	Indirect Discharge
49	OF.D07.00324	45.6623771338	-111.0166733890	Tributary - SWWW_00039	Direct Discharge
50	OF.D07.00325	45.6624558584	-111.0165546480	Tributary - SWWW_00039	Direct Discharge
51	OF.D07.00323	45.66193392170	-111.0173788830	Tributary - SWWW_00039	Direct Discharge
52	OF.D07.00320	45.66148883370	-111.0128869860	Tributary - SWWW_00037	Direct Discharge
53	OF.D07.00321	45.66327489890	-111.0129015960	Tributary - SWWW_00039	Direct Discharge
54	OF.D06.00493	45.6676923999	-111.0199507730	Tributary - SWWW_00040	Direct Discharge
55	OF.D06.00492	45.6681763224	-111.0185806740	Tributary - SWWW_00040	Direct Discharge
56	OF.D06.00491	45.6695143448	-111.0170868320	Tributary - SWWW_00040	Direct Discharge
57	OF.E06.00495	45.6662566883	-111.0215020650	Tributary - SWWW_00040	Direct Discharge
58	OF.E06.00621	45.66662708710	-111.0262627500	Bozeman Creek	Indirect Discharge
59	OF.E06.00630	45.66641545310	-111.0267211850	Bozeman Creek	Indirect Discharge
60	OF.E06.00496	45.66558077720	-111.0215140670	Tributary - SWWW_00040	Direct Discharge
61	OF.E06.00494	45.66693146420	-111.0212261550	Tributary - SWWW_00040	Direct Discharge
62	OF.E06.00411	45.6710554620	-111.0304518720	Bozeman Creek	Direct Discharge
63	OF.E06.00410	45.6710523487	-111.0304345300	Bozeman Creek	Direct Discharge
64	OF.E06.00409	45.6710483897	-111.0303855530	Bozeman Creek	Direct Discharge
65	OF.H06.00189	45.6651027798	-111.0552678520	Mandeville Creek	Direct Discharge
66	OF.H06.00015	45.6655722039	-111.0546698210	Mandeville Creek	Direct Discharge
67	OF.H06.00016	45.6656051508	-111.0546752610	Mandeville Creek	Direct Discharge
68	OF.H06.00018	45.6671494683	-111.0539788730	Mandeville Creek	Direct Discharge
69	OF.H06.00019	45.6671632267	-111.0539223220	Mandeville Creek	Direct Discharge
70	OF.H06.00020	45.6674387472	-111.0540683880	Mandeville Creek	Direct Discharge
71	OF.H06.00021	45.6679591502	-111.0541279870	Mandeville Creek	Direct Discharge
72	OF.H06.00022	45.6686606655	-111.0541126320	Mandeville Creek	Direct Discharge
73	OF.H06.00023	45.6690538092	-111.0537613640	Mandeville Creek	Indirect Discharge
74	OF.H06.00024	45.6700866078	-111.0534940700	Mandeville Creek	Indirect Discharge
75	OF.H06.00025	45.6701507332	-111.0535064930	Mandeville Creek	Indirect Discharge
76	OF.H06.00026	45.6702890908	-111.0534451700	Mandeville Creek	Indirect Discharge
77	OF.H06.00027	45.6704595459	-111.0534135860	Mandeville Creek	Indirect Discharge
78	OF.H06.00028	45.6709043556	-111.0531407180	Mandeville Creek	Indirect Discharge
79	OF.I06.00200	45.66789727680	-111.0700236060	West Fork Catron Creek	Indirect Discharge
80	OF.I06.00199	45.6677314989	-111.0645236210	East Fork Catron Creek	Indirect Discharge
81	OF.I06.00160	45.6687217029	-111.0646154690	East Fork Catron Creek	Indirect Discharge
82	OF.I06.00163	45.6712588469	-111.0647070640	Farmers Canal	Direct Discharge
83	OF.I06.00164	45.6712567412	-111.0638984530	Farmers Canal	Direct Discharge
84	OF.I06.00698	45.6691625686	-111.0645445470	East Fork Catron Creek	Indirect Discharge
85	OF.I06.00162	45.6707878033	-111.0645963480	East Fork Catron Creek	Direct Discharge
86	OF.I06.00161	45.6691131694	-111.0645551790	East Fork Catron Creek	Indirect Discharge
87	OF.J06.00201	45.6678388781	-111.0809504470	Cattail Creek	Indirect Discharge
88	OF.J06.00203	45.6703991492	-111.0802510150	Cattail Creek	Indirect Discharge
89	OF.J06.00204	45.6704905356	-111.0802578400	Cattail Creek	Indirect Discharge
90	OF.J06.00205	45.6706586973	-111.0797444600	Cattail Creek	Indirect Discharge

91	OF.K06.00202	45.6686140934	-111.0831152020	West Gallatin Canal	Indirect Discharge
92	OF.K06.00243	45.6708461126	-111.0837751790	West Gallatin Canal	Indirect Discharge
93	OF.K06.00242	45.6708212756	-111.0837936720	West Gallatin Canal	Indirect Discharge
94	OF.M06.00013	45.6685316943	-111.1054009680	Baxter Creek	Indirect Discharge
95	OF.M06.00014	45.6677027069	-111.1050698320	Baxter Creek	Indirect Discharge
96	OF.M06.00009	45.6709242304	-111.1061551810	Baxter Creek	Indirect Discharge
97	OF.M06.00011	45.6703807593	-111.1061150680	Baxter Creek	Indirect Discharge
98	OF.M06.00012	45.6703896969	-111.1061454600	Baxter Creek	Indirect Discharge
99	OF.B05.00477	45.67270032870	-110.9972931210	Rocky Creek	Indirect Discharge
100	OF.B05.00478	45.67262403750	-110.9969071330	Rocky Creek	Indirect Discharge
101	OF.C05.00329	45.67219656840	-111.0108988660	Tributary - SWWW_00065	Direct Discharge
102	OF.C05.00334	45.67306091690	-111.0104048890	Tributary - SWWW_00065	Direct Discharge
103	OF.C05.00332	45.67191758430	-111.0104035020	Tributary - SWWW_00065	Indirect Discharge
104	OF.C05.00330	45.67248696370	-111.0107899760	Tributary - SWWW_00065	Indirect Discharge
105	OF.C05.00694	45.67264447500	-111.0094293500	Tributary - SWWW_00065	Indirect Discharge
106	OF.C05.00333	45.6726021702	-111.0106174190	Tributary - SWWW_00065	Indirect Discharge
107	OF.C05.00331	45.6725199015	-111.0107801770	Tributary - SWWW_00065	Indirect Discharge
108	OF.E05.00101	45.6781742650	-111.0268179210	Story Ditch	Indirect Discharge
109	OF.F05.00416	45.6773127483	-111.0319353550	Bozeman Creek	Direct Discharge
110	OF.F05.00417	45.6773181581	-111.0320148400	Bozeman Creek	Direct Discharge
111	OF.F05.00419	45.6773658172	-111.0320292580	Bozeman Creek	Direct Discharge
112	OF.F05.00418	45.6772748487	-111.0320017370	Bozeman Creek	Direct Discharge
113	OF.F05.00424	45.6783026272	-111.0326830240	Bozeman Creek	Direct Discharge
114	OF.F05.00421	45.6783491608	-111.0327301770	Bozeman Creek	Direct Discharge
115	OF.F05.00412	45.6739517454	-111.0320919630	Bozeman Creek	Direct Discharge
116	OF.F05.00095	45.6726075747	-111.0322551740	Bozeman Creek	Direct Discharge
117	OF.F05.00413	45.6741398452	-111.0321470890	Bozeman Creek	Direct Discharge
118	OF.F05.00414	45.6746525848	-111.0321110680	Bozeman Creek	Direct Discharge
119	OF.F05.00415	45.6755764260	-111.0319626300	Bozeman Creek	Direct Discharge
120	OF.F05.00110	45.6764560201	-111.0319472160	Bozeman Creek	Direct Discharge
121	OF.F05.00422	45.6783239135	-111.0327045910	Bozeman Creek	Direct Discharge
122	OF.F05.00420	45.6782846109	-111.0326647700	Bozeman Creek	Direct Discharge
123	OF.F05.00423	45.6782686904	-111.0326486350	Bozeman Creek	Direct Discharge
124	OF.H05.00370	45.6718694561	-111.0520143050	Mandeville Creek	Direct Discharge
125	OF.H05.00371	45.6723741663	-111.0520057050	Mandeville Creek	Direct Discharge
126	OF.H05.00378	45.6733081619	-111.0519632420	Mandeville Creek	Direct Discharge
127	OF.H05.00381	45.6742950238	-111.0519248630	Mandeville Creek	Direct Discharge
128	OF.H05.00384	45.6752818436	-111.0518878070	Mandeville Creek	Direct Discharge
129	OF.H05.00386	45.6762667567	-111.0518527470	Mandeville Creek	Direct Discharge
130	OF.H05.00387	45.6764032867	-111.0518814590	Mandeville Creek	Direct Discharge
131	OF.H05.00388	45.6771875147	-111.0518801790	Mandeville Creek	Direct Discharge
132	OF.H05.00390	45.6783381682	-111.0518356610	Mandeville Creek	Direct Discharge
133	OF.H05.00391	45.6783381682	-111.0518356610	Mandeville Creek	Direct Discharge
134	OF.H05.00377	45.6733081619	-111.0519632420	Mandeville Creek	Direct Discharge
135	OF.K05.00246	45.6781443387	-111.0861790700	West Gallatin Canal	Indirect Discharge
136	OF.K05.00245	45.6780993747	-111.0858709910	West Gallatin Canal	Indirect Discharge
137	OF.K05.00244	45.6720464192	-111.0851631670	West Gallatin Canal	Indirect Discharge
138	OF.K05.00482	45.6717275269	-111.0832431900	Irrigation Ditch	Indirect Discharge
139	OF.K05.00655	45.6783253011	-111.0861799860	West Gallatin Canal	Indirect Discharge

140	OF.K05.00656	45.6784421358	-111.0862109300	West Gallatin Canal	Indirect Discharge
141	OF.L05.00489	45.6750450872	-111.0989337720	Maynard Border Ditch	Indirect Discharge
142	OF.L05.00488	45.6738915513	-111.1030525600	Tributary - SWWW_00006	Indirect Discharge
143	OF.L05.00487	45.6780334544	-111.1038367750	Tributary - SWWW_00006	Indirect Discharge
144	OF.L05.00622	45.67728088880	-111.0938587290	Tributary - SWWW_00007	Indirect Discharge
145	OF.L05.00485	45.67478514510	-111.1035114200	Tributary - SWWW_00006	Indirect Discharge
146	OF.M05.00614	45.67704671110	-111.1136048070	Tributary - SWWW_00054	Indirect Discharge
147	OF.M05.00617	45.67478543320	-111.1054892770	Baxter Creek	Indirect Discharge
148	OF.M05.00289	45.67831902390	-111.1044260220	Tributary - SWWW_00006	Indirect Discharge
149	OF.M05.00004	45.67828150010	-111.1079092320	Baxter Creek	Indirect Discharge
150	OF.M05.00005	45.67827498380	-111.1081259290	Baxter Creek	Indirect Discharge
151	OF.M05.00006	45.67508606120	-111.1077068540	Baxter Creek	Indirect Discharge
152	OF.M05.00008	45.6728528092	-111.1068342950	Baxter Creek	Indirect Discharge
153	OF.M05.00474	45.6782085285	-111.1135716090	Tributary - SWWW_00054	Indirect Discharge
154	OF.G04.00045	45.6846820699	-111.0516085370	Mandeville Creek	Direct Discharge
155	OF.G04.00398	45.6830902204	-111.0482359930	Tributary - SWWW_00053	Direct Discharge
156	OF.H04.00058	45.6815646295	-111.0516863850	Mandeville Creek	Direct Discharge
157	OF.H04.00454	45.6820298660	-111.0516890090	Mandeville Creek	Direct Discharge
158	OF.H04.00059	45.6806301473	-111.0517434350	Mandeville Creek	Direct Discharge
159	OF.H04.00455	45.6795390487	-111.0518051850	Mandeville Creek	Direct Discharge
160	OF.H04.00696	45.6814730712	-111.0516681700	Mandeville Creek	Direct Discharge
161	OF.H04.00057	45.6827097945	-111.0516710970	Mandeville Creek	Direct Discharge
162	OF.I04.00661	45.6822796555	-111.0647431520	East Fork Catron Creek	Direct Discharge
163	OF.I04.00169	45.6791023745	-111.0657657050	East Fork Catron Creek	Direct Discharge
164	OF.I04.00473	45.6820426918	-111.0697190310	West Fork Catron Creek	Indirect Discharge
165	OF.I04.00686	45.6806302707	-111.0701451140	West Fork Catron Creek	Direct Discharge
166	OF.I04.00690	45.6790884067	-111.0624737310	Farmers Canal	Direct Discharge
167	OF.I04.00115	45.6799125644	-111.0700573570	West Fork Catron Creek	Direct Discharge
168	OF.I04.00688	45.6802381515	-111.0702928880	West Fork Catron Creek	Direct Discharge
169	OF.I04.00117	45.6822862762	-111.0693049990	West Fork Catron Creek	Indirect Discharge
170	OF.I04.00701	45.6812981939	-111.0622328030	Farmers Canal	Direct Discharge
171	OF.J04.00214	45.6851991695	-111.0739185930	Cattail Creek	Indirect Discharge
172	OF.K04.00457	45.6794210247	-111.0934060110	Tributary - SWWW_00007	Indirect Discharge
173	OF.K04.00272	45.6817472371	-111.0933318080	Tributary - SWWW_00007	Indirect Discharge
174	OF.K04.00274	45.6838064067	-111.0932998290	Tributary - SWWW_00007	Indirect Discharge
175	OF.K04.00275	45.6854708262	-111.0932804150	Tributary - SWWW_00007	Indirect Discharge
176	OF.K04.00397	45.6839956349	-111.0877133620	West Gallatin Canal	Indirect Discharge
177	OF.K04.00271	45.6786596538	-111.0934439960	Tributary - SWWW_00007	Indirect Discharge
178	OF.K04.00396	45.6830050276	-111.0832421430	Tributary - SWWW_00050	Indirect Discharge
179	OF.K04.00248	45.6856359977	-111.0876986560	West Gallatin Canal	Direct Discharge
180	OF.K04.00649	45.6856369895	-111.0883274030	West Gallatin Canal	Direct Discharge
181	OF.K04.00650	45.6856369895	-111.0883274030	West Gallatin Canal	Direct Discharge
182	OF.K04.00651	45.6856413329	-111.0894029410	West Gallatin Canal	Direct Discharge
183	OF.K04.00652	45.6856413329	-111.0894029410	West Gallatin Canal	Direct Discharge
184	OF.K04.00653	45.6856362883	-111.0903988060	West Gallatin Canal	Direct Discharge
185	OF.K04.00654	45.6856362883	-111.0903988060	West Gallatin Canal	Direct Discharge
186	OF.K04.00273	45.6837478485	-111.0933037820	Tributary - SWWW_00007	Indirect Discharge
187	OF.L04.00460	45.6797706260	-111.0981481610	Maynard Border Ditch	Indirect Discharge
188	OF.L04.00461	45.6797293986	-111.0984974040	Maynard Border Ditch	Indirect Discharge

189	OF.L04.00003	45.6812049166	-111.0983797890	Maynard Border Ditch	Indirect Discharge
190	OF.L04.00469	45.6832211221	-111.0987508340	Maynard Border Ditch	Indirect Discharge
191	OF.L04.00277	45.6854549387	-111.0948471690	Tributary - SWWW_00007	Indirect Discharge
192	OF.L04.00278	45.6855116303	-111.0959522500	Tributary - SWWW_00007	Indirect Discharge
193	OF.L04.00276	45.6853893402	-111.0937834850	Tributary - SWWW_00007	Indirect Discharge
194	OF.L04.00279	45.6855678853	-111.0963130290	Tributary - SWWW_00007	Indirect Discharge
195	OF.L04.00283	45.6838545909	-111.1041869350	Tributary - SWWW_00006	Indirect Discharge
196	OF.M04.00285	45.68429199540	-111.1085183060	Tributary - SWWW_00005	Indirect Discharge
197	OF.M04.00284	45.68381965600	-111.1080342280	Tributary - SWWW_00005	Indirect Discharge
198	OF.M04.00467	45.6845418277	-111.1042107630	Tributary - SWWW_00006	Indirect Discharge
199	OF.M04.00287	45.6786505717	-111.1043457140	Tributary - SWWW_00006	Indirect Discharge
200	OF.M04.00290	45.6792339570	-111.1140991940	Tributary - SWWW_00054	Indirect Discharge
201	OF.M04.00468	45.6816825955	-111.1043063980	Tributary - SWWW_00006	Indirect Discharge
202	OF.M04.00286	45.6813971977	-111.1042874460	Tributary - SWWW_00006	Indirect Discharge
203	OF.E03.00447	45.6866493571	-111.0306714020	Bozeman Creek	Direct Discharge
204	OF.E03.00450	45.6886404438	-111.0298616780	Bozeman Creek	Direct Discharge
205	OF.E03.00453	45.6915632547	-111.0300317710	Bozeman Creek	Direct Discharge
206	OF.E03.00448	45.6866803997	-111.0307299600	Bozeman Creek	Direct Discharge
207	OF.F03.00446	45.6857498520	-111.0311696050	Bozeman Creek	Direct Discharge
208	OF.F03.00445	45.6856828289	-111.0311169850	Bozeman Creek	Direct Discharge
209	OF.F03.00444	45.6856087927	-111.0311591600	Bozeman Creek	Direct Discharge
210	OF.F03.00443	45.6856064121	-111.0312245490	Bozeman Creek	Direct Discharge
211	OF.G03.00399	45.6860442959	-111.0428519780	Tributary - SWWW_00034	Direct Discharge
212	OF.G03.00308	45.6928301267	-111.0431395530	Tributary - SWWW_00034	Direct Discharge
213	OF.G03.00306	45.6905108823	-111.0431442970	Tributary - SWWW_00034	Direct Discharge
214	OF.G03.00303	45.6905176057	-111.0437976670	Tributary - SWWW_00034	Direct Discharge
215	OF.G03.00400	45.6885877925	-111.0437900650	Tributary - SWWW_00034	Direct Discharge
216	OF.G03.00401	45.6885619450	-111.0437895720	Tributary - SWWW_00034	Direct Discharge
217	OF.G03.00677	45.6855228934	-111.0482860520	Tributary - SWWW_00053	Direct Discharge
218	OF.G03.00676	45.6856231040	-111.0483462720	Tributary - SWWW_00053	Direct Discharge
219	OF.G03.00046	45.6857142308	-111.0512465000	Mandeville Creek	Direct Discharge
220	OF.G03.00687	45.69243223410	-111.0493339090	Mandeville Creek	Direct Discharge
221	OF.G03.00307	45.69165680000	-111.0431608710	Tributary - SWWW_00034	Direct Discharge
222	OF.H03.00643	45.69207583060	-111.0574237810	Farmers Canal	Direct Discharge
223	OF.K03.00256	45.6904465220	-111.0897660030	West Gallatin Canal	Indirect Discharge
224	OF.K03.00250	45.6876827523	-111.0904061880	West Gallatin Canal	Indirect Discharge
225	OF.K03.00249	45.6861527483	-111.0904309070	West Gallatin Canal	Indirect Discharge
226	OF.K03.00251	45.6883881651	-111.0902866750	West Gallatin Canal	Indirect Discharge
227	OF.K03.00252	45.6887021360	-111.0902284290	West Gallatin Canal	Indirect Discharge
228	OF.K03.00253	45.6891051110	-111.0901321990	West Gallatin Canal	Indirect Discharge
229	OF.K03.00254	45.6894310762	-111.0900318500	West Gallatin Canal	Indirect Discharge
230	OF.K03.00255	45.6898104273	-111.0899254500	West Gallatin Canal	Indirect Discharge
231	OF.K03.00258	45.6908261464	-111.0898898760	West Gallatin Canal	Indirect Discharge
232	OF.K03.00259	45.6927044898	-111.0908127470	West Gallatin Canal	Indirect Discharge
233	OF.K03.00260	45.6926406908	-111.0909848860	West Gallatin Canal	Indirect Discharge
234	OF.K03.00616	45.68929703230	-111.0852370470	Tributary - SWWW_00011	Indirect Discharge
235	OF.K03.00257	45.69044949260	-111.0898022740	West Gallatin Canal	Indirect Discharge
236	OF.K03.00699	45.68588140590	-111.0829200840	Tributary - SWWW_00011	Indirect Discharge
237	OF.L03.00280	45.68740084650	-111.0968876260	Tributary - SWWW_00007	Indirect Discharge

238	OF.L03.00618	45.69274014420	-111.0939918450	Tributary - SWWW_00007	Indirect Discharge
239	OF.M03.00293	45.6908557029	-111.1085482600	Tributary - SWWW_00006	Indirect Discharge
240	OF.M03.00294	45.6908489890	-111.1085579070	Tributary - SWWW_00006	Indirect Discharge
241	OF.M03.00292	45.6897476003	-111.1080372450	Tributary - SWWW_00006	Indirect Discharge
242	OF.M03.00464	45.6880048731	-111.1068663540	Tributary - SWWW_00006	Indirect Discharge
243	OF.M03.00007	45.6903551962	-111.1129622000	Baxter Creek	Indirect Discharge
244	OF.M03.00291	45.6886883520	-111.1071120450	Tributary - SWWW_00006	Indirect Discharge
245	OF.N03.00299	45.6885527853	-111.1191140090	Tributary - SWWW_00054	Indirect Discharge
246	OF.N03.00297	45.6875933511	-111.1186630860	Tributary - SWWW_00054	Indirect Discharge
247	OF.N03.00296	45.6860177700	-111.1181491380	Tributary - SWWW_00054	Indirect Discharge
248	OF.N03.00298	45.6891026985	-111.1190856810	Tributary - SWWW_00054	Indirect Discharge
249	OF.N03.00300	45.69288543800	-111.1157359840	Baxter Creek	Indirect Discharge
250	OF.D02.00318	45.6949822409	-111.0193257970	Rocky Creek	Direct Discharge
251	OF.G02.00048	45.6964415389	-111.0511567570	Mandeville Creek	Indirect Discharge
252	OF.G02.00309	45.6959106215	-111.0430559250	Tributary - SWWW_00034	Indirect Discharge
253	OF.G02.00311	45.6978339397	-111.0436265820	Tributary - SWWW_00034	Direct Discharge
254	OF.G02.00312	45.6979347107	-111.0436274950	Tributary - SWWW_00034	Direct Discharge
255	OF.G02.00310	45.6974930155	-111.0434446380	Tributary - SWWW_00034	Direct Discharge
256	OF.G02.00314	45.69995592850	-111.0429775210	Mandeville Creek	Direct Discharge
257	OF.G02.00313	45.69914843840	-111.0436482590	Tributary - SWWW_00034	Direct Discharge
258	OF.G02.00047	45.69620214030	-111.0511108360	Mandeville Creek	Indirect Discharge
259	OF.H02.00054	45.69653448320	-111.0568903530	Farmers Canal	Indirect Discharge
260	OF.H02.00056	45.69947859160	-111.0567514490	Farmers Canal	Indirect Discharge
261	OF.G08.00066	45.70006308510	-111.0576020060	Farmers Canal	Indirect Discharge
262	OF.H02.00641	45.69596233080	-111.0515865490	Mandeville Creek	Indirect Discharge
263	OF.H02.00369	45.69322778250	-111.0578780470	Farmers Canal	Direct Discharge
264	OF.H02.00049	45.69765047920	-111.0519269340	Mandeville Creek	Indirect Discharge
265	OF.H02.00055	45.69747471210	-111.0560945980	Farmers Canal	Indirect Discharge
266	OF.H02.00490	45.6950856692	-111.0571419910	Farmers Canal	Indirect Discharge
267	OF.I02.00137	45.6941124615	-111.0653829780	East Fork Catron Creek	Indirect Discharge
268	OF.I02.00124	45.6936393900	-111.0678476000	West Fork Catron Creek	Indirect Discharge
269	OF.I02.00126	45.6963743693	-111.0666416750	Catron Creek	Indirect Discharge
270	OF.I02.00368	45.6932393350	-111.0622045090	Farmers Canal	Direct Discharge
271	OF.I02.00127	45.6977811251	-111.0662486820	Catron Creek	Indirect Discharge
272	OF.I02.00125	45.6941420360	-111.0675147650	West Fork Catron Creek	Indirect Discharge
273	OF.I02.00301	45.7000782325	-111.0660548230	Catron Creek	Indirect Discharge
274	OF.J02.00232	45.7000946315	-111.0759883660	Cattail Creek	Indirect Discharge
275	OF.J02.00231	45.6984193276	-111.0771488220	Cattail Creek	Indirect Discharge
276	OF.J02.00230	45.6965771954	-111.0768193010	Cattail Creek	Indirect Discharge
277	OF.J02.00228	45.6955945802	-111.0768415110	Cattail Creek	Indirect Discharge
278	OF.J02.00227	45.6933716830	-111.0766788280	Cattail Creek	Indirect Discharge
279	OF.J02.00648	45.7000569911	-111.0761220200	Cattail Creek	Indirect Discharge
280	OF.K02.00262	45.6991961358	-111.0880166850	Tributary - SWWW_00012	Indirect Discharge
281	OF.K02.00465	45.7000010419	-111.0894173150	Tributary - SWWW_00012	Indirect Discharge
282	OF.K02.00261	45.6999789860	-111.0926906160	West Gallatin Canal	Indirect Discharge
283	OF.K02.00270	45.69574619200	-111.0845656790	Tributary - SWWW_00012	Indirect Discharge
284	OF.D01.00680	45.70557579820	-111.0112776400	Bridger Creek	Indirect Discharge
285	OF.E01.00050	45.70016460640	-111.0296744120	East Gallatin River	Indirect Discharge
286	OF.E01.00051	45.70195356540	-111.0302759780	East Gallatin River	Indirect Discharge

287	OF.E01.00703	45.70689462760	-111.0300589770	East Gallatin River	Indirect Discharge
288	OF.E01.00704	45.70620691200	-111.0300066790	East Gallatin River	Indirect Discharge
289	OF.E01.00705	45.70543213670	-111.0289637630	East Gallatin River	Indirect Discharge
290	OF.F01.00636	45.70400127270	-111.0313295090	East Gallatin River	Indirect Discharge
291	OF.H01.00679	45.70301991490	-111.0597019670	Catron Creek	Indirect Discharge
292	OF.I01.00128	45.70753612680	-111.0687185030	Catron Creek	Indirect Discharge
293	OF.I01.00129	45.70754637920	-111.0689447170	Catron Creek	Indirect Discharge
294	OF.I01.00624	45.70023779570	-111.0695531350	Tributary - SWWW_00014	Indirect Discharge
295	OF.J01.00234	45.70169995600	-111.0762290660	Cattail Creek	Indirect Discharge
296	OF.J01.00233	45.70055656480	-111.0760891110	Cattail Creek	Indirect Discharge
297	OF.E00.00052	45.70948913140	-111.0282244740	Bridger Creek	Indirect Discharge
298	OF.E00.00706	45.71088934700	-111.0306848230	Tributary - SWWW_00014	Indirect Discharge
299	OF.G00.00472	45.70853993840	-111.0423050280	Tributary - SWWW_00034	Indirect Discharge
300	OF.I00.00131	45.70838232650	-111.0687085610	Catron Creek	Indirect Discharge
301	OF.I00.00155	45.71067100760	-111.0687015050	Catron Creek	Indirect Discharge
302	OF.I00.00132	45.71408241600	-111.0688598770	Catron Creek	Indirect Discharge
303	OF.I00.00130	45.70777462040	-111.0686868180	Catron Creek	Indirect Discharge
304	OF.J00.00466	45.70909840920	-111.0780237690	Cattail Creek	Indirect Discharge
305	OF.J00.00235	45.71011069030	-111.0780418120	Cattail Creek	Indirect Discharge
306	OF.J00.00236	45.71050344260	-111.0776421640	Cattail Creek	Indirect Discharge
307	OF.J00.00237	45.71245140170	-111.0778929570	Cattail Creek	Indirect Discharge
308	OF.J00.00619	45.70966598850	-111.0719438550	Tributary - SWWW_00014	Indirect Discharge
309	OF.J00.00133	45.71202851870	-111.0721355570	Tributary - SWWW_00014	Indirect Discharge
310	OF.J00.00238	45.71248214500	-111.0781115200	Cattail Creek	Indirect Discharge
311	OF.K50.00483	45.71912668010	-111.0822062650	Tributary - SWWW_00011	Indirect Discharge
312	OF.I51.00497	45.72404432790	-111.0669248960	East Gallatin River	Indirect Discharge
313	OF.I51.00499	45.72442063470	-111.0693719000	East Gallatin River	Indirect Discharge
314	OF.I51.00500	45.72535138550	-111.0709461960	East Gallatin River	Indirect Discharge
315	OF.I51.00498	45.72433804400	-111.0683901940	East Gallatin River	Indirect Discharge
316	OF.I51.00053	45.7222256846	-111.0616927310	East Gallatin River	Direct Discharge
317	OF.F07.00041	45.6600360482	-111.0394064130	Figgins Creek	Direct Discharge
318	OF.F07.00078	45.6590802370	-111.0411383000	Figgins Creek	Direct Discharge
319	OF.F07.00079	45.6598151874	-111.0392177170	Figgins Creek	Direct Discharge
320	OF.F07.00076	45.6603998869	-111.0379126390	Figgins Creek	Direct Discharge
321	OF.F07.00080	45.6603998869	-111.0379126390	Figgins Creek	Direct Discharge
322	OF.F07.00075	45.6602498844	-111.0382424130	Figgins Creek	Direct Discharge
323	OF.F07.00637	45.6604959201	-111.0376974870	Figgins Creek	Direct Discharge
324	OF.F07.00647	45.6586307641	-111.0338305980	Flat Creek	Direct Discharge
325	OF.F07.00646	45.6583203549	-111.0338739250	Flat Creek	Direct Discharge
326	OF.F07.00667	45.6609137942	-111.0331762370	Flat Creek	Direct Discharge
327	OF.F07.00668	45.6609115645	-111.0324973020	Flat Creek	Direct Discharge
328	OF.F07.00669	45.6609123185	-111.0324948290	Flat Creek	Direct Discharge
329	OF.F07.00670	45.6618477691	-111.0324984560	Flat Creek	Direct Discharge
330	OF.F07.00672	45.6626093777	-111.0325010690	Flat Creek	Direct Discharge
331	OF.F07.00675	45.6637616215	-111.0325071800	Flat Creek	Direct Discharge
332	OF.F07.00081	45.6611357795	-111.0357849550	Mathew Bird Creek	Direct Discharge
333	OF.F07.00083	45.6632514462	-111.0371520630	Mathew Bird Creek	Direct Discharge
334	OF.F07.00084	45.6632674227	-111.0371273100	Mathew Bird Creek	Direct Discharge
335	OF.F07.00042	45.6609020140	-111.0402276360	Tributary - SWWW_00046	Direct Discharge

336	OF.F07.00085	45.6639391981	-111.0379534220	Tributary - SWWW_00046	Direct Discharge
337	OF.F07.00695	45.6599602841	-111.0350975230	Mathew Bird Creek	Direct Discharge
338	OF.F07.00043	45.6609372207	-111.0365704010	Figgins Creek	Direct Discharge
339	OF.F07.00082	45.6621452798	-111.0366220280	Mathew Bird Creek	Direct Discharge
340	OF.F07.00098	45.6575340928	-111.0314745940	Tributary - SWWW_00064	Direct Discharge
341	OF.L01.00002	45.7014360770	-111.0985968000	Maynard Border Ditch	Indirect Discharge
342	OF.L01.00001	45.7029721167	-111.0987281010	Maynard Border Ditch	Indirect Discharge
343	OF.L01.00269	45.7047304713	-111.0958061090	Tributary - SWWW_00047	Indirect Discharge
344	OF.L01.00615	45.7004431984	-111.0983860370	Maynard Border Ditch	Indirect Discharge
345	OF.L01.00634	45.7004148147	-111.0984389380	Maynard Border Ditch	Indirect Discharge
346	OF.L01.00456	45.7052931738	-111.0967761890	Tributary - SWWW_00047	Indirect Discharge
347	OF.L01.00664	45.7051466734	-111.0991439370	Maynard Border Ditch	Indirect Discharge
348	OF.L01.00463	45.7073517126	-111.0936124630	Tributary - SWWW_00062	Indirect Discharge
349	OF.I07.00175	45.6625565963	-111.0655562590	East Fork Catron Creek	Indirect Discharge
350	OF.I07.00176	45.6628719319	-111.0655410360	East Fork Catron Creek	Indirect Discharge
351	OF.I07.00177	45.6629977488	-111.0655521570	East Fork Catron Creek	Indirect Discharge
352	OF.F06.00090	45.6691118329	-111.0349721270	Mathew Bird Creek	Direct Discharge
353	OF.F06.00088	45.6672323599	-111.0362388490	Mathew Bird Creek	Direct Discharge
354	OF.F06.00683	45.6672744406	-111.0365193960	Mathew Bird Creek	Direct Discharge
355	OF.F06.00091	45.6680603977	-111.0358965790	Mathew Bird Creek	Direct Discharge
356	OF.F06.00089	45.6692772476	-111.0349062440	Mathew Bird Creek	Direct Discharge
357	OF.F06.00094	45.6711715969	-111.0324232220	Mathew Bird Creek	Direct Discharge
358	OF.F06.00100	45.67106117560	-111.0328532440	Mathew Bird Creek	Direct Discharge
359	OF.F06.00087	45.66629419970	-111.0368503470	Mathew Bird Creek	Direct Discharge
360	OF.F06.00093	45.67126402460	-111.0340065300	Mathew Bird Creek	Direct Discharge
361	OF.F06.00092	45.67124393300	-111.0340725520	Mathew Bird Creek	Direct Discharge
362	OF.D05.00327	45.67190818910	-111.0161061340	Tributary - SWWW_00040	Direct Discharge
363	OF.D05.00338	45.67753423680	-111.0162752920	Tributary - SWWW_00065	Direct Discharge
364	OF.D05.00336	45.67406858510	-111.0123882140	Tributary - SWWW_00065	Direct Discharge
365	OF.D05.00335	45.67347542450	-111.0112414160	Tributary - SWWW_00065	Direct Discharge
366	OF.D05.00337	45.67655826380	-111.0156593840	Tributary - SWWW_00065	Direct Discharge
367	OF.D05.00692	45.67324692490	-111.0174919160	Tributary - SWWW_00040	Direct Discharge
368	OF.D05.00693	45.67477083000	-111.0184578610	Tributary - SWWW_00040	Direct Discharge
369	OF.D05.00326	45.67162252170	-111.0165890360	Tributary - SWWW_00040	Indirect Discharge
370	OF.D05.00339	45.67747418150	-111.0162292240	Tributary - SWWW_00065	Direct Discharge
371	OF.J50.00239	45.71459747810	-111.0781948710	Cattail Creek	Indirect Discharge
372	OF.J50.00241	45.71732181600	-111.0811973930	Cattail Creek	Indirect Discharge
373	OF.J50.00240	45.71458194460	-111.0783839190	Cattail Creek	Indirect Discharge
374	OF.E07.00632	45.66303363560	-111.0262501640	Bozeman Creek	Indirect Discharge
375	OF.E07.00097	45.6570648952	-111.0284915320	Bozeman Creek	Direct Discharge
376	OF.E07.00408	45.6626978500	-111.0306514780	Bozeman Creek	Direct Discharge
377	OF.E07.00407	45.6596836470	-111.0299894400	Bozeman Creek	Direct Discharge
378	OF.G01.00316	45.7017536198	-111.0436134270	Tributary - SWWW_00034	Direct Discharge
379	OF.G01.00315	45.7017536198	-111.0436134270	Tributary - SWWW_00034	Direct Discharge
380	OF.G01.00317	45.7020354947	-111.0430106010	Tributary - SWWW_00034	Direct Discharge
381	OF.I05.00174	45.6743264646	-111.0647506120	East Fork Catron Creek	Direct Discharge
382	OF.I05.00172	45.6753713041	-111.0647442550	East Fork Catron Creek	Direct Discharge
383	OF.I05.00173	45.6752768076	-111.0647444660	East Fork Catron Creek	Direct Discharge
384	OF.I05.00113	45.6784814346	-111.0699672640	West Fork Catron Creek	Direct Discharge

385	OF.I05.00114	45.6783829678	-111.0699395490	West Fork Catron Creek	Direct Discharge
386	OF.I05.00111	45.6783647108	-111.0699654930	West Fork Catron Creek	Direct Discharge
387	OF.I05.00342	45.6724927719	-111.0625046730	Farmers Canal	Direct Discharge
388	OF.I05.00340	45.6724927719	-111.0625046730	Farmers Canal	Direct Discharge
389	OF.I05.00341	45.6724927719	-111.0625046730	Farmers Canal	Direct Discharge
390	OF.I05.00343	45.6729173286	-111.0625022740	Farmers Canal	Direct Discharge
391	OF.I05.00344	45.6729173286	-111.0625022740	Farmers Canal	Direct Discharge
392	OF.I05.00347	45.6731823467	-111.0625000700	Farmers Canal	Direct Discharge
393	OF.I05.00345	45.6731823467	-111.0625000700	Farmers Canal	Direct Discharge
394	OF.I05.00346	45.6731823467	-111.0625000700	Farmers Canal	Direct Discharge
395	OF.I05.00348	45.6744285368	-111.0624914860	Farmers Canal	Direct Discharge
396	OF.I05.00349	45.6744285368	-111.0624914860	Farmers Canal	Direct Discharge
397	OF.I05.00350	45.6751449272	-111.0624858600	Farmers Canal	Direct Discharge
398	OF.I05.00351	45.6751449272	-111.0624858600	Farmers Canal	Direct Discharge
399	OF.I05.00352	45.6762748975	-111.0624778260	Farmers Canal	Direct Discharge
400	OF.I05.00353	45.6762748975	-111.0624778260	Farmers Canal	Direct Discharge
401	OF.I05.00354	45.6771728557	-111.0624721130	Farmers Canal	Direct Discharge
402	OF.I05.00355	45.6771728557	-111.0624721130	Farmers Canal	Direct Discharge
403	OF.I05.00356	45.6773760543	-111.0624758950	Farmers Canal	Direct Discharge
404	OF.I05.00359	45.6776956323	-111.0624693210	Farmers Canal	Direct Discharge
405	OF.I05.00358	45.6776956323	-111.0624693210	Farmers Canal	Direct Discharge
406	OF.I05.00357	45.6776956323	-111.0624693210	Farmers Canal	Direct Discharge
407	OF.I05.00360	45.6783533015	-111.0624789420	Farmers Canal	Direct Discharge
408	OF.I05.00361	45.6783533015	-111.0624789420	Farmers Canal	Direct Discharge
409	OF.I05.00170	45.6785106364	-111.0651852770	East Fork Catron Creek	Direct Discharge
410	OF.I05.00678	45.6785106364	-111.0651852770	East Fork Catron Creek	Direct Discharge
411	OF.I05.00171	45.6771860781	-111.0647290600	East Fork Catron Creek	Direct Discharge
412	OF.I05.00685	45.6765461678	-111.0690652310	West Fork Catron Creek	Direct Discharge
413	OF.I05.00156	45.6757464265	-111.0689918450	West Fork Catron Creek	Direct Discharge
414	OF.I05.00112	45.6783647108	-111.0699654930	West Fork Catron Creek	Direct Discharge
415	OF.I05.00157	45.6744836363	-111.0688881120	West Fork Catron Creek	Direct Discharge
416	OF.I05.00158	45.6718219741	-111.0689108270	West Fork Catron Creek	Direct Discharge
417	OF.I05.00159	45.6717526988	-111.0689155400	West Fork Catron Creek	Direct Discharge
418	OF.J05.00211	45.6781600617	-111.0764391120	Cattail Creek	Indirect Discharge
419	OF.J05.00208	45.6760608495	-111.0771238790	Cattail Creek	Indirect Discharge
420	OF.J05.00626	45.6784869088	-111.0819309870	Tributary - SWWW_00050	Indirect Discharge
421	OF.J05.00213	45.6785137119	-111.0756501980	Cattail Creek	Direct Discharge
422	OF.J05.00212	45.6784642924	-111.0757945690	Cattail Creek	Direct Discharge
423	OF.J05.00395	45.6783081957	-111.0818385300	Tributary - SWWW_00050	Indirect Discharge
424	OF.J05.00658	45.6784401288	-111.0819396060	Tributary - SWWW_00050	Indirect Discharge
425	OF.J05.00659	45.6782692291	-111.0758412690	Cattail Creek	Direct Discharge
426	OF.J05.00660	45.6784404634	-111.0758002750	Cattail Creek	Direct Discharge
427	OF.J05.00207	45.6747159876	-111.0778438730	Cattail Creek	Indirect Discharge
428	OF.J05.00206	45.6747128714	-111.0778294200	Cattail Creek	Indirect Discharge
429	OF.J05.00209	45.6769651909	-111.0766381560	Cattail Creek	Indirect Discharge
430	OF.J05.00210	45.6768751803	-111.0767121760	Cattail Creek	Indirect Discharge
431	OF.D04.00106	45.68295426820	-111.0195838140	Story Ditch	Indirect Discharge
432	OF.D04.00319	45.6791967622	-111.0182564980	Tributary - SWWW_00048	Indirect Discharge
433	OF.E04.00109	45.6793711468	-111.0252796770	Story Ditch	Indirect Discharge

434	OF.E04.00108	45.6793582748	-111.0252385880	Story Ditch	Indirect Discharge
435	OF.E04.00226	45.6803382413	-111.0251332910	Story Ditch	Indirect Discharge
436	OF.E04.00102	45.6808145280	-111.0246854990	Story Ditch	Indirect Discharge
437	OF.E04.00105	45.6839768867	-111.0219927910	Story Ditch	Indirect Discharge
438	OF.E04.00104	45.6839622070	-111.0221565300	Story Ditch	Indirect Discharge
439	OF.E04.00103	45.6824120110	-111.0241556070	Story Ditch	Indirect Discharge
440	OF.E04.00225	45.6812279879	-111.0247791000	Story Ditch	Indirect Discharge
441	OF.E04.00442	45.6853221559	-111.0310319650	Bozeman Creek	Direct Discharge
442	OF.K01.00265	45.7044165000	-111.0892862590	Tributary - SWWW_00012	Indirect Discharge
443	OF.K01.00264	45.7032896823	-111.0897132050	Tributary - SWWW_00012	Indirect Discharge
444	OF.K01.00462	45.7061344202	-111.0856472290	Tributary - SWWW_00060	Indirect Discharge
445	OF.K01.00266	45.7045696448	-111.0893903630	Tributary - SWWW_00012	Indirect Discharge
446	OF.K01.00263	45.7014379085	-111.0895456440	Tributary - SWWW_00012	Indirect Discharge
447	OF.K01.00267	45.7072345447	-111.0903033290	Tributary - SWWW_00012	Indirect Discharge
448	OF.K01.00268	45.7068737015	-111.0889782230	Tributary - SWWW_00012	Indirect Discharge
449	OF.F07.00084	45.6640498823	-111.0549550830	Mandeville Creek	Direct Discharge
450	OF.H07.00187	45.6625895199	-111.0547334260	Mandeville Creek	Direct Discharge
451	OF.H07.00188	45.6628444207	-111.0547324320	Mandeville Creek	Direct Discharge
452	OF.H06.00189	45.6640502537	-111.0549295260	Mandeville Creek	Direct Discharge
453	OF.H07.00190	45.6640502537	-111.0549295260	Mandeville Creek	Direct Discharge
454	OF.J03.00224	45.6927383837	-111.0763857980	Cattail Creek	Indirect Discharge
455	OF.J03.00223	45.6926924751	-111.0763694690	Cattail Creek	Indirect Discharge
456	OF.J03.00219	45.6892738201	-111.0753729100	Cattail Creek	Indirect Discharge
457	OF.J03.00221	45.6911767455	-111.0761040670	Cattail Creek	Indirect Discharge
458	OF.J03.00220	45.6911515672	-111.0757537680	Cattail Creek	Indirect Discharge
459	OF.J03.00217	45.6878783746	-111.0746873430	Cattail Creek	Indirect Discharge
460	OF.J03.00216	45.6872737904	-111.0745833540	Cattail Creek	Indirect Discharge
461	OF.J03.00215	45.6861624722	-111.0745278710	Cattail Creek	Indirect Discharge
462	OF.J03.00222	45.6912461684	-111.0763019180	Cattail Creek	Indirect Discharge
463	OF.J03.00218	45.6889448618	-111.0751670330	Cattail Creek	Indirect Discharge
464	OF.J03.00691	45.6929956251	-111.0762991050	Cattail Creek	Indirect Discharge
465	OF.I03.00120	45.6888802713	-111.0676521740	West Fork Catron Creek	Indirect Discharge
466	OF.I03.00123	45.6911579238	-111.0680790880	West Fork Catron Creek	Indirect Discharge
467	OF.I03.00620	45.69125083980	-111.0708990790	Tributary-SWWW_00017	Indirect Discharge
468	OF.I03.00153	45.6866876835	-111.0634391730	East Fork Catron Creek	Indirect Discharge
469	OF.I03.00148	45.6890175550	-111.0637836600	East Fork Catron Creek	Indirect Discharge
470	OF.I03.00146	45.6894294399	-111.0638185390	East Fork Catron Creek	Indirect Discharge
471	OF.I03.00145	45.6902767055	-111.0640968620	East Fork Catron Creek	Indirect Discharge
472	OF.I03.00144	45.6904989260	-111.0641661190	East Fork Catron Creek	Indirect Discharge
473	OF.I03.00143	45.6908173970	-111.0642352420	East Fork Catron Creek	Indirect Discharge
474	OF.I03.00142	45.6909936665	-111.0642818400	East Fork Catron Creek	Indirect Discharge
475	OF.I03.00141	45.6923351376	-111.0645825470	East Fork Catron Creek	Indirect Discharge
476	OF.I03.00138	45.6926257688	-111.0646578170	East Fork Catron Creek	Indirect Discharge
477	OF.I03.00139	45.6928731434	-111.0647526400	East Fork Catron Creek	Indirect Discharge
478	OF.I03.00635	45.6859574119	-111.0634198080	East Fork Catron Creek	Direct Discharge
479	OF.I03.00154	45.6859552123	-111.0634501760	East Fork Catron Creek	Direct Discharge
480	OF.I03.00367	45.6928969036	-111.0622229700	Farmers Canal	Direct Discharge
481	OF.I03.00366	45.6928969036	-111.0622229700	Farmers Canal	Direct Discharge
482	OF.I03.00365	45.6900844815	-111.0621010790	Farmers Canal	Direct Discharge

483	OF.I03.00364	45.6898561397	-111.0620887470	Farmers Canal	Direct Discharge
484	OF.I03.00363	45.6887142944	-111.0620326530	Farmers Canal	Direct Discharge
485	OF.I03.00362	45.6882315267	-111.0620022290	Farmers Canal	Direct Discharge
486	OF.I03.00484	45.6912310483	-111.0642992750	East Fork Catron Creek	Indirect Discharge
487	OF.I03.00152	45.6879686286	-111.0638050880	East Fork Catron Creek	Indirect Discharge
488	OF.I03.00149	45.6886821236	-111.0638268580	East Fork Catron Creek	Indirect Discharge
489	OF.I03.00150	45.6885148713	-111.0638343900	East Fork Catron Creek	Indirect Discharge
490	OF.I03.00118	45.6858180827	-111.0671891790	West Fork Catron Creek	Direct Discharge
491	OF.I03.00119	45.6858177359	-111.0672110220	West Fork Catron Creek	Direct Discharge
492	OF.I03.00141	45.6919417608	-111.0645648940	East Fork Catron Creek	Indirect Discharge
493	OF.I03.00147	45.6897007549	-111.0639503150	East Fork Catron Creek	Indirect Discharge
494	OF.I03.00151	45.6884270014	-111.0637911370	East Fork Catron Creek	Indirect Discharge
495	OF.I03.00121	45.6889983546	-111.0676454070	West Fork Catron Creek	Indirect Discharge
496	OF.I03.00122	45.6890986522	-111.0676538260	West Fork Catron Creek	Indirect Discharge
497	OF.F04.00426	45.6786923413	-111.0327597850	Bozeman Creek	Direct Discharge
498	OF.F04.00441	45.6830849026	-111.0319974030	Bozeman Creek	Direct Discharge
499	OF.F04.00440	45.6819808773	-111.0321364030	Bozeman Creek	Direct Discharge
500	OF.F04.00644	45.6788283411	-111.0327047440	Bozeman Creek	Direct Discharge
501	OF.F04.00439	45.6819412590	-111.0321435020	Bozeman Creek	Direct Discharge
502	OF.F04.00697	45.6840457486	-111.0316796060	Bozeman Creek	Direct Discharge
503	OF.F04.00428	45.6788575411	-111.0326845580	Bozeman Creek	Direct Discharge
504	OF.F04.00427	45.6788244144	-111.0326811740	Bozeman Creek	Direct Discharge
505	OF.F04.00431	45.6794164261	-111.0326514080	Bozeman Creek	Direct Discharge
506	OF.F04.00429	45.6792579542	-111.0326616260	Bozeman Creek	Direct Discharge
507	OF.F04.00430	45.6797465074	-111.0326598030	Bozeman Creek	Direct Discharge
508	OF.F04.00432	45.6798932180	-111.0327374050	Bozeman Creek	Direct Discharge
509	OF.F04.00433	45.6798909981	-111.0326816120	Bozeman Creek	Direct Discharge
510	OF.F04.00434	45.6803708316	-111.0327069670	Bozeman Creek	Direct Discharge
511	OF.F04.00435	45.6804694739	-111.0327223290	Bozeman Creek	Direct Discharge
512	OF.F04.00437	45.6809133939	-111.0327194500	Bozeman Creek	Direct Discharge
513	OF.F04.00436	45.6808580398	-111.0327280490	Bozeman Creek	Direct Discharge
514	OF.F04.00438	45.6819006384	-111.0321394000	Bozeman Creek	Direct Discharge
515	OF.I09.00186	45.6435695599	-111.0710798400	Middle Creek Ditch	Indirect Discharge
516	OF.I09.00183	45.6459427695	-111.0685090010	Middle Creek Ditch	Indirect Discharge
517	OF.I09.00184	45.6454919156	-111.0683879440	Middle Creek Ditch	Indirect Discharge
518	OF.I09.00193	45.6450783261	-111.0680874870	Middle Creek Ditch	Indirect Discharge
519	OF.I09.00471	45.6474033846	-111.0693893550	Middle Creek Ditch	Indirect Discharge
520	OF.I09.00470	45.6480097990	-111.0700159770	Middle Creek Ditch	Indirect Discharge
521	OF.I09.00185	45.6474483205	-111.0689914660	Middle Creek Ditch	Indirect Discharge
522	OF.I09.00191	45.6489618617	-111.0641952090	East Fork Catron Creek	Indirect Discharge
523	OF.I09.00198	45.6475118735	-111.0641498120	East Fork Catron Creek	Indirect Discharge
524	OF.I09.00196	45.6431466222	-111.0641483730	East Fork Catron Creek	Indirect Discharge
525	OF.I09.00195	45.6450541893	-111.0635651200	East Fork Catron Creek	Indirect Discharge
526	OF.I09.00194	45.6455524662	-111.0637794280	East Fork Catron Creek	Indirect Discharge
527	OF.I09.00197	45.6467437184	-111.0639781550	East Fork Catron Creek	Indirect Discharge
528	OF.I09.00192	45.6423839092	-111.0644445730	East Fork Catron Creek	Indirect Discharge
529	OF.G01.00707	45.70332781960	-111.0426056240	Tributary - SWWW_00034	Direct Discharge
530	OF.H02.00708	45.69326050970	-111.0578295590	Farmers Canal	Direct Discharge
531	OF.I04.00709	45.68283365880	-111.0651022870	East Fork Catron Creek	Direct Discharge

532	OF.F01.00637	45.70285552290	-111.0361662000	East Gallatin River	Indirect Discharge
533	OF.F05.00097	45.67395551370	-111.0321445690	Bozeman Creek	Direct Discharge
534	OF.I09.00001	45.64699428010	-111.0715632400	Middle Creek Ditch	Indirect Discharge
535	OF.L01.00003	45.70474791880	-111.0992131950	Maynard Border Ditch	Indirect Discharge
536	OF.L01.00004	45.7040683602	-111.0991208210	Maynard Border Ditch	Indirect Discharge
537	OF.G08.00033	45.6503740251	-111.0499408970	Figgins Creek	Indirect Discharge
538	OF.I51.00054	45.7235092119	-111.0722489290	Catron Creek	Direct Discharge
539	OF.C05.00001	45.67505653210	-111.0082765270	Tributary - SWWW_00065	Direct Discharge
540	OF.C05.00002	45.67506380310	-111.0089440040	Tributary - SWWW_00065	Direct Discharge
541	OF.C05.00003	45.67505810040	-111.0095208900	Tributary - SWWW_00065	Direct Discharge
542	OF.D05.00001	45.67641051460	-111.0141711950	Tributary - SWWW_00065	Direct Discharge
543	OF.D05.00002	45.67610305840	-111.0133678850	Tributary - SWWW_00065	Direct Discharge
544	OF.H05.00001	45.6784497589	-111.0518139600	Mandeville Creek	Direct Discharge
545	OF.H04.00060	45.6792074961	-111.0517891240	Mandeville Creek	Direct Discharge
546	OF.H06.00029	45.6693667100	-111.0595287430	Middle Creek Ditch	Direct Discharge
547	OF.H05.00002	45.6747692403	-111.0575623060	Middle Creek Ditch	Indirect Discharge
548	OF.H05.00003	45.6752806660	-111.0587390920	Middle Creek Ditch	Direct Discharge
549	OF.H05.00005	45.6772730798	-111.0594189150	Middle Creek Ditch	Direct Discharge
550	OF.H05.00006	45.6783702579	-111.0593963580	Middle Creek Ditch	Direct Discharge
551	OF.H04.00001	45.6785417801	-111.0599217920	Middle Creek Ditch	Direct Discharge
552	OF.H04.00002	45.6793732918	-111.0599246550	Middle Creek Ditch	Direct Discharge
553	OF.I04.00001	45.6800924136	-111.0623292870	Farmers Canal	Direct Discharge
554	OF.I04.00002	45.6821052715	-111.0621841440	Farmers Canal	Direct Discharge
555	OF.I04.00003	45.6855468393	-111.0619452240	Farmers Canal	Direct Discharge
556	OF.H02.00050	45.6983689906	-111.0519743930	Mandeville Creek	Direct Discharge
557	OF.G02.00049	45.69760225430	-111.0513360050	Mandeville Creek	Direct Discharge
558	OF.E01.00052	45.70052426010	-111.0302720750	East Gallatin River	Direct Discharge
559	OF.E01.00053	45.70055323200	-111.0302242380	East Gallatin River	Direct Discharge
560	OF.E01.00054	45.70061346560	-111.0301111610	East Gallatin River	Direct Discharge
561	OF.E01.00055	45.70064015030	-111.0300633230	East Gallatin River	Direct Discharge
562	OF.E01.00056	45.70042371290	-111.0300980090	East Gallatin River	Direct Discharge
563	OF.E01.00057	45.70045268500	-111.0300490830	East Gallatin River	Direct Discharge
564	OF.E01.00058	45.70051901730	-111.0299262230	East Gallatin River	Direct Discharge
565	OF.E01.00059	45.70054494020	-111.0298794710	East Gallatin River	Direct Discharge
566	OF.D04.00107	45.67880140800	-111.0122737110	Tributary - SWWW_00065	Direct Discharge
567	OF.L03.00001	45.6903452316	-111.0967073040	Tributary - SWWW_00007	Indirect Discharge
568	OF.M05.00009	45.67868040040	-111.1148390300	Tributary - SWWW_00054	Indirect Discharge
569	OF.M05.00010	45.67653067490	-111.1139996910	Tributary - SWWW_00054	Indirect Discharge
570	OF.L04.00005	45.6856035544	-111.1041566210	Tributary - SWWW_00006	Indirect Discharge
571	OF.L04.00004	45.6855715706	-111.1041746360	Tributary - SWWW_00006	Indirect Discharge
572	OF.M04.00292	45.6855995616	-111.1059130960	Tributary - SWWW_00006	Indirect Discharge
573	OF.M04.00293	45.6855164030	-111.1110089760	Baxter Creek	Indirect Discharge
574	OF.M04.00291	45.6856095520	-111.1094789900	Tributary - SWWW_00005	Indirect Discharge
575	OF.H07.00192	45.6614277711	-111.0534903970	Mandeville Creek	Direct Discharge
576	OF.H07.00191	45.6614146037	-111.0535018720	Mandeville Creek	Direct Discharge
577	OF.L05.00490	45.6750507211	-111.1038384950	Tributary - SWWW_00006	Indirect Discharge
578	OF.E15.00001	45.59956688340	-111.0264094230	Bozeman Creek	Indirect Discharge
579	OF.E15.00002	45.60052456060	-111.0248062650	Bozeman Creek	Direct Discharge
580	OF.K01.00269	45.7063645222	-111.0894875360	Tributary - SWWW_00012	Indirect Discharge

581	OF.F09.00480	45.6449101742	-111.0337244740	Flat Creek	Indirect Discharge
582	OF.F03.00447	45.6859525862	-111.0310962120	Bozeman Creek	Direct Discharge
583	OF.F03.00448	45.6855184277	-111.0311496570	Bozeman Creek	Direct Discharge
584	OF.F04.00698	45.6840504484	-111.0316291380	Bozeman Creek	Direct Discharge
585	OF.F04.00699	45.6797222957	-111.0326610020	Bozeman Creek	Direct Discharge
586	OF.F06.00101	45.6689594516	-111.0351137090	Mathew Bird Creek	Direct Discharge
587	OF.F04.00442	45.6803757696	-111.0327820590	Bozeman Creek	Direct Discharge
588	OF.L03.00002	45.69178412510	-111.0956105820	Tributary - SWWW_00007	Indirect Discharge
589	OF.M03.00008	45.6926933481	-111.1087827410	Tributary - SWWW_00006	Indirect Discharge
590	OF.K02.00271	tbd	tbd	Tributary - SWWW_00012	Indirect Discharge
591	OF.I09.00200	tbd	tbd	Catron Creek	Indirect Discharge
592	OF.F03.00449	tbd	tbd	Bozeman Creek	Indirect Discharge
593	OF.F05.00426	tbd	tbd	Bozeman Creek	Direct Discharge

Project No.		Date Received		Date Reviewed	
					
Construction Stormwater Permit Review Checklist Sites Greater than One (1) Acre					
Unit 1 - Project Information					
Project Name			Project Location		
Total Project Area		Total Disturbed Area		Receiving Water	
Estimated Start Date		Estimated Completion Date		Estimated Final Stabilization Date	
Applicant	Address	Email	Phone Number		
SWPPP Administrator	Address	Email	Phone Number		
Unit 2 - Review History					
First Review					
Plan Received Date:		Approved/Denied:			
Review Completed Date:		Comments:			
Reviewed By:					
Second Review					
Plan Received Date:		Approved/Denied:			
Review Completed Date:		Comments:			
Reviewed By:					
Third Review					
Plan Received Date:		Approved/Denied:			
Review Completed Date:		Comments:			
Reviewed By:					
Unit 3 - Review Conclusion					
☐	The Stormwater Pollution Prevention Plan for the project above adequately meets the necessary components identified within the attached checklist.				
☐	The Stormwater Pollution Prevention Plan for the project above does not adequately meet the necessary components identified within the attached checklist and must be resubmitted to the Stormwater Division with changes prior to approval.				
Notes: _____					

Reviewed By: _____ Date: _____					

Notice of Intent and Stormwater Pollution Prevention Plan Review			
Local Erosion & Sediment Control Requirements		Comment	
1	Are NOI Sec. A – K accurate and complete? Specifically, are SWPPP Administrator, receiving surface waters, description of construction activities, BMP summary, area of construction related disturbance, and certifications accurate and complete?	☐ Yes ☐ No	
2	Are SWPPP Sections A – E accurate, complete, and consistent with the NOI?	☐ Yes ☐ No	
3	Have major construction activities and associated BMPs been broken into an adequate number of construction phases? Have legible site maps been submitted for each phase of construction?	☐ Yes ☐ No	
4	Are inlets receiving surface runoff protected with BMPs that filter stormwater before flowing into underground infrastructure?	☐ Yes ☐ No	
5	Are disturbed areas contained with perimeter protection BMP(s) that contain stormwater flowing off of disturbed areas?	☐ Yes ☐ No	

Notice of Intent and Stormwater Pollution Prevention Plan Review			
Local Erosion & Sediment Control Requirements		Comment	
6	Is vehicle and equipment tracking being mitigated by limiting site access to approved stabilized construction site entrances / exits?	☐ Yes ☐ No	
7	Are concrete washout water, concrete cutting slurry, and other masonry washwaters contained in a lined washout facility BMP(s)?	☐ Yes ☐ No	
8	Are materials and soil stockpiles, not already contained within an existing perimeter protection BMP, covered or contained with perimeter control BMP(s)?	☐ Yes ☐ No	
9	Are dewatering discharges being managed with filters, wells, or land application? Are dewatering wells (if applicable), discharge locations, and receiving surface water shown on site maps?	☐ Yes ☐ No	
10	Are post-construction stormwater features (ponds, infiltration basins, etc.) protected with an approved permanent or temporary stabilization BMP?	☐ Yes ☐ No	

Notice of Intent and Stormwater Pollution Prevention Plan Review			
Local Erosion and Sediment Control Requirements		Comment	
11	Are all disturbed areas not under active construction identified on site maps and temporarily stabilized with an approved temporary soil stabilization BMP?	☐ Yes ☐ No	
12	Are natural resource areas (e.g., streams, wetlands, etc.) protected by natural buffers, barriers, or structural BMPs?	☐ Yes ☐ No	
Local Operational and Administrative Control Requirements		Comment	
13	Has a spill prevention and response plan be formulated and has the spill kit location been identified on all site maps?	☐ Yes ☐ No	
14	Are good housekeeping BMP(s), including covered / contained chemical storage location, dumpster location, and sanitary facility location identified on all site maps?	☐ Yes ☐ No	
15	Are vehicle and equipment fueling, cleaning, storage, and maintenance staging areas identified on site maps?	☐ Yes ☐ No	

Notice of Intent and Stormwater Pollution Prevention Plan Review			
Local Operational and Administrative Control Requirements		Comment	
16	Does the SWPPP include the preservation of existing vegetation, and are preservation areas shown on all site maps?	☐ Yes ☐ No	
18	Are there locations where additional BMPs appear to be necessary?	☐ Yes ☐ No	
19	Is SWPPP Sec. O – Certification signed and dated?	☐ Yes ☐ No	

CONSTRUCTION STORMWATER SITE VISIT INSPECTION FORM
Sites Greater than One (1) Acre

General Information	
Project Name:	
Location:	
Date of Inspection:	Start/End Time:
Inspector's Name(s) & Title(s):	
Inspector's Contact Info:	
SWPPP Administrator's Name:	
SWPPP Administrator's Contact Info:	
SWPPP Applicant's Name:	
SWPPP Applicant's Contact Info:	
Describe Present Phase of Construction:	
Is this a High Priority Site? ☐ YES ☐ NO	
Type of Inspection: ☐ Unannounced ☐ Announced ☐ Complaint Driven ☐ Audit ☐ Post Snowmelt / Thawing Event ☐ Post Rain Event Was the inspection within 48 hours post rain / snowmelt event? ☐ Yes ☐ No ☐ N/A	
Weather Information	
☐ Clear ☐ Cloudy ☐ Rain ☐ Sleet ☐ Fog ☐ Snowing ☐ High Winds ☐ Other: _____ Temperature: _____	
Prohibited Discharges	
Do you suspect that discharges may have occurred since the last inspection? ☐ Yes ☐ No ☐ N/A: _____	
Are there any prohibited discharges at the time of inspection? ☐ Yes ☐ No If yes, provide location(s) and a description (presence of suspended sediment, turbid water, discoloration, and/or oil sheen): NTU: _____	

	BMP/Activity	Implemented?	Maintained?	Findings
Erosion, Sediment, and Pollutant Controls				
1	Are inlets receiving surface runoff protected with BMPs that filter stormwater before flowing into underground infrastructure?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
2	Are disturbed areas contained with BMP(s) that contain stormwater flowing off of disturbed areas?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
3	Is vehicle and equipment tracking be mitigated by limiting site access to stabilized areas?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
4	Are concrete washout water, concrete cutting slurry, and other masonry wash-waters contained in a lined washout facility BMP(s)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
5	Are materials and soil stockpiles, not already contained within an existing perimeter control, covered or contained with a perimeter control BMP(s)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
6	Are dewatering discharges being managed with filters, wells, or land application?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
7	Are post-construction stormwater features (ponds, infiltration basins, etc.) protected with BMP(s) which stabilize side slopes?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
8	Are all disturbed areas, not under active construction, temporarily stabilized?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
9	Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) protected by natural buffers, barriers, or similar BMPs?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

	BMP/Activity	Implemented?	Maintained?	Findings
Erosion, Sediment, and Pollutant Controls				
10	Are discharge points and receiving waters free of sediment deposits? If no, provide locations.	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
11	Are materials that are potential stormwater contaminants stored inside or under cover?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
12	Are vehicle and equipment fueling, cleaning, material storage, and maintenance areas free of spills, leaks, or other harmful materials?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
13	Is a spill kit on site?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
14	Is trash/litter from work areas collected and placed in covered dumpsters?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
15	Are there locations where additional BMPs are required?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Records Review				
16	Is the SWPPP on site and available for review?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
17	Is the SWPPP updated to reflect current site conditions?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
18	Are SWPPP maps on site and available for review?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

	BMP/Activity	Implemented?	Maintained?	Findings
Records Review				
19	Are SWPPP maps updated to show current site conditions?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
20	Are self-inspection forms on site, available for review, and current?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

Additional Notes, Findings, and Corrective Actions:

Inspector's Signature

Date

Monday, February 26, 2018

TO: Development Review Committee

FROM: [REDACTED]

RE: [REDACTED]

DATE: February 26, 2018

Project Description:

1. Project Specific Questions:

2. Development Review Process:

- a. Site Plan Review is required for the proposed development. Subsequent building permits are required for the building. All building permits must be issued within one year of site plan approval with an extension possible for up to one additional year.
- b. The City strongly advises the applicant to review the proposed draft UDC and design the project according to the recommended code provisions. Designing the project according to the new code will help alleviate the risk of constructing buildings according to the existing code setting up the potential for non-conformities with a new code.
- c. The advisory review body is the Development Review Committee (DRC). The Director of Community Development will make the final decision pursuant to Section 38.34.010, BMC if no variance is requested.
- d. Section 38.39.030.C provides the criteria for site plan concurrent construction. The applicant must respond to the criteria and the DRC must review the request for concurrent construction and obtain approval from the Fire Marshall. An irrevocable offer of dedication is required.
- e. Any improvements not installed at time of occupancy are subject to a financial guarantee and improvements agreement. The City may restrict what items may be financially guaranteed and withhold occupancy to protect the public health and safety.

3. Project Location, Design, and General Comments:

- a. This is a prominent intersection planned for walkable, compact, neighborhood scale commercial uses. The development must provide a visible and distinctive focal point and be developed in an integrated, pedestrian friendly manner.
- b. Provide direct pedestrian connections to the public sidewalk from all building entrances.
- c. Utility easements may require additional building and parking setbacks, if present. All easements must be clearly depicted on the formal application.
- d. Please coordinate all private utility setbacks for transformers and outside conductors closest to the building.
- e. Please note the setback requirements for structures and parking areas along pedestrian walks. Additional easement area may be necessary to accommodate setbacks.

- f. A detailed lighting plan including photometric calculations and fixture cutsheets must be submitted with the formal plan. Establishing a lighting hierarchy is essential to quality design, functionality, site surveillance, and pedestrian safety.
- 4. **Landscaping:**
 - a. Please contact the City Forester for an initial analysis for the existing trees and provide adequate protection zones during and after construction.
- 7. **Parking:**
 - a. Parking scenario one: First parking stall to the south is within the setback, please modify or request a departure.
- 8. **Building Design:**
 - a. **Sec. 38.10.050. - Yards.** The purpose of differentiated yard setback requirements is to encourage the placement and development of buildings in a manner to address the street and adjacent pedestrian activity and encourage a vigorous and diverse streetscape. **Pedestrian connection and access from the front of building required, recommend central building circulation core to connect front entry and rear entry from parking lot.**
- 9. **Additional comments**

Engineering Division Comments (Shawn Kohtz, PE, skohtz@bozeman.net, 582-2280)

Code Corrections

- 1. Bozeman Municipal Code (BMC) Section 38.24.010.A states: All streets shall be provided in accordance with the adopted growth policy and/or transportation plan. The arrangement, type, extent, width, grade and location of all streets shall be considered in their relation to existing and planned streets, to topographical conditions, to public convenience and safety, and to the proposed uses of the land to be served by such streets.
 - **The applicant must widen Babcock Street on the south side of the street and adjust the lane configuration to the City's collector street requirements between Cottonwood Road and Ferguson Avenue. The applicant's direct responsibility is to construct the section of Babcock Street adjacent to the property. However, City policy does not allow transitions of street sections at property boundaries. Therefore, the applicant may approach the City Commission to establish a payback district for portions of Babcock Street that are not adjacent to the applicants property, or the applicant may approach other property owners with frontage along the south side of Babcock Street directly to participate in the cost of the upgrade. Widening of Babcock Street must occur prior to the proposed Phase 13. The applicant must indicate Babcock Street improvements in the site plan application and on the drawings prior to site plan approval.**
 - **Some of the applicant's drawings indicate painted parking spaces on local streets. Parking spaces on local, public streets may not be painted as the City will not maintain paint striping. The applicant must remove painted parking spaces on local, public streets prior to site plan**

- approval.
- Trench backfill within the Babcock Street right-of-way must be flowable fill. The applicant must indicate this requirement on the plans prior to site plan approval.
 - The applicant's drawings indicate a curb bulb width on Palisade Drive as 23-feet. The curb bulb width must be at least 24-feet. Additionally, the minimum allowed radius on curb bulbs is 35-feet. The applicant must correct the plans to reflect this change prior to site plan approval.
 - The applicant must angle street signs at 45-degrees where adjacent to the project. The applicant must reflect this on the plans prior to site plan approval.
 - The applicant must eliminate the cross walk markings at the intersection of Palisade Drive and Stafford Avenue. The City will not maintain these markings. The applicant must reflect this change on the plans prior to site plan approval.
2. BMC 38.24.010.A.8 states: To facilitate traffic movement, the provision of emergency services and the placement of utility easements, all developments shall be provided with a second means of access. **The applicant must construct proposed Phase 6 Stafford Avenue and proposed Phase 7 Palisade Drive in the project Phase I. The applicant must adjust the phasing plan to reflect this change prior to site plan approval.**
 3. City standard *sidewalks* (including a concrete *sidewalk* section through all private drive approaches) shall be constructed in all developments on all public and private street frontages, except for alleys. The requirements of the city design standards and specifications policy and the city modifications to state public works standard specifications shall apply. **The maximum allowed cross slope on public sidewalks is 2%. Some of the proposed cross slopes are greater than 2%. The applicant must adjust the grading plans to reflect the maximum allowed cross slope prior to site plan approval.**
 4. BMC Section 38.24.090.A States: All final site plans and plats shall contain a statement requiring lot accesses to be built to the standard contained in this section, the city design standards and specifications policy, and the city modifications to state public works standard specifications.
 - **The applicant must use City standard drive accesses to access all public streets per City Standard Drawing 02529-12. The applicant must indicate the drive access requirement on the drawings prior to site plan approval.**
 - **The applicant must remove the City Standard detail drawing SD 02529-13 from the site plan drawings. There are no accesses to arterial streets. The detail must be removed prior to site plan approval.**
 5. BMC 38.23.150.C states: Street lighting consists of *street* lighting and pathway intersection lighting, and shall comply with the City of Bozeman Design Standards and Specifications Policy. **In addition to the street lights that seem to be indicated by the light symbol "3" on the lighting plans, the applicant must include a street light at the intersection of Stafford Avenue and Palisade Drive.**

6. BMC 38.23.070.A.1 states: The developer shall install complete municipal *water* and sanitary sewer system facilities, or a system allowed by 38.21.030.D, and may be required by the city to install municipal storm sewer system facilities. These systems shall be installed in accordance with the requirements of the state department of environmental quality and the city, and shall conform with any applicable facilities plan. The city's requirements are contained in the Design Standards and Specifications Policy and the City of Bozeman Modifications to Montana Public Works Standard Specifications, and by this reference these standards are incorporated into and made a part of these regulations. The developer shall submit plans and specifications for the proposed facilities to the city and to the state department of environmental quality and shall obtain their approvals prior to commencing construction of any municipal *water*, sanitary sewer or storm sewer system facilities.
- **The applicant's sanitary sewer analysis indicates the need to upgrade sanitary sewer main in Babcock Street to accommodate the proposed project. The applicant must upgrade the sanitary sewer in Babcock Street to accommodate flows from the proposed project prior to Phase 13. The applicant must indicate this requirement in the drawings and application prior to site plan approval.**
 - **The City is currently designing an upgrade to Cottonwood Road between Babcock Street and Durston Road. The sanitary sewer will be upgraded from a 12-inch main to an 18-inch main with the Cottonwood Road project. The sewer main upgrade on Cottonwood Road must be complete prior to obtaining building permits for Phase 1 as this main is at capacity due to previously approved projects that will add flows to this main.**
 - **The City is in the process of verifying sanitary sewer flows to the sanitary sewer interceptor downstream of the intersection of Cottonwood and Durston. Verification is being performed with flow monitoring to verify hydraulic model calibration. Downstream interceptor capacity must be verified prior to site plan approval. Any segments that are not sufficient to accommodate the proposed project must be upgraded prior to site plan approval.**
 - **The applicant must add a segment of water main loop from the drive aisle in Phase I to the water main in Fallon Street. The applicant must indicate this on the plans prior to site plan approval.**
 - **Trees or other significant landscaping features may not be located within 10-feet of a water main, sanitary sewer main, water service, or sanitary sewer service. The applicant must verify these distances are maintained prior to site plan approval.**
 - **The applicant proposed some sanitary sewer services connected at angles to the sanitary sewer main. The applicant must construct services at right angles to the main to the easement line before changing direction unless the City Water and Sewer Superintendent (John Alston) approves an alternate configuration. The applicant must reflect this correction on the plans prior to site plan approval.**
 - **The applicant must abandon existing, unused water services at the main. The applicant must indicate this abandonment on the plans prior to site plan approval.**

- The applicant must construct separate water and fire services from the water mains to the building. The applicant must correct the drawings to indicate this change prior to site plan approval.
 - The proposed corporation stop locations for the water services is not the standard location. The corporation stops must be placed at the connection to the water main. The applicant must indicate this correction on the drawings prior to site plan approval.
 - The applicant must coordinate curb stop locations with the City Water and Sewer Superintendent (John Alston) and show the correct locations prior to site plan approval.
 - There does not appear to be enough cover over the water main at the connection to the existing water main in Babcock Street. Where cover is less than 6.5-feet until adequate cover can be achieved, the applicant must construct insulation over the main. The applicant must demonstrate this change on the plans prior to site plan approval.
 - The required cover depth over the water main shown on Sheet C7.8 is not achieved. The applicant must maintain a minimum of 6.5-feet of cover over water mains. The applicant must correct this item on the plans prior to site plan approval.
 - The applicant must indicate the proposed fire hydrant locations on the plans prior to site plan approval.
 - The water design report submitted with the application indicates the use of PVC water mains. All water mains must be constructed as CL 51 ductile iron. The applicant must adjust the water system design report to reflect this change prior to site plan approval.
 - The water design report submitted with the application indicates flow estimates from a project other than Icon Apartments. The applicant must correct the water system design report to reflect demands from the proposed Icon Apartments project.
 - The applicant proposed a concrete trash pad and enclosure over a water main. No structures may be located within the water and sewer main easement. The applicant must correct this item prior to site plan approval.
 - The applicant must ensure that the water main connection to the main in Babcock is connected to the correct main. There are parallel water mains at this location that are located in different pressure zones.
 - The applicant must abandon any unused sewer services per City Water and Sewer Department requirements. The applicant must indicate this on the plans prior to site plan approval.
7. Bozeman Municipal Code (BMC) Section 38.23.060.A states: Where determined to be necessary, public and/or private easements shall be provided for private and public utilities, drainage, vehicular or pedestrian access, etc.
- The applicant must execute and deliver all required easements to the City prior to site plan approval.

- The applicant must execute easements on City standard forms. The easements proposed in the application were not the City standard forms.
 - The applicant must provide an easement for the access to the Cottonwood Corner Apartments prior to site plan approval.
8. BMC Section 38.23.090 states: All developments shall be planned, designed, constructed and maintained so as to minimize risk of *fire* and to permit the effective and efficient suppression of fires in order to protect persons and property. **The applicant's drawings indicate fire lane red curb paint. However, the applicant must also install "fire lane no parking" signs at all fire lanes. The applicant must indicate this requirement on the plans prior to site plan approval.**
9. BMC Section 38.23.180 states: the transfer of water rights or the payment of cash-in-lieu (CIL) of water rights shall be provided. **The applicant must contact the City Engineering Department (Brian Heaston) for an analysis of CIL of water rights and pay any CIL of water rights due prior to site plan approval.**
10. (BMC) Section 38.25.020.M states: Snow removal storage areas shall be provided sufficient to store snow accumulation on site. Such areas shall not cause unsafe ingress/egress to the parking areas, shall not cause snow to be deposited on public rights-of-way, shall not include areas provided for required parking access and spaces, and shall not be placed in such a manner as to damage landscaping. **On-site snow storage is inadequate. Adequate snow storage areas must be designated outside the sight triangles but on the subject property.**
11. Bozeman Municipal Code (BMC) Section 38.23.030.A states: The developer shall install complete drainage facilities in accordance with the requirements of the state department of environmental quality and the city, and shall conform to any applicable facilities plan and the terms of any approved site specific stormwater control plan. The city's requirements are contained in the design standards and specifications policy and the city modifications to state public works standard specifications, and by this reference these standards are incorporated into and made a part of these regulations.
- **The developer proposed that the City maintain underground perforated storm drain pipe in the Stafford Avenue boulevard and in the proposed park. The City does not maintain detention or retention systems for private development. Retention systems must be maintained by the property owner. Additionally, the proposed retention system is not maintainable as the proposed perforated pipe will clog, and there isn't a clear maintenance mechanism to maintain the proposed perforated pipe. The City will consider a low impact development (LID) stormwater solution in the local street boulevards that is maintainable. The applicant is advised to contact the City Stormwater Division (Kyle Mehrens) to discuss possible LID solutions. The applicant must adjust the application materials to demonstrate a viable stormwater solution prior to site plan approval. The applicant must also obtain a utility occupancy permit from the**

City Engineering Department for placement of the proposed retention facilities in City public street and park easements as a condition of approval. The applicant must also adjust the stormwater maintenance plan to include maintenance of any LID solutions by the property owner.

- The applicant is proposing to eliminate an existing detention facility on the southwest corner of the site that accommodates runoff from Fallon Street and the Ferguson Farm Subdivision south of Fallon Street. The applicant must accommodate the offsite runoff in the on-site detention or retention and conveyance system. The applicant must provide runoff and detention or retention calculations that demonstrate how the runoff to the pre-existing detention facility will be accommodated. Additionally, the applicant is proposing to eliminate an existing inlet and PVC storm drain that routes flow to the pre-existing detention facility on the project site. That inlet and storm drain may not be eliminated and may only be relocated to another detention or retention facility or conveyance on site. The applicant must demonstrate how the existing stormwater detention and conveyance facilities will be accommodated prior to site plan approval.
- The applicant must provide calculations demonstrating the retention volume and infiltration rate to accommodate stormwater runoff for each "Watershed."
- The stormwater calculations indicate no volume of storage is provided for Watershed 6 (Offsite) runoff. However, runoff from Watershed 6 must be accommodated on-site. The applicant must demonstrate this prior to site plan approval.
- The stormwater calculations indicate storage less than required for Watershed 9. The applicant must demonstrate adequate storage for Watershed 9 prior to site plan approval.
- The applicant must demonstrate stormwater detention or retention storage volume above the seasonal high groundwater level (SHGWL). Storage volume located below the SHGWL may not be included in the storage volume to meet detention or retention volume requirements. The applicant must reasonably demonstrate the SHGWL prior to site plan approval.

12. BMC 38.39.030.C states requirements for completion of improvements.

- All off-site infrastructure improvements must be complete prior to site plan approval unless a master site plan application is submitted and approved per the infrastructure phasing requirements defined in this letter.
- All on-site infrastructure improvements must be complete prior to receiving occupancy permits for any buildings beginning with Phase I unless a master site plan application is submitted and approved per the infrastructure phasing requirements defined in this letter.

Conditions of Approval

1. The applicant must contact the City Engineering Department (Bill Stezner) and the City Fire Department (Trisha Wolford) and develop an addressing plan approved by the City prior to site plan

approval. Additionally, Stafford Avenue must be called South Stafford Avenue to accommodate the “zero” block numbering line located on Babcock Street. The applicant must reflect this on the drawings prior to site plan approval.

2. The proposed development falls within a known area of high groundwater. No crawl spaces or basements may be constructed such that sump pumps are required to pump water from these spaces. Sump pumps are not allowed to be connected to the sanitary sewer system. Sump pumps are also not allowed to be connected to the drainage system unless capacity is designed into the drainage system to accept the pumped water. Water from sump pumps may not be discharged onto streets, such as into the curb and gutters where they may create a safety hazard for pedestrians and vehicles.
3. If not already filed with the subdivision, the applicant must provide and file with the County Clerk and Recorder's office executed Waivers of Right to Protest Creation of Special Improvement Districts (SID's) for the following:
 - a. Street improvements to W. Babcock Street including paving, curb/gutter, sidewalk, and storm drainage
 - b. Street improvements to S. Cottonwood Road including paving, curb/gutter, sidewalk, and storm drainage
 - c. Street improvements to Fallon Street including paving, curb/gutter, sidewalk, and storm drainage
 - d. Street improvements to S. Ferguson Avenue including paving, curb/gutter, sidewalk, and storm drainage
 - e. Intersection improvements to Babcock Street and Cottonwood Road
 - f. Intersection improvements to Cottonwood Road and Fallon Street
 - g. Intersection improvements to Cottonwood Road and Huffine Lane
 - h. Intersection improvements to Ferguson Avenue and Babcock Street
 - i. Intersection improvements to Fallon Street and Ferguson Avenue.

The document filed must specify that in the event an SID is not utilized for the completion of these improvements, the developer agrees to participate in an alternate financing method for the completion of said improvements on a fair share, proportionate basis as determined by square footage of property, taxable valuation of the property, traffic contribution from the development, or a combination thereof. The applicant must provide a copy of the filed SID waiver prior to site plan approval.

Advisory Comments

1. The applicant must contact the Gallatin County Conservation District, Montana Department of Environmental Quality, and U.S. Army Corps of Engineers regarding the proposed project and any required permits (i.e., 310, 404, Turbidity exemption, etc.) must be obtained by the applicant.
2. The applicant must submit plans and specifications for water and sewer main extensions, streets, and storm water improvements, prepared and signed by a professional engineer (PE) registered in the State of Montana, which must be provided to and approved by the City Engineer. Water and sewer plans must also be approved by the Montana Department of Environmental Quality. The applicant must also provide professional engineering services for construction inspection, post-construction certification, and preparation of mylar record drawings. Construction shall not be initiated on the public infrastructure improvements until the plans and specifications have been approved and a preconstruction conference has been conducted.

Building permits will not be issued prior to City acceptance of the site infrastructure improvements unless all provisions set forth in Section 38.39.030.C of the Bozeman Municipal Code are met to allow for concurrent construction.

3. This site plan review does not represent an infrastructure design review. Additional items may be identified upon submittal of infrastructure plans and specifications to the City Engineering Department.
4. The applicant must prepare plans and specifications for any fire service line in accordance with the City's Fire Service Line Policy. The plans must be prepared by a Professional Engineer and be provided to and approved by the City Engineer prior to initiation of construction of the fire service or fire protection system. The applicant must also provide Professional Engineering services for construction inspection, post-construction certification and preparation of mylar record drawings. Fire service plans, and domestic services 4" or larger, must be a standalone submittal, separate from the site plan submittal. City of Bozeman applications for service must be completed by the applicant.

Building Division; Bob Risk brisk@bozeman.net 406-582-2377

Parks and Recreation; Carolyn Poissant; cpoissant@bozeman.net 406-582-2908

Sustainability Division; Natalie Meyer nmeyer@bozeman.net 406-582-2317

Solid Waste Division; Kevin Handelin khandelin@bozeman.net 406-582-3238

Water Conservation; Jessica Ahlstrom jahlstrom@bozeman.net 406-582-2265

Stormwater Division; Kyle Mehrens jkmehrens@bozeman.net 406-582-2270

Monday, February 26, 2018

Fire Department; Trisha Wolford twolford@bozeman.net **406-582-2353**

Water and Sewer Division; John Alston jalston@bozeman.net **406-582-3200**

Forestry Division; Alex Nordquest; anordquest@bozeman.net **406-582-3205**

NorthWestern Energy; Dustin Workman; dustin.workman@northwestern.com

Note: The comments and advice contained in this DRC and Staff letter are intended to assist the applicant in preparing the development application based on the limited information submitted as part of the informal plan submittal. However, further comments and/or recommendations on matters not discussed during the informal plan review may arise based on the information and supplemental data provided with the formal application and applicable comments provided by local and state agencies.

**DESIGN STANDARDS
AND
SPECIFICATIONS POLICY**

CITY OF BOZEMAN, MONTANA



CITY ENGINEERING DIVISION

MARCH 2004

ADOPTED: April 5, 2004, Ordinance 1611

Including: Addendum No. 1 approved 7/19/05
Addendum No. 2 approved 6/28/06
Addendum No. 3 approved 2/20/08
Addendum No. 4 approved 3/31/11
Addendum No. 5 approved 8/26/13
Addendum No. 6 approved 5/1/17

CITY OF BOZEMAN
DESIGN STANDARDS AND SPECIFICATIONS POLICY

Prepared by

City Engineering Department

March 2004

Revised: 7/19/05; 6/28/06; 2/20/08; 3/31/11; 8/26/13; 5/1/17

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FOREWORD

This document has been prepared to assist design engineers, architects, developers, contractors, or other interested individuals with the preparation of plans and specifications for public infrastructure improvements so that they will meet the requirements of the City of Bozeman (COB). The requirements specified herein have been established through the subdivision regulations, municipal code, or City policies.

It is the intent of the COB to revise this document on an as-needed basis as regulations and policies are modified. Written comments on this "Design Standards and Specifications Policy" are encouraged and may be submitted to the City Engineer.

If any portion of this document is found to conflict with the Bozeman Municipal Code (BMC), the provisions of the BMC shall supersede this Guide.

Abbreviations Used

AASHTO - American Association of State Highway and Transportation Officials
ADA - Americans with Disabilities Act
ASTM - American Society for Testing and Materials
AWWA - American Water Works Association
BMC - Bozeman Municipal Code
BUDO – Bozeman Unified Development Ordinance
COB - City of Bozeman
DEQ - Department of Environmental Quality
ESAL - Equivalent Single Axle Load
FSP - Final Site Plan
MPWSS - Montana Public Works Standard Specifications
MUTCD - Manual of Uniform Traffic Control Devices
PUD - Planned Unit Development
RCP - Reinforced Concrete Pipe
WQB - Water Quality Bureau

CITY OF BOZEMAN
PLANS AND SPECIFICATIONS REVIEW POLICY

A. Standard Process

1. Initial submittal of plans and specifications, and all subsequent correspondence and submittals for public infrastructure improvements including, but not limited to, sanitary sewer and water mains, storm sewer mains, street and transportation improvements, are to be made to the City Engineer's Office, 20 E. Olive Street, P.O. Box 1230, Bozeman, Montana, 59771-1230. Prior to submission of infrastructure plans and specifications, project approval (preliminary plat, Planned Unit Developments (PUD's), and in some cases Final Site Plans (FSP's)) from the City Commission must be obtained.
2. The minimum number of complete sets of plans and specifications which must be submitted for each review are as follows:

<u>Type of Project</u>	<u>Number*</u>	<u>Reviewers</u>
Water and Sewer Main Extensions	4 Sets	Eng., W/S
Fire Service Lines	2 Sets	Eng., W/S
Streets and/or Storm Sewers	4 Sets	Eng., W/S, ST
Water & Sewer Mains with Streets and/or Storm Sewers	4 Sets	Eng., W/S, ST

Eng. = Engineering Department

W/S = Water and Sewer Department

ST = Street Department

* See Paragraph 8 below

3. The COB shall attempt to complete the initial review and provide written comments to the Engineer/Owner within thirty (30) calendar days of receiving the initial submittal. A review meeting may be scheduled with the design Engineer and City representatives to discuss review comments if the design Engineer desires. Pre-design and interim meetings with the design Engineer and City Engineering staff are encouraged.

4. To expedite the review process each submittal of revised plans and specifications shall be accompanied by a written response from the Design Engineer which addresses each item in the COB review comment letter. The revised documents will be distributed and reviewed as described above in item 2. Generally, "red-lined" copies of the plans and specifications will be provided to the Design Engineer to facilitate revisions of the documents. Red-lines must be returned with each subsequent re-submittal.
5. The COB shall attempt to complete each review of revised plans and specifications within fourteen (14) calendar days of receiving the revisions. A review comment letter may be mailed to the Engineer/Owner at the completion of each review.
6. All COB review comments must be adequately addressed and resolved before the final plans and specifications are approved by the City Engineer for construction.
7. The plans and specifications for water or sewer projects will not be considered for approval by the City Engineer without written approval of the final plans and specifications from the Superintendent of Water and Sewer or his designated representative.
8. Once all COB review comments have been adequately addressed and resolved the City Engineer must be supplied with four (4) complete sets of the final plans and specifications, signed and stamped by a Professional Engineer licensed in the State of Montana, and one half-size set of plans. Specification manuals are to be bound and contain the most current version of the revised documents and plan sheets are to be the most current version. The four (4) final full-size sets and one ½ size set of plans and specifications submitted for City approval will be reviewed by the City Engineer to ensure that all requested modifications are included. An electronic version of the approved plans shall also be provided in either Autocad or PDF format.
9. For projects subject to Department of Environmental Quality (DEQ) review and approval, a copy of the project approval letter from DEQ must be submitted to the City Engineer prior to the preconstruction meeting.
10. The City Engineer will either approve or disapprove the submitted documents. An approval or disapproval letter will be sent to the Engineer/Owner.
11. Final stamped and approved plans and specifications will be distributed as follows:
 - a. One set returned to the Engineer/Owner.
 - b. One set and ½ size set to the COB Water/Sewer Department.
 - c. One set for the COB Engineering Department.
 - d. One set for the COB Engineering Department Field Inspector.
12. No work is to begin on the project prior to obtaining the COB's and DEQ's written approval of the plans and specifications, and the completion of a preconstruction meeting conducted by the Owner's Engineer and attended by the Contractor(s) and COB

representative(s). A "Pre-construction Meeting Checklist" will typically be included with the approval letter specifying additional documents which must be submitted prior to scheduling a pre-construction meeting.

B. Self-certification Process

1. Introduction/Intent

- A. Plans and specifications submitted using this process will not be reviewed in detail by the City Engineering Department. **Fire service lines and domestic service lines are specifically excluded from this process.** The City's existing review process will remain in place, and will be used unless the submittal conforms with the self-certification process and is accompanied by a completed self-certification Checklist.
- B. The intention of this policy is that plans and specifications stamped and signed by a Professional Engineer registered in the State of Montana, submitted in conformance with this policy, and accompanied by the required checklists and certifications, will be acceptable to the City.
- C. The following are specifically excluded from the self-certification process: force mains, lift stations, booster stations, pressure reducing valves, and traffic signals.

2 Applicable Standards

All infrastructure projects shall comply with the following design standards in order of precedence:

- A. COB Design Standards and Specifications Policy
- B. COB Modifications to Montana Public Works Standard Specifications (MPWSS)
- C. Bozeman Unified Development Ordinance
- D. DEQ Circulars 1 and 2
- E. City Adopted MPWSS and Adopted Addenda

The most recently adopted versions of the City Water and Wastewater Facilities Plans shall govern sewer and water trunk main design and sizing. The Storm Water Master Plan and Transportation Plan shall govern their respective service area issues.

3. Submittal Requirements

Prior to submission of infrastructure plans and specifications, project approval (preliminary plat, Planned Unit Developments (PUD's), and in some cases Final Site Plans (FSP's)) from the City

Commission must be obtained.

The following shall be submitted to the City Engineering Department and approved by the Public Service Department (through the City Engineer):

Prior to Plan and Specification Submittal;

- A. Water and Sewer Utilities Design Report as detailed in the project conditions of approval. Subsequent to receipt and approval of this report, the City will issue a water/sewer capacity letter if warranted.
- B. Pavement Design Report and Traffic Impact Analysis (if required).
- C. Stormwater Facilities Design Report.
- D. A schematic signage plan for the subdivision, noting any proposed traffic calming measures.

With plans and specifications;

- E. Four (4) sets of plans and specifications (24" x 36" sheets only) stamped and signed by a P.E., registered in the State of Montana, one ½ size set of plans, and an electronic version of the plans in either Autocad or PDF format.
- F. A completed and signed COB Plan and Specification Checklist.
- G. Any easements which may be required. Easements must be properly executed.

4. City Review and Disposition

- A. Upon receipt of the plans and specifications and checklist, one complete set will be sent to the City Water/Sewer Superintendent and one set to the City Street Superintendent.
- B. Upon review and approval of the Checklist, Plans, and Specifications, the City Engineering Department will provide the engineer with a letter of approval and one set of plans and specifications stamped "Approved For One Year From This Date".
- C. *Estimated* time frames for City approval:

<i>With Deviations requested on City Checklist</i>	<i>2 weeks; this is a guideline only</i>
--	--

<i>Without Deviations or with pre-approved variance</i>	<i>1 week</i>
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- D. No construction may begin prior to a pre-construction meeting which must be

- attended by the applicant's engineer, the contractor and the City. All preconstruction meeting requirements currently in place will remain in place.
- E. Any changes to the approved plans must be reviewed and approved by the City Engineering Department and the Water/Sewer Superintendent.

5. Project Audits

A. The intent of the self certification process is to place upon the design engineer the sole and significant burden and expectation that Public infrastructure plans and work completed within Bozeman fully comply with the City's infrastructure standards and requirements. The process necessitates a high degree of trust by the City and certainty by the design engineer that the plans and specifications fully meet the City's requirements.

B. Deficiencies in plans which are discovered during project construction are inherently much more costly to the project schedule and budget than design deficiencies or issues resolved and addressed prior to construction. Subsequent to the City's approval of self certified plans and specifications, selected project plans will undergo audit review to assure compliance. Deficiencies discovered during the audit review or during construction may require revised plans to be submitted and approved, and may further require untimely and expensive correction or replacement of noncompliant work installed on the project. Project design self certification falsely or indiscriminately provided may be referred to the Montana Board of Professional Licensing.

C. Project engineers with a history of design deficiencies or whose track record demonstrates repeated problems in their ability to design and complete projects adequately meeting the City's design standards will be more frequently audited, and may be prohibited from utilizing the self-certification process until adequate proficiency is demonstrated. As such, engineers are strongly encouraged to work closely with the City's engineering, field and operations staff throughout the pre-design, design and construction phases of a project. Engineers without adequate experience with the City's design and infrastructure standards and who have not previously successfully completed infrastructure projects within the City are advised to utilize the City's full design review process in lieu of the self certification process.

C. CONSTRUCTION COORDINATION

1. Pre-construction Meeting

Following approval of infrastructure plans and specifications, the Engineer shall schedule a pre-construction meeting with the City of Bozeman, Contractor(s), and if applicable, other affected utilities or governmental agencies. A "Preconstruction Meeting Checklist" will be included with the letter of approval which lists submittals that must be received by the City of Bozeman prior to scheduling a preconstruction meeting.

2. Shop/Fabrication Drawings

Any required shop/fabrication drawings shall be submitted by the Contractor to the Engineer. Upon approval, the Engineer shall submit four sets of the shop/fabrication drawings to the City Engineer a minimum of two days prior to the preconstruction meeting.

3. Bonding

All new infrastructure that will be publicly maintained shall be bonded. Prior to initiation of construction, copies of the Contractor's Performance and Payment Bonds, each in an amount equal to 100% of the contract amount, in favor of the Owner, shall be filed with the Owner and the City of Bozeman. Prior to acceptance of the publicly maintained infrastructure, the Contractor shall post a Maintenance Bond with the Owner equal to 20% of the actual cost of the improvements to correct any deficiencies in workmanship and/or materials which are found within the two-year warranty period. The City of Bozeman shall be named as a dual obligee on the bond. The City of Bozeman expressly reserves the right to draft the Maintenance Bond for repairs not completed by the Property Owner, Developer, or Contractor within thirty calendar days of being advised that repairs are required. The Commencement Date for the Maintenance Bond shall be the date of acceptance by the City of Bozeman on the Certificate of Completion and Acceptance. The Maintenance Bond shall remain in full force for the two-year period following this date, however if the expiration date of the Maintenance Bond falls after November 16, the expiration date of the Maintenance Bond shall be June 30 of the following year. Maintenance Bonds may be in the form of a Surety Bond or a Certified Check.

4. Engineer's Status/Responsibility During Construction

The Engineer will furnish a qualified Resident Project Representative (RPR) and other field staff to assist the Engineer in observing the performance of the work. The RPR will act as directed by and under the supervision of the Engineer, and will confer with the Engineer regarding the RPR's actions. The RPR shall not authorize any deviation from the approved plans and specifications or substitution of materials or equipment, unless authorized by the Engineer.

Duties of RPR. The RPR and/or other field staff of the Engineer will:

- Conduct extensive on-site observations of the work in progress and field checks of materials and equipment to provide protection against defects and deficiencies in the work of the Contractor.
- Perform construction observation, documentation, and required testing of all critical construction work including, but not limited to: all underground or buried work including placement and connection of utility lines and appurtenances, trench backfill and compaction, placement of geotextile fabric membranes, placement of fill or embankments; placement of curb and gutter and other surface drainage improvements; placement of pavement base and surface courses; and placement of sidewalks.
- Advise the Engineer and Contractor of the commencement of any work requiring Shop Drawings or sample if the submittal has not been approved by the

Engineer.

- Report to the Engineer whenever RPR believes that any work is unsatisfactory, faulty, or defective or does not conform to the approved plans and specifications, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made.
- Advise the Engineer of work that the RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection, or approval.
- Verify that all tests are conducted in the presence of appropriate personnel, and observe, record and report to the Engineer appropriate details relative to testing procedures.
- Accompany visiting inspectors representing the City of Bozeman or other public agencies having jurisdiction over the project.
- Maintain at the job site orderly files for correspondence, reports of job conferences, Shop Drawings and samples, reproductions of original Contract Documents including all Work Directive Changes, Addenda, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the contract or beginning of work, Engineer's clarifications and interpretations of the Contract Documents, and other Project related documents.
- Keep a detailed and accurate diary or log book, recording Contractor hours on the job site, weather conditions, prime and subcontractor daily work force, daily log of equipment onsite or standby, data relative to questions of Work Directive Changes, Change Orders, or changed conditions, list of job site visitors, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures.
- Furnish Engineer with periodic reports of progress of the work.
- Furnish Engineer and Contractor a list of observed items requiring completion or correction before Engineer may issue a Certificate of Substantial Completion, assess completion or correction of said items, advising Engineer on their status, and make recommendation to Engineer regarding issuance of a Certificate of Substantial Completion.
- Conduct final inspection of the project in the company of Engineer, Owner, Contractor, and City of Bozeman, and prepare final list of items to be completed or corrected.
- Verify that all items on final list have been completed or corrected and make recommendations to Engineer concerning final acceptance.

Duties of Engineer: The Engineer will:

- Issue written clarifications or interpretations of the requirements of the Contract Documents (i.e. plans and specifications).
- Disapprove or reject work which Engineer believes to be defective, and require special inspection or testing of the work whether or not the work is fabricated, installed, or completed.
- Review Shop Drawings and samples for compliance with the Contract Documents.

- Review proposed changes in work and submit such changes to the City of Bozeman or other public agencies having jurisdiction for review.
- Issue Certificate of Substantial Completion and Certificate of Completion and Acceptance.

5. Testing and Documentation Requirements for Infrastructure Improvements

In order to better document the inspection and certification of public infrastructure improvements, the City Engineering Division shall require the following information for all projects approved for construction. This documentation shall be required prior to final acceptance of sanitary sewer, water main, storm drain, Portland cement concrete, and bituminous pavement improvements within City right-of-way or easements.

THE FOLLOWING DOCUMENTATION SHALL BE REQUIRED ON ALL PROJECTS APPROVED BY THE CITY ENGINEERING DIVISION:

- A. The Engineer shall submit a letter to the City certifying that the public improvements (i.e. sanitary sewers, water mains, drainage structures and streets) were installed in accordance with the approved plans and specifications and shall be accompanied by Record Drawings for the project.
- B. Dates of acceptable tests for sanitary sewer, which shall include TV inspection by the City of Bozeman, cleaning, exfiltration by air or water, and manhole testing, shall be included in the certification letter. This information shall be required for all public sewer main extensions.
- C. Dates of acceptable tests for water mains, which shall include hydrostatic and leakage testing, bacteriological testing, and continuity testing shall be included in the certification letter. This information shall be required for all public water main extensions.
- D. Benchmark elevations shall be established for all new hydrants on the project. Benchmarks shall be set on the hydrant bonnet bolt closest to the point of the operating arrow on Mueller hydrants and on the bury depth tag on Waterous hydrants. Said elevations shall be certified by either a P.E. or L.S. registered in the state of Montana. Elevations shall also be provided for the top of the water main at 50' intervals. The datum used as the basis for the elevations shall be clearly identified.
- E. Verification that all thrust blocking was installed in accordance with the approved plans and specifications shall be included in the certification letter. If mechanical restraints are used in lieu of thrust blocks, verification that the restrained length as installed meets or exceeds the manufacturers recommendations shall be included.
- F. An accurate record of the location of all sanitary sewer service connections as installed, and the length and slope of all service lines installed must be provided

by the Engineer. Elevations at the end of dry service line stub-ins is required. Sanitary sewer service connections shall be tied to manholes. This information shall be required for all public sewer main extensions and service connections to existing mains.

- G. The Engineer shall furnish documentation of tests in accordance with methods prescribed by AASHTO for theoretical maximum density, optimum moisture content, and sieve analysis for the sub-base course, crushed base course, pit run, and native backfill and subgrade material within the right-of-way. This information shall be required for all public sewer main, water main, storm drain and street extensions.
- H. The Engineer shall furnish documentation of in-place field density tests. In-place density tests for trenches and embankments shall, as a minimum, be required for the first lift of backfill to set a pattern of compaction, shall be provided daily, and as backfill material changes. In-place density tests for roadways shall, as a minimum, be required at intervals of 50 feet. Tests for roadways shall be provided for subgrade, sub-base course and/or pit run, and crushed base course materials. A minimum of the top 6 inches of subgrade which are to be paved or covered with curb, gutter, or sidewalk, shall be field density tested. All trench backfill material in improved areas and all embankments shall be compacted for the full depth and shall be compacted to 95% of the theoretical maximum proctor density as determined by AASHTO-T-99. This information shall be required for all public sewer main, water main, storm drain, and street extensions.
- I. The Engineer shall furnish a dated job-mix formula for hot plant mix bituminous pavement which conforms to the procedures of the Asphalt Institute's MS-2 manual. The job mix formula shall be no older than one year, and shall have the same aggregate and asphalt sources and grades as the mix used for the public improvements. The Engineer shall furnish certified results of a Marshall Test showing the bulk specific gravity determination, stability and flow data, and density and void analysis. The engineer shall furnish a minimum of one "field Marshall Test" per 2000 tons of mixture placed to check for variations from the job-mix formula. In addition, test results of ASTM D 1075 for the effect of water on cohesion of compacted bituminous material shall be provided by the Engineer. This information shall be required for all public street extensions.
- J. The Engineer shall furnish asphalt core samples for bituminous pavement in the public right-of-way. Four core sample shall be required for every 1000 tons of mixture placed, with a minimum of three samples for projects that use less than 1000 tons. The location of the core samples shall be determined on a random basis using a system of random numbers, so that each ton of material has the same probability of being selected. For random locations falling near the pavement joints, obtain the core as close to the location as possible without having any part of the core circumference coming closer than 12 inches to the pavement edge or

joint. The Engineer may take additional core samples at locations where he/she has, based on observations of the paving process and/or the results of nuclear density tests, reasonable belief that the in-place material is unsatisfactory. The Engineer shall submit the sampling plan to the City Engineer upon completion of the paving, prior to taking cores. (An example for one method of determining random sample locations is included in the appendix of these Design Standards). The Engineer shall provide a certified laboratory report from the samples taken as to thickness and actual density. Testing laboratories shall meet the requirements of ASTM D3666 (Evaluating and Qualifying Agencies Testing and Inspecting Bituminous Paving Materials). The engineer shall certify that the core holes have been patched with hot plant mix asphalt. This information shall be required for all public street extensions.

- K. The Engineer shall furnish Portland cement concrete tests for concrete placed in the public right-of-way and concrete incorporated into public infrastructure improvements. One set of tests shall be required for every 50 cubic yards of concrete placed with a minimum of one set of tests per project. The concrete shall be sampled, specimens made, and compliance determined in accordance with the following:

Sampling Fresh Concrete	ASTM C-172
Slump	ASTM C-143 or AASHTO T119
Air Content	ASTM C-231 or C-173 or C-138 or AASHTO T152
Compressive Strength	ASTM C-39 or AASHTO T22
Making and Curing Test	ASTM C-31 or AASHTO T23
Specimens in the Field	

Sampling and testing shall be done by persons that are currently certified as ACI Concrete Field Testing Technicians, Grade 1. This information shall be required for all public street extensions.

6. Pre-Paving Inspection

The Engineer shall conduct a pre-paving inspection for any projects that have paved streets as part of the improvements. The Contractor and a representative from the City shall attend the inspection.

7. Acceptance/Correction of Deficient Pavement Improvements

Acceptance tests shall be evaluated by the Engineer for conformance with the specifications. Any results that indicate the in-place material does not conform with the specifications shall be immediately reported to the City Engineer, along with a recommendation of corrective action to bring the material into compliance with the specifications. The City Engineer shall determine what corrective action is necessary in order for the improvements to be accepted by the City of Bozeman. Corrective action may include total removal and replacement of the deficient

material, partial removal and replacement, placing additional material, or in lieu of corrective action, payment of a penalty to the City of Bozeman in certain instances.

A. Portland Cement Concrete

If an individual strength test (average of two cylinders tested at 28 days) falls below the specified strength by more than 500 psi, the in-place material represented by the failed test shall immediately be randomly cored for acceptance testing. A minimum of three and maximum of six cores shall be taken. If the average strength tests of the acceptance cores are deficient in strength by more than 500 psi but not more than 1000 psi, the Contractor shall remove and replace the deficient concrete or pay the City of Bozeman 0.25 times the unit price bid times the area determined to be deficient in strength; if the average strength tests are deficient by more than 1000 psi, the area of the concrete determined to be deficient shall be removed and replaced.

B. Asphaltic Concrete Pavement

The asphaltic concrete pavement shall be tested and evaluated for acceptance on a lot basis, with one lot being 1000 tons of material.

1. Thickness. If the average thickness of the pavement cores is more than $\frac{1}{4}$ " below the plan thickness, or if any one individual core is more than $\frac{1}{2}$ " below the plan thickness, corrective action or payment of a penalty will be required.

a. Average Thickness Deficiencies. If the average thickness deficiency is between $\frac{1}{4}$ " and $\frac{1}{2}$ ", corrective action such as placement of additional material (i.e. overlay or chip seal), as determined by the City Engineer, will be required. In lieu of placing additional material, the City Engineer may allow the payment of a penalty to the City of Bozeman in the amount of 0.25 times the unit price bid of the asphalt pavement times the amount of pavement determined to be deficient. If the average thickness deficiency is more than $\frac{1}{2}$ ", an overlay will be required, along with cold milling of the existing pavement to provide for a minimum overlay thickness of 1.5".

b. Individual Core Thickness Deficiency. If any one core thickness is determined to be more than $\frac{1}{2}$ " below plan thickness, additional cores shall be taken at 10 foot intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which is not deficient by more than $\frac{1}{4}$ ", in order to determine the extent of the deficient pavement. If the thickness deficiency is more than $\frac{3}{4}$ ", the area that is deficient shall be removed from pavement edge to pavement edge and replaced to bring the non-complying areas to planned thickness. If the thickness deficiency is not more than $\frac{3}{4}$ ", the deficient area will either be removed and replaced to the planned thickness, or a penalty will be paid to the City of Bozeman in the amount of 1.5 times the unit price bid times the amount of pavement that is deficient in thickness.

2. Density. The average density of the pavement cores shall equal or exceed 93% of the maximum density as determined by ASTM D2041 (Rice's density). If the average density is less than 93% but more than 90.9%, the pavement that has

deficient compaction shall be milled and overlaid (1.5" minimum depth), or a penalty in the amount of 0.10 times the unit price bid for the pavement material times the amount of pavement that has deficient compaction shall be paid to the City of Bozeman. If the average density is 90.9% or less, the pavement area affected will be removed and replaced or overlaid as determined by the City Engineer. If any one core is determined to have a density of less than 86%, additional cores shall be taken at 10 foot intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which has a density of at least 91%. The area that is determined to have deficient compaction shall be removed from pavement edge to pavement edge and replaced, or a penalty will be paid to the City of Bozeman in the amount of 1.5 times the unit price bid times the amount of pavement that is deficient in density.

C. Unit Prices

If unit prices for the project are unavailable, unit prices shall be as determined from time to time by the City Engineer for the various items of work.

8. Project Close-out and Acceptance

Upon completion of the work, the following documentation shall be submitted to the City Engineer:

- A. An executed "Certificate of Completion and Acceptance" (included in the Appendix of this Policy).
- B. Project Inspection Diary and Testing Records.
- C. Certified Checklist for Testing and Documentation Requirements.

Within 90-days of project completion, the Engineer shall sign and submit record drawings to the City Engineer. The drawings shall be full-size and consist of one reproducible set, two blueprint sets, and one digital (Autocad) copy.

Failure to provide all of the necessary close-out documentation within the 90-day period may result in delaying approval for future projects submitted by the Engineer until such time as the necessary documents are provided.

9. Two-Year Warranty Inspection

The Project Engineer, or his designated representative, shall conduct a two-year warranty inspection to be attended by a least one representative from the Public Works Department. The inspection shall take place not less than seventy-five (75) or more than one hundred and twenty (120) days prior to the expiration date of the Maintenance Bond. The Maintenance Bond will be released when all deficiencies have been corrected to the satisfaction of the City Engineer.

The City Engineer, the Project Engineer, or the designated representative shall notify the Principal and Bonding Company as listed in the Maintenance Bond of any work found to be deficient. The Principal shall restore the work to meet the requirements of the approved construction documents prior to release of the Maintenance Bond. The City of Bozeman expressly reserves the right to draft the Maintenance Bond for repairs not completed by the Owner, Developer, or Contractor within thirty calendar days of being advised that repairs are required.

DESIGN STANDARDS AND SPECIFICATIONS

I. CONSTRUCTION PLANS AND SPECIFICATIONS REQUIREMENTS

A. GENERAL REQUIREMENTS

1. Any required design reports must be submitted and approved prior to submittal of plans and specifications when the self-certification process is utilized. If the standard review process is utilized, design reports may be submitted prior to or along with submittal of the plans and specifications.
2. Project plans and specifications will not be accepted until the project has been approved by the City of Bozeman.
3. All project infrastructure plans must be submitted at the same time. Separate approval of infrastructure elements may be provided if necessary.
4. Where existing infrastructure is being extended, existing material, size, elevation, horizontal alignment, and grade shall be field verified, and all critical utility crossings shall be field verified, prior to plan and specification submittal.
5. All full-sized plans shall be on 24-inch by 36-inch plan sheets or 22-inch by 34-inch plan sheets. Reduced scale plans may be submitted for review if approved by the City Engineer, but all plans for final approval (excepting the one required 1/2 size set) and all record drawings shall be full-sized. All plans submitted for review and approval will be stamped, signed, and dated by a professional engineer licensed in the State of Montana.
6. Separate plans shall be submitted for water facilities and sanitary sewer facilities. Plans for storm sewer facilities may be included with plans for street facilities.
7. All plans will have both plan and profile views of the proposed improvements. A general location map shall be provided showing the relationship of each page to the overall development.
8. Project datum and benchmarks shall be clearly identified on the plans.
9. English units are required.

B. SPECIFICATIONS REQUIREMENTS

1. The City of Bozeman has adopted “Montana Public Works Standard Specifications” (MPWSS) as the standard specifications for new construction. A separate document, “City of Bozeman Modifications to MPWSS” has been adopted which supplements and supercedes MPWSS. All project manuals must incorporate, preferably by reference, MPWSS (latest adopted edition) and the “City of Bozeman Modifications to MPWSS”, including any addenda.
2. Additions or changes to the above standard specifications must be done through Special Provisions or similar supplemental sections in the project manual.

C. DRAWING SCALES

The following scales are required. Other scales will be considered on a case by case basis if all information can be clearly shown.

1. Plan View: 1" = 50'
2. Profile View, Horizontal: 1" = 50' (or match plan view scale)
Profile View, Vertical: 1" = 5'
3. Stationing interval: 100 feet or 50 feet

D. PLAN REQUIREMENTS

The following items will be required on all plans. Existing features should be shown dashed or with a lighter shading than proposed new features. All construction will be tied to the centerline of a City right-of-way, to the centerline of a City easement, to a platted property line, or to section lines.

1. Plan View
 - North Arrow.
 - Legend of Symbols.
 - Property lines and ownership or subdivision information.
 - Street names and easements with width dimensions.
 - Project Stationing.
 - Limits of existing paved or graveled surfaces.
 - Monument boxes.
 - Culverts.
- Existing and proposed utilities and structures, including:
Line size and material where appropriate;

Water lines (main lines and service lines), valves, and hydrants;
Sanitary sewer lines (main lines and service lines) and manholes;
Storm sewer lines, manholes, and inlets;
Gas lines;
Electric lines, poles, transformers;
Telephone lines, manholes, junction boxes;
Cable T.V. lines, junction boxes;
Irrigation ditches and structures;
Irrigation systems;
Fiber optic lines, manholes, junction boxes;
Street lights;
Proposed method of restoration of all areas disturbed during construction.

2. Profile View

- Vertical and horizontal grids to scales.
- Final grade (solid).
- Existing grade (dashed).
- Existing utility lines where crossed.
- Project Stationing
- Utility crossings

E. UTILITY PLAN REQUIREMENTS

1. The following general notes must appear on all plan sets:

- a. All construction will conform to MPWSS, (Latest) Edition, and COB Modifications to MPWSS.
- b. Any existing or new valves which control the COB's water supply shall be operated by COB personnel only.
- c. The Contractor shall notify the Water Department a minimum of 24-hours prior to beginning any work.
- d. Contractor shall field-verify line and grade of existing connections.

2. Plans for water facilities shall show the following:

- Size, type and structural class of proposed new water line(s), including AWWA specifications.
- Bedding class.
- Type of excavation and backfill.
- Existing water lines including size and material.
- Proposed valves, fittings, fire hydrants, and service lines, with stationing.
- Depth of cover from finish grade to proposed water line(s).

- Requirements for pipe deflection, if necessary.
 - Type of joint restraint, if required.
 - Size of gravity thrust blocks based on calculated design.
 - Existing or proposed pressure reducing valves.
3. Plans for sanitary sewer facilities shall show the following:
 - Size, type, and structural class of proposed new sewer line(s), including American Society for Testing and Materials (ASTM) specifications.
 - Slope of each proposed pipeline segment.
 - Bedding class.
 - Type of excavation and backfill.
 - Existing sewer lines and manholes including size, material, field-verified invert elevations, and field-verified slopes.
 - Proposed manholes with stationing and rim and invert elevations.
 - Existing and proposed sewer service lines with size and stationing.
 - Existing and proposed cleanouts.
 4. Plans for storm sewer facilities shall show the following:
 - Size, type, and structural class of proposed new storm sewer line(s), including ASTM specifications.
 - Slope of each proposed pipeline segment.
 - Bedding class.
 - Type of excavation and backfill.
 - Proposed manholes with stationing and rim and invert elevations.
 - Proposed inlets and inlet service lines with stationing and invert elevations.
 - Points of stormwater discharge.

F. ROADWAY PLAN REQUIREMENTS

1. Plans for streets or roadways shall show the following:
 - Limit of cut or fill.
 - Existing and proposed utilities, including manholes and valves.
 - Proposed new construction, including paving width and limits, curb and gutter, crosspans, sidewalks, and pedestrian ramps.
 - Existing and finished grades, with finished grade slopes.
 - Vertical and horizontal curves, with curve data:
 - Horizontal curves - R, Δ , L, PC and PT Stationing
 - Vertical curves - K, L, Station of PT's
 - Profile of centerline.
 - Profiles of left and right curb lines, if they are not the same.
 - Any required utility adjustments.
 - Existing and proposed signs and pavement markings.
 - Existing and proposed storm drainage facilities, including culverts, pipes, inlets, sidewalk chases, ditches and detention/retention ponds, with

- invert and/or spot elevations.
- Top of curb elevations at P.C.s, P.T.s, and inlets.
- Existing and proposed street monuments.
- Typical roadway section(s), dimensioned and drawn to scale, showing:
 - Right-of-way
 - Backslopes
 - Sidewalks
 - Curb and gutter
 - Pavement thickness
 - Base and sub-base thickness
 - Compaction requirements
 - Cross-slopes

II. DRAINAGE POLICY

A. GENERAL DESIGN CRITERIA

A Stormwater Drainage Plan is required for all new developments. The following criteria shall be used in the design of all Drainage Plans:

1. The stormwater drainage plan shall be designed to limit stormwater runoff from the development site to the pre-development runoff rates. The pre-developed rate calculations shall be included as part of the required facility design calculations. Adequate on-site stormwater detention shall be provided for design storm runoff exceeding the pre-development rate.
2. The stormwater storage and treatment facilities shall be designed to remove solids, silt, oils, grease, and other pollutants. Where required, oil/water separators shall be provided in the facility design.
3. Where the storm drainage plan includes storm sewers they shall meet the following minimum requirements:
 - a. Alignment between manholes shall be straight.
 - b. The sewers shall be uniformly sloped to maintain a minimum velocity of 3-fps at the design storm depth of flow, or when flowing full, to prevent sediment deposits.
 - c. Pond inlet and outlet piping shall be protected and designed to prevent erosion (i.e. splash pads, rip rap, etc.).
 - d. Publicly maintained storm sewers located in the public right-of-way shall be constructed of reinforced concrete pipe (RCP) or solid-wall or corrugated PVC pipe, complying and installed in accordance with the current edition of MPWSS as modified by the COB. PVC pipe may only be used for pipe sizes of 36" diameter or less. Other pipe materials may be considered for private storm sewer facilities. Use 12-inch minimum pipe size for inlet structures and 15-inch minimum pipe size within the storm drain system.
 - e. Storm sewer facilities shall be designed to handle a 25-year storm event.
 - f. Inlets and manholes shall have 9-inch sumps for sediment collection unless otherwise approved by the City Engineer.
4. For all new development or redevelopment projects greater than or equal to

one acre, the drainage plan shall include, to the greatest extent feasible, low impact development practices that infiltrate, evapotranspire, or capture for reuse the runoff generated from the first 0.5 inches of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation.

B. STORM DRAINAGE PLAN

A Storm Drainage Plan shall be submitted to the City Engineer for all new developments. The plan shall include the following:

1. A map or plat showing building site(s), open areas, drainage ways, ditches, culverts, bridges, storm sewers, inlets, storage ponds, roads, streets, and any other drainage improvements. The map shall also include identification and square foot coverage of the various ground surfaces (i.e. vegetation, gravel, pavement, structures).
2. Topographic contours (one-foot intervals) and sufficient spot elevation data.
3. Description of the ultimate destination of stormwater runoff from the project and an evaluation of its impact on downslope drainage facilities and water quality.
4. Design calculations determining runoff quantities and storage requirements.
5. A storm drainage facilities maintenance plan. The plan shall:
 - a. Identify ownership of all facilities.
 - b. Establish a schedule for maintenance activities necessary to keep the system operationally effective.
 - c. Identify the responsible party in charge of the specific maintenance duties.
6. Details and specifications (including invert and other pertinent elevation information) for all storm drainage improvements, such as storm sewers, manholes, inlets, discharge structures; and retention/detention pond dimensions and volume, side slope, and top, bottom, and maximum water surface elevations.

C. STORAGE/TREATMENT FACILITIES

Detention is the storage and gradual release of runoff to a storm sewer system, waterway, or a soil of high porosity. Detention facilities dampen peak runoff rates and provide treatment of runoff flows. For new development, on-site detention with release rates limited to pre-development runoff rates is required. Complete retention facilities may be

provided or required where discharge is not feasible or desirable. Retention ponds shall be sized based on a 10-year, 2-hour storm intensity.

1. Detention Basins: Detention basins utilize natural or manmade depressions or ponds for storage. Release of water is controlled by specially designed outlet structures (Figure A-2 in the Appendix of this Guide).
2. Basin Sizing: A minimum basin area of 145-square feet per 1-cfs release rate is required for sediment control. The controlling basin volume is determined by subtracting the total basin release volume from the runoff volume at different storm durations. The release rate is equivalent to the pre-development runoff rate at the piping system design frequency (Table I-3). The runoff rate is determined at the piping system design frequency using development runoff coefficients. Where the potential for major property damage exists due to downstream flooding and the terrain and availability of land permit the construction of a large detention basin, a 100-year design frequency should be used for sizing the pond. Basins located in areas accessible to the public shall have a maximum water depth of 1½-feet and a maximum basin depth of 2½- feet. Deep basins designed only for stormwater detention shall be placed in remote areas and fenced. A sample problem for sizing detention basins is included in the Appendix of this Policy.
3. Basin Location: Basins serving multiple lots shall be located in common open space owned by a Homeowners or Property Owners Association. Locating a basin within an easement on a lot will not be permitted unless approved by the governing body. Public park land shall not be used for storm water detention or retention ponds unless approved by the Superintendent of Facilities and Lands.
4. Additional Requirements: The following additional requirements apply to the design of above ground earth formed detention basins:
 - a. To prevent short circuiting, basin length shall be at least three times the width and inlet velocities should be dissipated.
 - b. Basin slopes shall be 4:1 or flatter. (UDO 18.48.050)
 - c. Vegetative channels shall be utilized wherever possible to remove wastewater contaminants.
 - d. Basins in floodplains shall have adequate erosion protection on the embankments.
 - e. Overflows shall be provided to prevent overtopping of dike walls.

5. Retention volumes shall be calculated using the following formulas:

$$Q = CIA$$

$$V = 7200Q \text{ (cf)}$$

Where : C = Weighted C Factor
 I = 0.41 in/hr (see figure I-2, I-3 for 10 year 2 hr storm)
 A = Area (acres)
 Q = runoff (cfs)
 V = volume (cf)

D. DISCHARGE STRUCTURES

1. A design detail shall be provided including adequate elevation information. Discharge structures shall be adequately protected from damage. A typical discharge structure is shown in Figure A-2 in the Appendix of this Policy.
2. Orifice or weir calculations shall be provided for controlling the discharge to the pre-development rate. For discharge structures similar to that in Figure A-2 of the Appendix, the slot width shall be sized using the equation:

$$Q = CLH^{3/2}$$

Where: Q = Discharge (cfs)
 C = Weir Coefficient = 3.33
 L = Horizontal Length (feet)
 H = Head (feet)

3. Failsafe features shall be provided including:
 - a. An emergency free-flowing overflow for rates exceeding design storm events.

- b. Discharge piping shall be a minimum of six (6) inches in diameter for maintenance, and capable of conveying a 25-year storm event.
- c. Ponds shall be designed so as to avoid long-term standing water in the pond.

E. ESTIMATION OF RUNOFF

1. GENERAL

The rational method shall be used to determine peak runoff rates with a slight modification of the method to determine runoff volumes. The basic assumptions that apply to the rational method are:

- a. Rainfall is uniformly distributed over the area for the duration of the storm.
- b. The peak runoff rate occurs when the duration of the storm equals the time of concentration.
- c. The runoff coefficient for a particular watershed is constant for a similar land use.

The method is based on the Rational Formula:

$$Q = CiA$$

Q - Peak runoff rate (cfs)
 C - Runoff coefficient
 i - Average rainfall intensity (in./hr.)
 A - Drainage area (acres)

2. RUNOFF COEFFICIENTS

The runoff coefficients shown in Table I-1 are recommended for design. Coefficients from other engineering texts may be considered for specific applications such as concrete, asphalt, roofs, etc..

TABLE I-1
RUNOFF COEFFICIENTS (C) FOR USE IN THE RATIONAL FORMULA

<u>LAND USE</u>	<u>RUNOFF COEFFICIENTS (C)</u>
Open Land	0.20
Low to Medium Density Residential	0.35
Dense Residential	0.50
Commercial Neighborhood	0.60
Commercial Downtown	0.80
<u>Industrial</u>	<u>0.80</u>

Source: City of Bozeman Stormwater Master Plan, Thomas Dean & Hoskins, Inc., 1982

3. TIME OF CONCENTRATION

A basic assumption of the rational method is that the peak runoff rate occurs when the duration of the storm equals the time of concentration. The time of concentration is the flow time from the most remote point in the drainage to the point in question. It generally consists of overland flow time and channel flow time. Overland flow time may be estimated from the nomograph in Figure I-1.

Channel flow time in gutters, ditches, or pipes may be determined by estimating velocities with the Manning equation:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

V - Mean velocity (ft/sec.)

n - Manning roughness coefficient (typical values in Table I-2)

R - Hydraulic radius* = $\frac{\text{cross sectional area}}{\text{wetted perimeter}}$

TABLE I-2
MANNING EQUATION - TYPICAL "n" VALUES

<u>Channel Type</u>	<u>"n" Factor</u>
Open Unlined Channels	0.035
Concrete and RCP Pipe	0.013
Corrugated Steel Pipe	0.024
PVC pipe	0.013

4. STORM INTENSITY

The intensity of the storm is determined from Figure I-2 or I-3. Duration is assumed to be equal to the time of concentration. The values in Table I-3 are the City of Bozeman design frequencies.

TABLE I-3
RAINFALL FREQUENCY FOR USE IN THE RATIONAL FORMULA

<u>Land Use</u>	<u>Design Rainfall Frequency</u>
Open Land	2-year
Residential	10-year
Commercial or Industrial	10-year

5. RUNOFF RATES AND VOLUMES

The rational formula provides a peak runoff rate which occurs at the time of concentration. The modified rational method approach shall be used to compute runoff volume for storm durations equal to or greater than the time of concentration. This method assumes the maximum runoff rate begins at the time of concentration and continues to the end of the storm. Maximum runoff rates for durations greater than the time of concentration are less than the peak runoff rate because average storm intensity decreases as duration increases. Total runoff volume is computed by multiplying the duration of the storm by the runoff rate.

6. RAINFALL INTENSITY DURATION CURVE

In order to use the rainfall intensity duration curve, the time of concentration must be known. This can be determined either by the following equation or Figure I-1:

$$T_c = \frac{1.87 (1.1 - CC_f) D^{1/2}}{S^{1/3}}$$

Where T_c = Time of concentration, minutes
 S = Slope of Basin, %
 C = Rational Method Runoff Coefficient
 D = Length of Basin, feet
 C_f = Frequency Adjustment Factor¹

Time of concentration calculations should reflect channel and storm sewer velocities as well as overland flow times.

1RATIONAL METHOD FREQUENCY ADJUSTMENT FACTORS	
Storm Return Period (years)	Frequency Factors C_f
2 to 10	1.00
11 to 25	1.10
26 to 50	1.20
51 to 100	1.25

Note: The product of C times C_f shall not exceed 1.00.

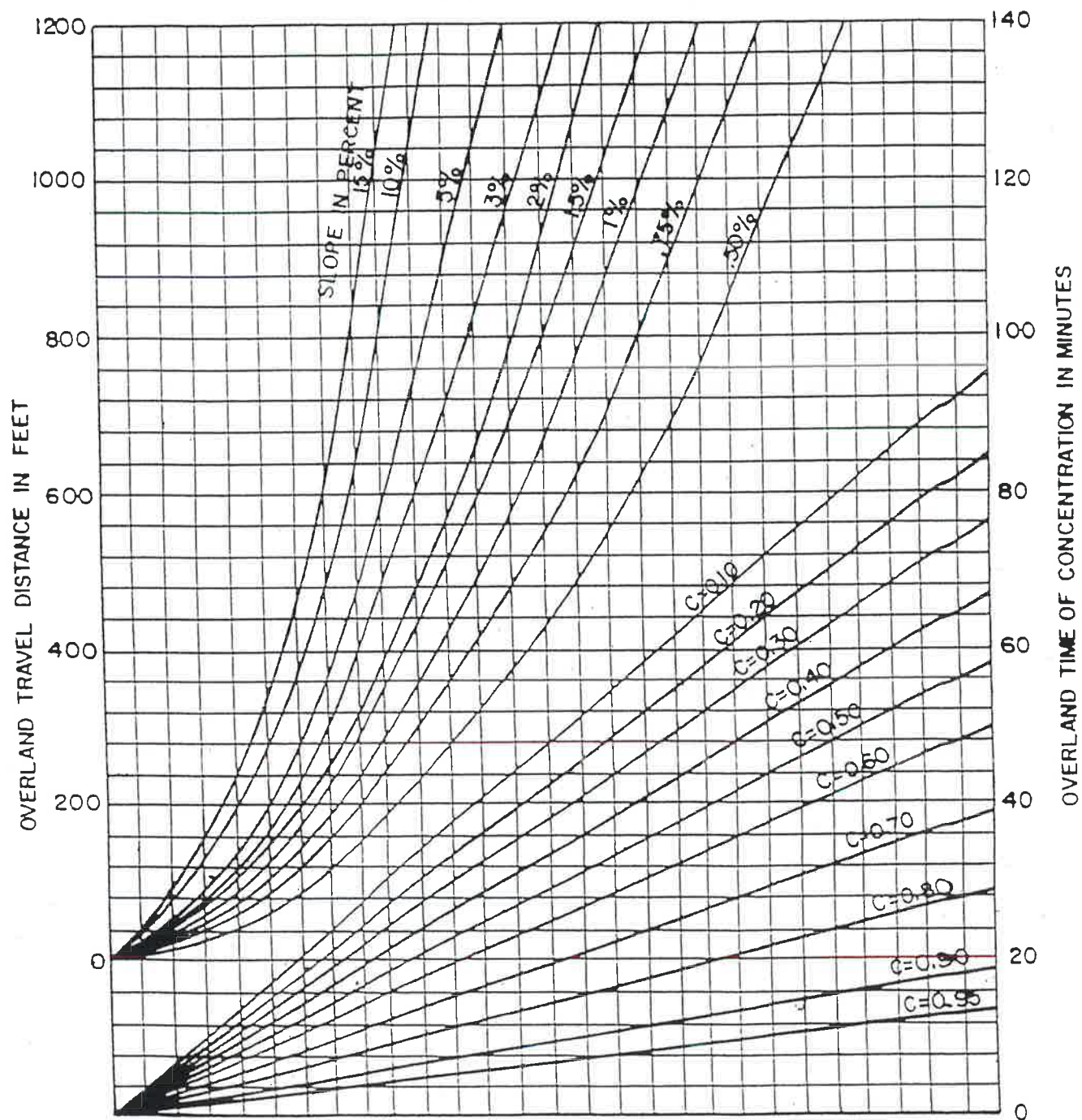


FIGURE I-1 TIME OF CONCENTRATION (Rational Formula)

RAINFALL INTENSITY - DURATION CURVES BOZEMAN, MONTANA

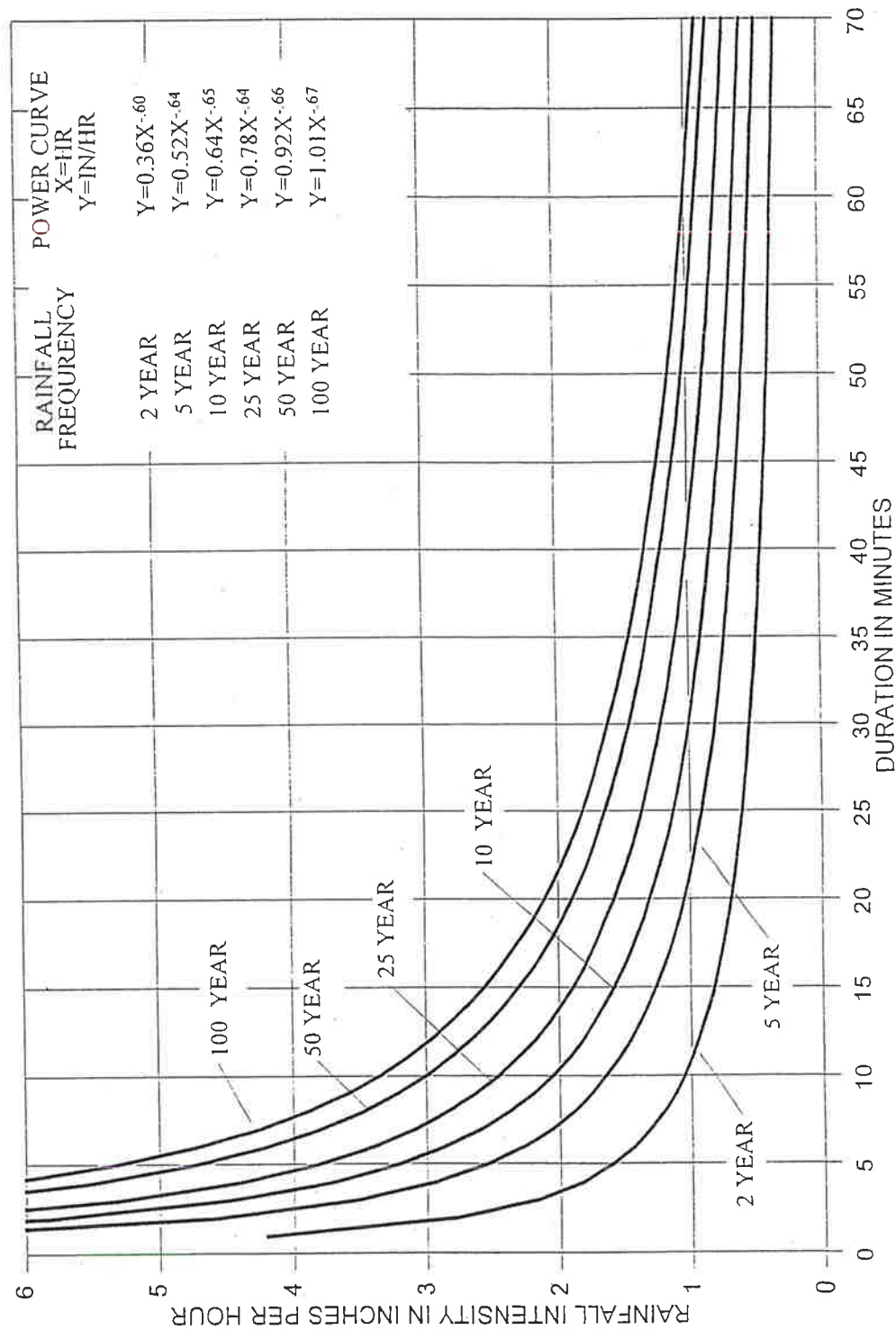


FIGURE I-2 RAINFALL INTENSITY - DURATION IN MINUTES

RAINFALL INTENSITY - DURATION CURVES BOZEMAN, MONTANA

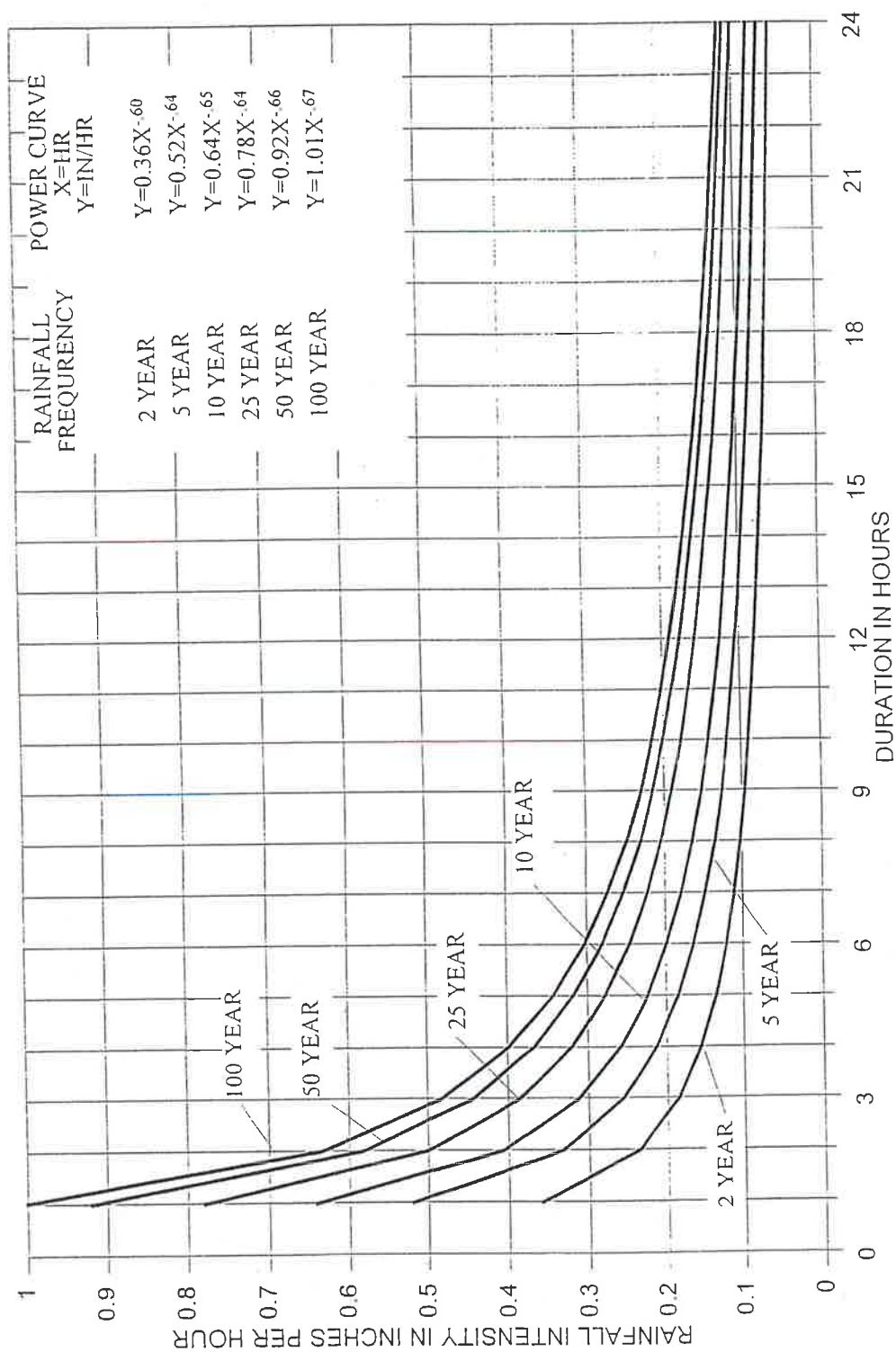


FIGURE I-3 RAINFALL INTENSITY - DURATION IN HOURS

III. FLOODPLAIN REGULATIONS

A. GENERAL

Floodplain regulations are detailed in Chapter 18.58 of the BUDO. These regulations are intended to protect the public health, welfare and safety in order that citizens and property owners can remain under the national flood insurance program. All proposed developments shall conform to the requirements of Chapter 18.58 of the BUDO.

IV. ROADWAY DESIGN AND TECHNICAL CRITERIA

A. GENERAL.

This section sets forth the minimum design and technical criteria and specifications to be used in the preparation of all roadway plans. All roadway plans should also be designed in conformance with MPWSS; City of Bozeman Modifications to MPWSS; Americans With Disabilities Act; and City of Bozeman Sidewalk Policy.

B. SIDEWALKS, CURBS AND GUTTERS AND DRIVEWAYS

1. Roadway typical sections are detailed in Figure A-1 in the Appendix of this Policy. Roadway typical sections shall conform to conditions of approval for the project.
2. Concrete sidewalks shall be constructed on both sides of all roadways unless otherwise approved by action of City Commission. Sidewalks shall be 6-inches thick across driveways, and 4-inches thick elsewhere. Sidewalk design and construction shall be in accordance with the "City of Bozeman Sidewalk Policy".
3. All sidewalks shall have a minimum width of five (5) feet, except the minimum width shall be ten (10) feet in the central business district. All sidewalks that are to be publicly-maintained and all sidewalks along arterial streets shall have a minimum width of six (6) feet and shall be 6-inches thick reinforced concrete. Publicly-maintained sidewalks are sidewalks along all parks, and any public facilities or city-owned structures which are anticipated to be maintained by the City of Bozeman.
4. Integral curb and gutter shall be used on all roadways.
5. Pedestrian ramps shall be installed at all intersections and at certain mid-block locations for all new construction or reconstruction of curb and sidewalk. Pedestrian ramps shall be constructed in accordance with City of Bozeman Standard Drawings and Americans with Disabilities Act (ADA) requirements. Pedestrian ramps may be shown at all curb returns or called out by a general note on the development plans.
6. Guardrails may be required in certain situations. Guardrails shall be designed and constructed in accordance with AASHTO Standards or as directed by the City Engineer.
7. Drop-curbs for driveways may only be installed with the initial curb construction when the final building locations have been determined. Driveway locations shall conform to Section 18.44.090, BUDO.

8. Curb transitions for curb bulbs shall be accomplished using 35' minimum radius curves to achieve the desired pavement narrowing. All curb bulbs shall be adequately marked with flexible roadway delineators and yellow curb paint as necessary. The minimum curb bulb throat width is 24 feet (back of curb to back of curb).

C. DRAINAGE

Drainage systems shall be designed in accordance with these Design Standards and Specifications, Section II, Drainage Policy. Development plans, including a drainage report, for the drainage system are required for concurrent review with, and shall be considered part of roadway design.

1. Crosspans. Crosspans (valley gutters) shall be constructed in accordance with City of Bozeman Standard Drawings. Crosspans are not allowed across collector or arterial roadways, nor are they allowed on roadways with storm sewer systems.

Crosspans may be used parallel with collector or arterial roadways to convey storm runoff across residential roadways. The use of crosspans elsewhere is discouraged, and will only be allowed after all other alternatives have been investigated.

2. Inlets:

- a. Inlets shall be located to intercept the major curb flow at intervals sufficient to ensure the depth of flow in the curb line is a maximum of 0.15' below the top of curb. This will result in a maximum spread width of approximately 9.5'. Inlets should be aligned with lot lines wherever possible.
- b. Inlets shall also be installed to intercept cross-pavement flows at points of transition in super elevation. Due to the presence of pedestrian ramps, inlets are not allowed in the curb return, but will be located at the tangent points of the curb returns.
- c. All inlets within the public right-of-way, or to be maintained by the City of Bozeman, shall be constructed in accordance with City of Bozeman Standard Drawings.

3. Cross Slope: Except at intersections, or where super-elevation is required, roadways shall be level from top of curb to top of curb and shall have a three (3) percent crown as measured from centerline to lip of curb, or lip of median curb to lip of outside curb on roadways with raised center islands. Parabolic or curve crowns are not allowed. Maximum pavement cross slope allowed is

five (5) percent at warped intersections, as measured above. In no case shall the pavement cross slope at warped intersections exceed the grade of the through street. When warping side streets at intersections, the crown transition should be completed within 75-feet horizontally for local streets, 100-feet horizontally for collector streets, and 150-feet horizontally for arterial streets. The crown of the through street shall be decreased to 1.5% through intersections, with the crown transitions being accomplished within 100 feet on either side of the intersections. Quarter crowning may be accepted on a case by case basis needing prior approval from the City Engineer.

4. Temporary Erosion Control: Temporary erosion control is required at the ends of all roadways that are not completed due to project phasing, subdivision boundaries, etc. Prevention of erosion at the roadway terminus shall be by methods approved by the City Engineer.
5. Sidewalk Chases:
 - a. Storm waters from concentrated points of discharge shall not be allowed to flow over sidewalks, but shall drain to the roadway by the use of chase sections. The use of sidewalk chases is discouraged, and their use is limited to situations where it is not possible to use standard storm inlets and piping.
 - b. Chase sections shall not be located within a curb cut of driveway. Chase sections shall be identified by station and elevation.
 - c. Sidewalk chase sections are to be constructed in accordance with the City of Bozeman Standard Drawings.

D. HORIZONTAL ALIGNMENT

1. Turning Radius: All roadways shall intersect at right angles as nearly as possible. In no case shall the angle of intersection be less than seventy-five degrees (75°).
2. Curb Return Radius: Minimum curb returns shall be as shown in Table IV-1 of these specifications. A larger radius may be used with the approval of the City Engineer.
3. Design Speed: Design speed shall be as shown in Table IV-2 of these specifications.
4. Horizontal Curves: The minimum centerline radius for horizontal curves shall be as shown in Table IV-2 of these specifications. Variances from the requirements of Table IV-2 for local streets only may be considered on a case by case basis.

5. Two streets meeting a third street from opposite sides shall meet at the same point, or their centerlines shall be off-set at least 125 feet.

TABLE IV-1
CURB RETURN RADIUS AT INTERSECTIONS*

	<u>LOCAL</u>	<u>COLLECTOR</u>	<u>MINOR ARTERIAL</u>	<u>MAJOR ARTERIAL</u>
LOCAL OR PRIVATE ST.	15'	15'	15'	15'
COLLECTOR	15'	25'	25'	25'
MINOR ARTERIAL	15'	25'	**	**
PRINCIPAL ARTERIAL	15'	25'	**	**

* Measured from back of curb

** Per AASHTO Standards

TABLE IV-2
MINIMUM STREET DESIGN STANDARDS FOR CITY STREETS

STREET TYPE	PRINCIPAL ARTERIAL	MINOR ARTERIAL	COLLECTOR	LOCAL	RURAL
Right-of-way width	110' - 120' ³	100'	90'	60'	90' – 110' ³
Centerline radius on curves	1	1	300'	150'	300'
Tangent length between reverse curves	1	1	100'	50'	100'
Stopping sight distance	1	1	300'	200'	300'
Angle at intersection centerline	1	1	>75°	>75°	>75°
Curb radius at intersections	2	2	2	2	N/A
Length of tangent at intersection	1	1	150'	100'	150'
Back of curb to back of curb	82'	50', 63', 71' ³	45', 48', 52', 62' ³	31', 33', 35' ³	33', 39', 62' ^{3, 4}
Length of cul-de-sac ⁵	N/A	N/A	N/A	500'	N/A
Outside radius on cul-de-sac right-of-way ⁵	5	5	N/A	50'	N/A
Grade – maximum	1	1	7%	10%	10%
Grade – minimum	0.5%	0.5%	0.5%	0.5%	0.5%
Grade within 150 feet of intersecting centerlines	1	1	3%	3%	3%
Design Speed (MPH)	50	45	45	30	45
K Factor (minimum)					
Crest	1	1	105	50	105
Sag	1	1	65	35	65
Minimum VCL					
Crest	1	1	90	50	90
Sag	1	1	70	50	70

¹All design criteria shall meet AASHTO standards.

²See Table IV-1

³The specific right-of-way and back of curb to back of curb street width will be determined on a case by case basis through the subdivision review process, and will be based on the specific needs, impacts and context of the development proposal.

⁴The rural street standard does not include curb and gutter. The street width is measured from the edge of pavement to the edge of pavement.

⁵Cul-de-sacs are generally not allowed. The City Engineer may consider and approve the installation of a cul-de-sac only when necessary due to topography, the presence of critical lands, access control, adjacency to parks or open space, or similar site constraints.

6. Super-elevation: Super-elevation may be required for arterial roadways and selected collector roadways. Horizontal curve radius and super-elevation shall be in accordance with the recommendations of AASHTO.

Super-elevation shall not be used on local roadways.

7. Spiral Curves: Spiral curves shall not be used on road-ways within the COB (State highways excluded) except by written approval of the City Engineer.
8. Railroad Crossing: All railroad crossings on streets shall be steel reinforced rubber for the full width of the roadway.
9. Barricades: Whenever roadways terminate due to project phasing, subdivision boundaries, etc., barricades are required in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) and City standards.

E. VERTICAL ALIGNMENT

Design controls for vertical alignment are shown in Table IV-2.

1. Permissible Roadway Grades: The minimum allowable grade for any roadway or alley is one-half (0.5) percent. The maximum allowable grade for any roadway is shown in Table IV-2 of this Policy. The maximum grade for an alley is subject to the approval of the City Engineer.
2. Changing Grades: Continuous grade changes or "roller-coastering" shall not be permitted. The use of grade breaks, in lieu of vertical curves, is not encouraged. Where the algebraic difference in grade (A) exceeds one percent (1.0%), a vertical curve is to be used.
3. Vertical Curves: All vertical curves shall be symmetrical. Design criteria for vertical curves are found in Table IV-2. The minimum grade within a sag (sump) vertical curve is five-tenths (0.50) of a percent. Minimum length of a vertical curve is shown in Table IV-2. All vertical curves shall be labeled, in the profile, with length of curve (L) and K ($=L/A$).
4. Intersections: The following additional criteria shall apply at intersections.

- a. The grade of the "through" street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the COB Engineering Department, shall have this precedence. Warp side streets to match through streets. See Section IV.C. 3 above.
 - b. The elevation at the point of tangency (PT) of the curb return on the through street is always set by the grade of the through street in conjunction with normal pavement cross slope.
 - c. Carrying the crown of the side street into the intersecting through street is not permitted.
 - d. At an arterial-arterial intersection, a more detailed review of the entire intersection's drive ability will be done.
5. Curb returns: Minimum fall around curb returns, when turning water, shall be three-tenths (0.3) of a foot for a fifteen (15) foot radius; four-tenths (0.4) of a foot for a twenty (20) foot radius; one-half (0.5) of a foot for a twenty-five (25) foot radius. For all other curb return radii use a grade of 1.25-percent within the return to establish minimum fall when turning water. The maximum fall around a curb return is 3.00-percent. Show and label high point location, elevation and intersection of flow line in plan view if applicable.
6. Connection with Existing Roadways: Connections with existing roadways shall be smooth transitions conforming to normal vertical curve criteria if the algebraic difference in grade (A) between the existing and proposed grade exceeds one percent (1.0%). When a vertical curve is used to make this transition, it shall be fully accomplished prior to the connection with the existing improvement. Field-verified slope and elevation of existing roadways shall be shown on the plans.
7. Offsite Design and Construction: The design grade, and existing ground at that design grade, of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued in the same plan and profile as the proposed design for at least three hundred (300) feet or to its intersection with an arterial roadway. This limit shall be extended to six hundred (600) feet when arterial roadways are being designed. If the offsite roadway adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of a transition with a 4-foot road base shoulder for the safe conveyance of traffic from his improved section to the existing roadway. The following formula shall be applied to the taper or land change necessary for this transition:

Speed Limit

40 MPH or Less	$L = WS^2/60$
45 MPH or Greater	$L = W \times S$

where

L = length of transition in feet

W = width of offset in feet

S = speed limit or 85th percentile speed

The City of Bozeman Engineering Department should be consulted for any unusual transition conditions. Grade breaks greater than 1-percent are not allowed when matching existing dirt or gravel streets.

8. The cost of offsite pavement transitions shall be borne by the developer.

F. MEDIAN TREATMENT

Median curbs should be integral curb and gutter (with spill curb) unless otherwise approved. Medians less than eight (8) feet wide should be capped with M-4000 concrete a minimum of three (3) inches thick. Wider medians should be top soiled and seeded with an approved seed mix. The minimum median width is 4 feet. All medians or raised islands should be made clearly visible at night through the use of adequate reflectorization and/or illumination. Flexible delineators shall be placed at the beginning and end of all medians, and at the point of any horizontal alignment change. All median curbs and island curbs shall be painted yellow with epoxy paint.

G. ROADWAY SPECIFICATIONS

Following are the requirements of the minimum roadway surfacing standards:

Surfacing. The pavement thickness design will be based on the current AASHTO Guide for Design of Pavement Structures, or the current Asphalt Institute Manual Series No. 1 (MS-1) for thickness design. A Pavement Design Report, based upon specific site soil data and design-year traffic loading conditions, prepared by a Professional Engineer, or other qualified professional approved by the City Engineer, shall be submitted to the City Engineer for approval prior to plan and specification submittal if using the self-certification process or with the plans and specifications if using the standard process. The design shall be based on at least a 20-year performance period traffic volume; however, the minimum design lane Equivalent 18,000-lb Single Axle Load (ESAL) used in the pavement design shall not be less than 50,000-ESAL. The minimum asphalt pavement thickness for any new local roadway shall be three (3) inches. The minimum asphalt pavement thickness for any new collector or arterial roadway shall be four (4) inches. A

minimum of six (6) inches of high quality untreated aggregate base shall be provided for designs utilizing asphalt pavement over untreated aggregate base. Where full-depth asphalt is designed, an adequate stabilizer lift shall be included, consistent with unpaved roadway design practices, to provide a suitable sub-base capable of withstanding the traffic required for the initial construction of the roadway. The City Engineer may require intersections with roundabouts or traffic circles to be constructed with Portland Cement Concrete surfacing.

H. SIGNS and MARKINGS

1. Street identification signs shall be installed at all new intersections in accordance with City of Bozeman Modifications to MPWSS. The design Engineer should consider, and the City Engineer may require, regulatory traffic control signs and pavement markings in accordance with the MUTCD. Stop signs shall be installed on local streets when they intersect with any collector or arterial streets.
2. Unless otherwise approved, all transverse markings, words and symbols, and 8" or larger lane line pavement markings shall be inlaid thermoplastic or pre-formed plastic tape. All other markings may be either inlaid or preformed thermoplastic or epoxy paint. The materials proposed for all markings shall be specified on the plans.
3. Crosswalk markings should not be used indiscriminately. An engineering study should be performed before they are installed at locations away from traffic signals or stop signs. Mid-block crosswalks are discouraged.
 - a. All marked crosswalks for designated school crossings shall be longitudinal white bars ("City of Bozeman Type B" style). "School Crossing" signs and "School Advance Warning" signs shall be installed at all designated school crossings.
 - b. At stop or signal controlled intersections, marked crosswalks shall be two 8" white lines, 8' apart typically, installed transverse to traffic and in-line with sidewalks, if any ("City of Bozeman Type A" style).
 - c. Marked crosswalks at uncontrolled intersections, and all mid-block crosswalks shall be "Type B", with "Pedestrian Crossing" signs. "Pedestrian Crossing Advance Warning" signs should be installed if deemed warranted by engineering judgment.
 - d. Parking shall be restricted by the use of signs and curb markings within 20 feet of crosswalks at a minimum, or longer based on engineering judgment.

- e. All crosswalk signs and advance crosswalk signs shall have a fluorescent yellow green background.
- 4. All signs shall comply with the “Standard Highway Signs” book (FHWA).
- 5. Street name signs for publicly-maintained roadways shall consist of white letters on a green background. Street name signs for privately-maintained roadways shall consist of white letters on a blue background.

I. MONUMENTATION

- 1. Monuments in monument boxes shall be provided in new or reconstructed streets at all section corners, quarter corners, and sixteenth corners.

J. LIGHTING

The design engineer shall consider the need for roadway lighting in the development of plans for any new or reconstructed roadways.

Street lighting consists of street lighting and pathway intersection lighting, and shall comply with the following requirements:

- 1. General.
 - a. All street lighting shall be operated and maintained through the creation of a new SILD, through the annexation to an existing SILD or through some other equivalent means approved by the City of Bozeman. The application to create or annex to an existing SILD shall be submitted to the City within 2 months of preliminary approval of the development. The approval to create or annex to an SILD shall be granted prior to final plat for a subdivision or Occupancy if a final plat is not required.
 - b. Street lighting shall be installed per 38.39.030 B, BMC (in regards to completion time for improvements).
 - c. Individual yard lights on private property shall not be used for street lighting.
 - d. Unless otherwise specified herein, installation of equipment for lighting shall conform to the requirements of “Bozeman Lighting and Electrical Specifications” (see appendix).

K. BIKE LANES/PATHS

All bike lanes/paths shall be designed in accordance with the “Guide for the Development of Bicycle Facilities” (AASHTO, latest edition). Bike lanes shall be marked and signed in accordance with the MUTCD.

V. UTILITY DESIGN CRITERIA

A. WATER DISTRIBUTION LINES DESIGN CRITERIA

1. All additions or modifications to the COB water system will be designed in accordance with the criteria set forth in this and other sections of this Policy as approved by the City Engineer. Ductile Iron Pipe (DIP) shall be used exclusively unless special approval, in writing, of alternate materials is given by the City Engineer. All additions to the water system will be designed and installed in accordance with the Water Quality Bureau (WQB) Circular No. 1; MPWSS; COB Modifications to MPWSS; COB Water Facility Plan; and COB Fire Service Line Standard.
2. Master Water Plan: A master water plan shall be submitted for each subdivision or other major development prior to approval of any portion of the water system. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be submitted.
3. A design report prepared by a professional engineer licensed in the State of Montana demonstrating compliance with these requirements shall be submitted to and approved by the City of Bozeman prior to plan and specification submittal if using the self-certification process or with the plans and specifications if using the standard process for any new development. Design parameters and the critical conditions shall be shown on a overall plan of the study area. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be included.
4. Main Size: The water distribution system shall be designed to meet the maximum demand plus fire flow and the peak hour demand. The design shall be based on a maximum hour to average day ratio of 3:1 (maximum day to average day ratio of 2.3:1 for an average daily usage of 170-gallons per day per person), plus fire flow demand as determined by ISO (Insurance Services Office) criteria. A "C" Factor of 130 shall be used in modeling system designs. The working residual water pressure shall not be less than 20-psi at any point in the water distribution system under maximum day plus fire flow. The velocity of the water in the system shall not exceed 15-feet per second through a public main line. The minimum diameter for any new main is 8-inch, unless specific approval in writing is obtained from the City of Bozeman for smaller diameters.
5. Main Extensions: All main extensions shall be looped, where possible. All dead end 8" mains shall end with a fire hydrant or 2" blowoff. Larger diameter dead end mains shall end with a fire hydrant. Permanent dead-end

mains shall not exceed 500-feet long. Temporary dead-end mains scheduled for future extension may end with a blow-off in lieu of a fire hydrant.

6. Services

- a. A water line is designated as either a service line or water main based on its use, not its size. Generally, a line serving a single building or facility is considered a service line; a line serving more than one building, or intended to serve more than one building or facility is generally designated a water main. The standard sizes of service lines are 3/4-, 1-, 1½-, 2-, 4-, 6-, or 8-inch. The minimum size of a fire service line is 1-inch. The minimum size of a service line stub is 1", to allow for the potential use of the domestic supply for a fire sprinkler system.
- b. Service pipe shall be type "K" copper for sizes less than 4-inch, and ductile iron for services 4-inch and larger. Plans and specifications prepared by a Professional Engineer licensed in the State of Montana shall be submitted for 4-inch and larger service lines.
- c. The service stubs shall be installed in accordance with the COB Standard Drawings for service lines. The service line stubs shall be installed at the center of each lot unless otherwise approved by the Water Superintendent.
- d. No service line shall be extended into a building until an "Application for Service" has been completed and a Plumbing Permit has been obtained from the Building Department.
- e. Backflow prevention devices as required by the Water Superintendent shall be installed on each fire and domestic service line. Meters will be installed inside the building by the Water Department on all service lines except for fire service lines. Meter pits shall not be used unless specifically approved by the Water Superintendent.
- f. All service connections shall be uniform size from the service line tap to the building structure or structures unless otherwise approved or required by the Water Superintendent. The Water Department shall reserve the right to require a larger service connection to any building, structure or development if the water requirements when calculated by the fixture unit method, as specified in the Uniform Plumbing Code, cause the service line velocity to exceed ten (10) feet per second. Each service line and meter shall supply a specific building.

- g. All service line stubs shall be sized to adequately serve the maximum anticipated demand for the property being served.
 - h. The Water Superintendent may require the termination of any existing service stubs (either for domestic or fire service) that are not utilized for service upon the development of the lot. Lines to be terminated shall be capped or plugged at the main, and any curb boxes or valve boxes on the line shall be removed.
- 7. Valves: Valves shall be installed in accordance with the following unless otherwise approved or required by the Water Superintendent:
 - a. All connections to an existing water main will begin with a new valve.
 - b. Valves shall be located at not more than 500-foot intervals in commercial districts and at not more than one block or 800-foot intervals in other districts.
 - c. Every leg of a main intersection shall have a valve.
 - d. Valves shall be placed so that main shut-downs can be accomplished with only one fire hydrant being out of service at a time.
- 8. Hydrants: Hydrants shall be provided at each street intersection and at intermediate points so that hydrants are spaced from 350- to 600-feet depending on the area being served. Mid-block hydrants shall be installed in line with lot lines.
- 9. Air Relief: Air relief shall be provided at all high points in the line where air can accumulate by means of hydrants, services, or air relief valves.
- 10. Pressure Reducing Valves: Pressure reducing valves shall be installed when the anticipated average-day line pressure exceeds 120 psi.
- 11. Thrust Restraint: All thrust restraint shall be designed to withstand the test pressure or the working pressure plus surge allowance, whichever is larger. Adequate factors of safety shall be employed in the design.

B. SANITARY SEWER SYSTEM DESIGN CRITERIA

- 1. All additions or modifications to the COB sanitary sewer system will be designed in accordance with the criteria set forth in this and other sections of

this Guide as approved by the City Engineer. All additions to the sewer system will be designed and installed in accordance with WQB Circular No. 2; MPWSS; COB Modifications to MPWSS; the Uniform Plumbing Code; and the COB Wastewater Facility Plan.

2. A design report prepared by a professional engineer licensed in the State of Montana demonstrating compliance with these requirements shall be submitted to and approved by the City of Bozeman prior to plan and specification submittal if using the self-certification process or with the plans and specifications if using the standard process for any new development. Design parameters and the critical conditions shall be shown on an overall plan of the study area. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be included.
3. New sewer lines shall be sized to flow at no more than 75-percent of full capacity at peak hour conditions upon the full build-out of the development. The effects of the proposed development's sewer loading on existing downstream sewer lines shall be analyzed.
4. New sanitary sewer lines to serve residential areas shall be designed to accommodate an average daily flow rate of 2.11 people per dwelling unit and 89-gallons per capita per day. An infiltration rate of 150-gallons/acre/day shall be added to all flow calculations when designing new sewers.
5. New sanitary sewer lines shall be designed to accommodate the average daily flows as shown in Table V-1, V-2, and V-3 of this Policy.
6. A Manning's friction factor of 0.013 shall be used in designing new sewers. A peaking factor shall be calculated for each pipe segment based on the following formula;

$$\frac{Q_{\max}}{Q_{\text{Ave}}} = \frac{18 + P^{1/2}}{4 + P^{1/2}} \quad (P = \text{Population/thousands})$$

For non-residential flows an equivalent population shall be calculated for use in the peaking factor formula.

To evaluate future collection needs, wastewater loading needs to be assigned to areas based on anticipated future land use characteristics. In areas within the City limits the assigned zoning provides the best tool to approximate future wastewater loadings. Table V-1 shows the recommended wastewater flow rates based on a per acre basis for zoned areas. Detailed information on how the flow rates were developed is located in Appendix 2A of the “City of Bozeman Wastewater Facilities Plan, 2007.”

TABLE V-1 WASTEWATER FLOW RATE FOR ZONED UNDEVELOPED AREAS¹

Designation	Dwelling Units per Acre	GAL./ACRE/DAY
R-S	6.5	1,220
R-1	3.9	730
R-2	5.2	980
R-3	6.5	1,220
R-4	10.4	1,950
R-O	5.2	980
R-MH	5.2	980
B-1		1,000
B-2		2,000
B-3		3,000
M-1		960
M-2		960
B-P		960
NEHMU	6.5	1,220
PLI		1,030

¹ The flow allocation in this table is based on gross area.

In areas within the 2020 Plan Boundary that have a defined land use, wastewater flows can be allocated on the land use designation. Table V-2 provides the recommended wastewater flow rate by land use designation.

TABLE V-2 WASTEWATER FLOW RATE BY LAND USE DESIGNATION¹

Designation	Dwelling Units per Acre	GAL./ACRE/DAY
Industrial	-	960
Neighborhood Commercial	-	1,200
Community Commercial	-	2,400
Regional Commercial	-	1,600
Business Park	-	960
Public Institutions	-	1,030
Residential	5.5	1,030
Suburban Residential	1.3	240
Park and Open Space	-	25
Other Public Lands	-	1,030
Golf Course	-	30
MSU	-	2,780
MSU West	-	1,030

¹ The flow allocation in this table is based on gross area as land area.

Table V-3 identifies the recommended flow allocation for areas that are defined as future urban by the 2020 Plan or are areas outside of the 2020 Plan Boundary. These areas are the least defined in terms of land use. As such, the projected flows are based on equivalent residential dwelling unit densities. Additional detail is provided in Appendix 2A of the "City of Bozeman Wastewater Facilities Plan, 2007".

TABLE V-3 WASTEWATER FLOW RATE FOR UNDEFINED LAND USE
DESIGNATIONS¹

Designation	Dwelling Units per Acre	GAL./ACRE/DAY
Future Urban	5.5	1,030
Future Expansion Area	5.5	1,030

¹ The flow allocation in this table is based on gross area.

7. Manhole Spacing: The maximum distance between manholes shall be as follows:

SANITARY SEWER

<u>PIPE SIZE</u>	<u>MAXIMUM DISTANCE</u>
8" to 15"	400'
18" to 30"	500'
larger than 30"	600'

8. Barrel Size: The alignment and number of pipes into the manhole will determine the barrel size for the size of pipe used. All 48-inch manholes will have eccentric cone top sections if total manhole height is greater than six feet. All other manholes will have flat tops. All drop manholes shall be "inside drop" with a minimum barrel diameter of 60-inch. The internal diameter of the manhole barrel shall be typically as follows:

SANITARY SEWER

<u>PIPE SIZE</u>	<u>BARREL SIZE</u>
12" or less	48"
15" to 27"	60"
30" to 48"	72"

Manholes larger than seventy-two (72) inches may be allowed with specific approval by the City Engineer.

9. Manhole Channels: All manholes shall have full-depth channels. When a smaller main is being connected to a larger main at a manhole, the manhole inverts shall be set so that the 8/10 depth of flow of each main is equal in elevation. The minimum drop across a manhole (invert in to invert out) is 0.2' (cut-in manholes excepted).
10. Sanitary Sewer Mains: The minimum diameter of a sewer main is 8-inches. Main lines shall be sized for design flow, not available slope. PVC pipe shall be used for all gravity flow main lines unless other materials are specifically approved.
11. Sanitary Sewer Services: The minimum diameter of a service is 4-inch. Services shall connect to the main with in-line gasketed wyes. The service line stub, from the main to the property line or easement line, shall be installed with a maximum slope of 1/2-inch per foot. The minimum slope of a 4-inch service line stub is 1/4-inch per foot. The minimum slope of a 6-inch service line stub is 1/8-inch per foot. Sewer service line stubs will typically be installed 15-feet from the downstream lot line. Services are to be installed perpendicular to the main.

Each building shall have a separate service line from the building to the sewer main, with the following exception: Accessory Dwelling Units (ADUs) may share sewer service with the service from the primary dwelling unit on the lot, provided that the service is television inspected at the owner's expense, and the Water/Sewer Superintendent determines that the service is in an acceptable condition for shared use.

12. Access Roads: A 12'-wide all-weather gravel access road, with turn-arounds if needed, shall be constructed to provide access to all sanitary sewer manholes not located within a paved public or private street or parking lot.
13. Cut-in Manholes: Pre-cast manhole bases are preferred for cut-in manholes. Poured-in-place cut-in manholes may be used if approved by the Sewer Superintendent.

C. STORM SEWERS

1. Materials: RCP (reinforced concrete pipe) or PVC pipe may be used, however PVC pipe may only be used for pipes sized 36" diameter and smaller. PVC pipe shall have a minimum stiffness of 46 PSI. Structural strength shall withstand HS-20 design load. If PVC pipe is used, all pipe exposed to sunlight shall be protected with concrete headwalls or prefabricated end sections in accordance with MPWSS Section 02725.
2. Minimum Sizes: Storm sewer mains shall not be less than 15-inch diameter. Privately owned storm sewers may be smaller, but shall still be designed in accordance with section C.5 below.
3. Manhole Spacing and Size:

<u>Storm Sewer Pipe Diameter or Vertical Rise</u>	<u>Maximum Manhole Spacing (Ft.)</u>
15" - 36"	400
42" - 60"	500
66" and Larger	750

<u>Storm Sewer Pipe Diameter</u>	<u>Barrel Size* (Ft.)</u>
15" - 18"	4
20" - 28"	5
30" - 48"	6

* Multiple pipe penetrations may require larger manhole barrels

4. Storm Inlets

- a. Publicly owned storm inlets shall comply with the applicable standard drawing in the COB Modifications to MPWSS. Where inadequate overflow paths are provided, inlets must be oversized 50-percent to accommodate plugging.
- b. The size of outlet pipes from storm water inlets shall be based upon the design capacity of the inlet, but shall not be less than 12-inches in diameter. The outlet pipes shall connect to the storm sewer main with a manhole.
- c. Computations for storm sewer design and storm inlet designs shall be submitted prior to plan and specification submittal if using the self-certification process or with the plans and specifications if using the standard process. Adequate details of inlets, manholes and other appurtenances shall be included in the overall drainage plan submitted for approval.
- d. Combination manhole/inlets may be used where approved as detailed in the City of Bozeman Modifications to MPWSS.

5. Hydraulic Design

Storm sewers shall be designed to convey the 25 year storm event with no surcharging (i.e. pipe full with no head). Inlets and sidewalk chases shall be designed to convey the 25 year storm flow with a maximum water surface elevation of 0.15' below the top of curb.

Drainage reports shall include hydraulic grade line calculations including losses from friction and transitions. Approved erosion control shall be designed and installed at all outlets.

6. Alignment

- a. Manholes are required wherever there is change in size, direction, elevation, grade or at sewer main junctions.
- b. The minimum vertical clearance between a potable water main and a storm sewer main is 1.5-feet. The minimum horizontal clearance between a potable water main and a storm sewer main is 10-feet.
- c. Horizontal alignment between manholes shall be straight.

7. Culverts

- a. A culvert is considered to be any structure which connects two

open channels. The culvert is to be designed to convey the 25-year frequency flow of the tributary drainage basin. The headwater depth will be limited by upstream conditions, but in no case shall exceed 1.5 times the culvert diameter. Excessive ponding above culvert entrances will not be acceptable if damage appears likely to surrounding property or to the roadway.

- b. Culverts shall be designed with an emergency overflow path. The emergency overflow capacity shall be 100-percent of the whole culvert for the major storm for culverts with area less than twenty square feet and for culverts with area greater than or equal twenty square feet, the overflow capacity shall be 100-percent of the capacity provided by the first twenty square feet plus 20-percent of the capacity provided for the additional area as established by the formula:

$$\% \text{ overflow} = (110\%) \frac{20 + (A - 20) \cdot 20}{A}, \text{ where "A" is the area of the culvert opening.}$$

If the culvert is located in a low point in the road the required overflow capacity can be provided by overtopping the road, as long as this does not result in more than 50 feet of street being flooded. Where the culvert is not in a low point, or where more than 50 feet will be flooded, the overflow capacity shall be provided by either increasing the culvert size, or additional culverts.

8. Culvert Hydraulics

- a. The culvert including inlet and outlet structures shall convey water, sediment and debris at all stages of flow.
- b. End Treatment: Flared end sections or headwalls with wingwalls are required. Inlets are to be designed to minimize head losses. Approved erosion control is to be provided at all culvert outlets and inlets. Trash racks should be used for culverts greater than 100-feet in length.
- c. Slopes: Culvert slopes shall prevent silting, yet avoid excessive velocities. Generally, the minimum culvert slope is 0.50-percent. Minimum barrel velocity is 3-fps and maximum is 12-fps.
- d. Hydraulic Analysis: Inlet and outlet control conditions shall be analyzed. Calculations shall be submitted with the design report.
- e. Minimum Size: Culverts crossing a roadway shall not be smaller

than 24-inch equivalent diameter. Driveway approach culverts shall not be smaller than 15-inch equivalent diameter. Culvert length shall be adequate to provide back slopes of 4:1 or less from pipe inverts to finished street section, including existing or future sidewalks.

- f. Materials: Culverts shall be RCP unless otherwise approved by the City.
- g. All culverts shall be designed to withstand HS-20 loading in accordance with American Association of State Highway and Transportation Officials (AASHTO) "Standard Specifications for Highway Bridges" and with the pipe manufacturers recommendation.

9. Utility Culverts

- a. Conduits placed in right-of-way to facilitate placement of future gas, electric, communication, or other utility lines shall have the structural strength to withstand HS-20 loading. Conduits shall have a minimum stiffness of 46 PSI. Conduits shall be adequately sized to accommodate all anticipated utility lines. HDPE utility culverts shall not be placed within any public right-of-way.

D. ALIGNMENT, DEPTH, AND EASEMENTS

1. General: Water mains, sanitary sewers, and storm sewers within the proposed development shall be arranged to allow the suitable development of any adjoining un-developed land, and shall be constructed to the boundary lines of the tract being developed, unless prevented by topography or other physical conditions, in which case a variance must be approved by the City of Bozeman. The alignment of all water, sanitary sewer, and storm sewer mains and services lines shall be arranged so that there is a minimum of ten (10) feet of horizontal separation between these lines and with any gas lines, power lines, communication lines, utility poles or other above-grade utility structures, and street lights.
2. Water Mains:
 - a. Water mains located in public street right-of-way shall be placed nineteen (19) feet off the north or west right-of-way lines for streets 35 feet in width or greater (back of curb to back of curb). For streets less than 35 feet in width, water mains shall be placed 5.5 feet west and north of the street centerline. On curvilinear street alignments, water mains will be a minimum of two (2) feet

from the edge of the concrete gutters at all locations.

- b. A minimum depth of cover of six and one-half (6 ½) feet below final grade will be maintained over all water mains.
- c. When water mains cross sanitary or storm sewer mains, the water line must have an eighteen (18) inch minimum vertical separation, with all water pipe joints no closer than ten (10) feet horizontal from the sewer pipe centerline, and the crossing will be perpendicular to the sewer line. A minimum of ten (10) feet horizontal separation shall be maintained between any water main and any sanitary or storm sewer main.

3. Sanitary Sewer Mains:

- a. Sanitary sewer mains located in public street right-of-way shall be placed along the centerline of the street for streets 35 feet in width or greater (back of curb to back of curb). For streets less than 35 feet in width, sewer mains shall be located 5.5 feet east and south of the street centerline. On curvilinear street alignments, sewer mains will be a minimum of two (2) feet from the edge of the concrete gutters at all locations.
- b. Sewer mains shall have a minimum depth of cover of four (4) feet below final grade. All sewer mains and services with less than five (5) feet of cover will be adequately insulated.
- c. Where streets are curvilinear, manholes should be located in the center of the street wherever possible, however non-centerline locations that are not in vehicle wheel paths are acceptable if it will reduce the total number of manholes required.

4. Storm Sewer Mains

- a. Storm sewer mains located in public street right-of-way shall typically be located on the opposite side of the street from the water main. Storm sewers may be located beneath curb and gutter if combination inlet/manholes are used.
- b. Storm sewer mains shall have a minimum depth of cover of two (2) feet below final grade, provided that the pipe material shall withstand the design load. Storm sewers shall be placed to maintain a minimum horizontal clearance of five (5) feet and a vertical clearance of six (6) inches from any sanitary sewer main.

- c. Manholes shall not be located in vehicle wheel paths.

5. Easements:

- a. A "utility easement" granted to the public is required for all public utility mains not located within public street right-of-way. An easement shall be a minimum of thirty (30) feet wide for one or two utility mains. An additional ten (10) feet is required for each additional main that occupies the easement. Wider easements may be required at the discretion of the City of Bozeman for large utility lines. Easements not established by plat will be executed on standard forms available from the City Engineer.
- b. At no time will the utility line in question be less than nine (9) feet from the edge of the easement or less than ten (10) feet from a parallel utility line. Utility easements will also be required for all meter pits and fire hydrants maintained by the City of Bozeman.
- c. No permanent structures shall be placed within a utility easement unless an encroachment permit has been obtained. Trees or other significant landscaping features shall not be placed within ten (10) feet of any utility main or service lines.
- d. All easements documents must conform to City of Bozeman requirements and must meet the formatting requirements of the Gallatin County Clerk and Recorder's office.

APPENDIX

City of Bozeman Fire Service Line Standard

Certificate of Completion and Acceptance

Figure A-1 Standard Roadway Typical Sections

Figure A-2 Typical Stormwater Detention Pond Concrete Outlet Structure

Sample Detention Basin Sizing Problem

Pre-construction Meeting Checklist

Plan and Specification Certified Checklist

Certified Checklist for Testing and Documentation Requirements

Random Sampling Example

City of Bozeman Street Naming and Addressing Policy

Bozeman Lighting and Electrical Specifications

CITY OF BOZEMAN
FIRE SERVICE LINE STANDARD
MARCH 31, 1997
Revised March 31, 2011

1. For all fire service lines (regardless of size) a City of Bozeman water service application must be completed prior to beginning work on the fire service line. Applications may be obtained at the City Building Department located at 20 E. Olive St..
2. Plans for all fire service lines will be reviewed by the City of Bozeman. The review and subsequent approval or denial will be for that portion of the proposed fire service line that starts at the point of connection to the City of Bozeman distribution system up to and including the backflow preventer and the flow detection device. The plans will be reviewed by the city of Bozeman Water Department, Fire Marshall, and Engineering Department. Upon satisfactory completion of the review process, the plans will be forwarded to the City Engineer with a recommendation for approval. The City Engineer will review the plans and either approve or deny the project. ***Installation of the fire service will not begin until the plans have been approved by the City of Bozeman and a City of Bozeman water service application has been completed.*** For maintenance of the fire service line after City of Bozeman final acceptance refer to Item 16 of this Standard. The Owner shall be completely responsible for assuring the fire service line is properly/adequately sized to provide the flows necessary for the fire protection system being serviced by the proposed fire service line.
3. Plans for all proposed fire service lines shall be drawn to scale on 24" x 36" plan sheet(s) and shall include all essential details such as:
 - a. Size and location of all water supplies.
 - b. Size and location of all piping indicating, where possible, the class, type and depth of existing pipe, the class and type of new pipe to be installed, and the depth to which it will be buried. For proposed fire service liens 4" in diameter and larger the plans must include a profile drawing of the proposed fire service line from the point of connection at the existing main up to and including the system riser. The profile drawing must show the finished grade, depth of cover for the line, and if applicable, all other utilities which the fire service line will cross or be adjacent to.
 - c. Size, type and location of valves.
 - d. Classification of the system (See Attachment A).
 - e. Sprinkler and standpipe riser to be supplied by the system.
 - f. Location of fire department connections.
 - g. Size of orifice necessary to achieve the flushing flows required under NFPA 24.
4. All fire service lines not installed by the City of Bozeman Water Department shall be designed, inspected and certified by a Professional Engineer.

5. Fire service lines 4" in diameter and larger shall be installed, tested, and disinfected by a single Contractor from the point of connection at the City water main (or existing stub) to the first control valve (OS&Y) inside of the building. (Note Item 16 of this Standard for maintenance of the fire line.)
6. For all fire service lines 2" in diameter and smaller where no stub exists, a licensed contractor shall install the line from the main up to and including the first control valve (OS&Y) and double check valve inside the building. The Water Department shall tap the main at the owner's expense and inspect the line under line pressure before it is backfilled. A curb stop and box shall be installed at a point 8' past property line unless otherwise directed by the Water Superintendent. Installation of the fire service line will not begin until the plans for the project have received City of Bozeman approval and a City of Bozeman water service application has been completed.
7. The City of Bozeman will only accept fire service lines which are 1", 1 ½", 2", 4", 6", or 8" in diameter, unless specifically approved by the Engineering and Water Departments.
8. When tapping tees are used for the fire service line connection to the main, the Contractor shall install the tapping tee and valve and the City of Bozeman shall make the actual tap to the main at the Owner's expense.

The fire service line connection to the City water main without the use of a tapping tee will be made by the Contractor installing the appropriate sized tee in the water main. The Water Department will operate all valves for the shut down of the line to install the tee and must be provided with a minimum of 24 hours advance notice before work is scheduled to begin. The Contractor shall notify all affected water customers of the water shut down a minimum of 24 hours before the work begins. Temporary water service shall be provided to all affected water customers if the shut down period is anticipated to exceed four hours. The City of Bozeman reserves the right to determine the likely extent of the main shut down based on the proposed work and Contractor experience, and require the installation of temporary water services by the Contractor.

9. Material and installation of fire service lines shall comply with the following standards:
 - a. **Montana Public Works Standard Specifications, Fifth Edition, March 2003.**
 - b. **City of Bozeman Modifications to the Montana Public Works Standard Specifications.**
 - c. **City of Bozeman Standard Drawings 02660-13 and 02660-14.**
 - d. **City of Bozeman Fire Service Line Standard.**
 - e. **NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances, (latest edition).**
10. The City of Bozeman's requirements for the installation of double check valve assemblies and reduced pressure backflow prevention assemblies are as follows:
 - a. The first fitting inside of the building shall be a UL listed flanged American Flow

Control, Kennedy or Mueller OS&Y valve the same size as the fire service line, for lines 4" and larger. For lines 2" and smaller, the first fitting inside the building shall be a NIBCO T-104-0 OS&Y valve.

- b. All double check valve assemblies and reduced pressure backflow prevention assemblies shall be:
 - 1. UL or FM listed
 - 2. Approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCCHR) for operation in the proposed position (vertical or horizontal) as shown on the approved plans.
 - 3. Installed as shown on the approved plans.
 - c. A flow detection device shall be installed immediately following the double check valve assembly or the reduced pressure backflow prevention assembly (alarm check valve, flow/sensor alarm, meter, etc.) as shown on the approved plans.
 - d. A double detector check valve assembly may be used with a standard City of Bozeman meter (for Class I, II and III systems only). The meter loop of the double detector check valve shall have a double check valve assembly installed which meets the same installation criteria specified above in requirement b.
 - e. Horizontal installations must be a minimum of 2 feet clear above the finished floor.
 - f. The fire service riser must be a minimum of 2 feet clear from any outside wall.
 - g. The incoming fire service line shall be a minimum of 6.5 feet and a maximum of 7.5 feet below the finished grade.
 - h. All fire service lines appurtenances shall have a minimum pressure rating of 175 p.s.i.
 - i. All fire service lines 4" and larger shall be Class 51 ductile iron pipe.
 - j. Line Sizing: The double check valve assembly or reduced pressure backflow prevention assembly shall be equal in size to the outgoing pipe diameter (downstream).
11. Prior the City of Bozeman's initial acceptance of the new fire service line (4" in diameter and larger) the line must be disinfected in accordance with Montana Public Works Specifications and City of Bozeman requirements. Flushing and pressure testing of the line shall be done in accordance with NFPA 24. Two (2) copies of the bacteriological tests results are to be submitted to the City Engineering Department, who will forward a

copy to the City Water Department.

12. Prior the City of Bozeman's initial acceptance of the new fire service line (4" in diameter and larger) the "Contractor's Material and Test Certificate for Underground Piping" (See Attachment B) must be completed and two (2) copies submitted to the City Engineering Department, who will forward a copy to the City Water Department.
13. Prior to the City of Bozeman's initial acceptance and activation of the fire service line (i.e., putting the line into service) a final inspection will be conducted by the City of Bozeman Water Superintendent, or his designated representative, to confirm that the installation is in accordance with the approved application and the approved plans. A Certificate of Inspection (see Attachment C) will be completed by the Water Superintendent, or his designated representative, upon completion of the final inspection, with copies of the Owner, Contractor, and Engineering Department. Installations that are in conformance with the approved plans for the project and have passed all required tests (see sections 11 and 12) will be initially accepted by the City of Bozeman as noted on the Certificate of Inspection. Installations that are not in conformance with the approved plans for the project will not be initially accepted by the City of Bozeman and the line will not be activated (i.e., placed in service) until the installation is in conformance with the approved plans and all required tests have been taken and passed.
14. The required two-year warranty period for the fire service line begins on the date of initial acceptance as noted on the Certificate of Inspection completed by the City of Bozeman Water Department.
15. Upon the City's initial acceptance (see Section 13) of the fire service line, the following must be submitted by the Project/Design Engineer to the City Engineer within thirty (30) days:
 - a. Two (2) sets of accurate blue line record drawings signed by the Engineer.
 - b. A letter of certification from the project Engineer stating that the fire service line was installed in accordance with the approved plans.

The City of Bozeman's final acceptance of the fire service line will be based on the letter of certification, record drawings, and correction of any deficiencies noted during the two-year warranty period.

16. Following the expiration of the two-year warranty period, the City of Bozeman will maintain, at its expense, the fire service line from the main up to the curb stop or curb valve, or to the property line or easement line, whichever is more. Any maintenance or repairs to the fire service line or its appurtenances beyond the point of City of Bozeman responsibility specified above shall be by a licensed contractor at the

Owner's expense. The building owner shall also be responsible for maintenance, repairs, and testing of all fire service line piping and appurtenances beyond the first control valve (OS&Y) inside the building.

17. The building owner may operate the first control valve (OS&Y) inside of the building when necessary for maintenance or repairs. When the first control valve (OS&Y) inside of the building is shut off for any reason, the City of Bozeman Fire Department must be notified immediately and informed of the shut down date, time and duration. **The building owner is completely responsible to ensure that this valve remains open at all times (except for maintenance or repairs) for the proper operation of the buildings fire protection system.**
18. Use of the fire service line shall be restricted to fire fighting use, emergency use and approved auxiliary (e.g., closed loop heating/cooling systems) including routine testing and flushing. Combined use lines (i.e., domestic and fire) are not acceptable for all buildings except single-family residences (SFRs). Separate service lines must be installed for individual domestic and fire services, except for SFRs. Fire sprinkler systems for SFRs may connect to the domestic supply inside the residence. Such connection must be made downstream of the backflow preventer. The backflow preventer must be a testable backflow preventer approved by the City of Bozeman's Backflow Prevention Specialist.
19. Bonding Requirements. The Owner shall require the Contractor to furnish Performance and Payment Bonds in favor of the Owner in an amount equal to one-hundred percent (100%) of the Agreement amount.

The bonds shall be signed by a surety company authorized to do business in the State of Montana, and acceptable as a surety to the Owner and countersigned by a Montana Resident Agent.

The bonds shall be filed with the Owner and the City of Bozeman and shall include a copy of Power of Attorney certified to include the date of the bonds.
20. Insurance Requirements. The Owner shall require the Contractor to secure and maintain such insurance from and insurance company (or companies) authorized to write insurance in the State of Montana, with a minimum "A.M. Best Rating" of B+, VI, as will protect himself, his subcontractors, the Owner, and the City of Bozeman and their respective agents and employees from claims for bodily injury, death, or property damage which may arise from operations and completed operations under the Agreement. The types and limits of coverage shall comply with the current edition of "Montana Public Works Standard Specifications". The Owner shall not authorize, nor shall the Contractor commence work under the Agreement until such insurance has been obtained and certificates of insurance, with binders, or certified copies of the insurance policy, have been filed with the Owner and the City of Bozeman.

All insurance coverages shall remain in effect throughout the life of the Agreement, except that the Contractor shall maintain the Commercial General Liability coverage for a period of at least one year following the substantial completion date for property damage resulting from occurrences during the Agreement period.

Each insurance policy shall contain a clause providing that it will not be cancelled by the insurance company without 30 days written notice to the Owner, and the City of Bozeman, of intention to cancel.

21. Warranty Period. If, within two years after initial acceptance of the work by the City of Bozeman, any of the work is found to be defective or not in accordance with the Contract Documents, and upon written notice from the City of Bozeman, the Owner shall cause the Contractor to correct any work within seven (7) calendar days of said written notice. Should the Owner or Contractor fail to the written notice within the designated time, the city of Bozeman may correct the work at the expense of the Owner/Contractor.

ATTACHMENT A

Backflow Prevention and System Classification

The City of Bozeman requires that the plans for the proposed fire service line include a description of the system including the “Class” of the system and the backflow prevention to be installed with the system. This Attachment provides standards for determining the Class of the proposed system and the required backflow protection to accompany the specific system. The standards in this Attachment are based on recommendations in American Water Works Association Manual M14, *Recommended Practice for Backflow Prevention and Cross-Connection Control*, and City of Bozeman requirements.

Classification for Backflow Protection

Class 1. Direct connections from public water mains only; no pumps, tanks, or reservoirs; no physical connection from other water supplies; no antifreeze or other additives of any kind; all sprinkler drains discharging to atmosphere, dry wells or other safe outlets.

Class 2. Same as Class 1 except that booster pumps may be installed in the building after the first interior control valve (OS&Y).

Class 3. Direct connection from public water supply mains, plus one or more of the following: elevated storage tanks, fire pumps taking suction from aboveground covered reservoir or tanks; and pressure tanks. (All storage facilities are filled or connected to public water only, the water in the tanks is to be maintained in a potable condition. Otherwise, Class 3 systems are the same as Class 1.)

Class 4. Directly supplied from public mains, similar to Class 1 and Class 2, with an auxiliary water supply dedicated to fire department use and available to the premises, such as an auxiliary supply located within 1700 feet of the pumper connection.

Class 5. Directly supplied from public mains and interconnected with auxiliary supplies, such as pumps taking suction from reservoirs exposed to contamination, or rivers and ponds; driven wells; mills or other industrial water systems; or where antifreeze or other additives are used.

Class 6. Combined industrial and fire protection systems supplied from the public water mains only, with or without gravity storage or pump suction tanks.

Required Protection

All systems regardless of Class require a means of flow detection which must be approved by the City of Bozeman.

Class 1. Minimum backflow protection requirement for a Class 1 system is an approved testable double check valve assembly to prevent water from backflowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Bozeman Standard Drawing 02660-13 for specific requirements.)

Exception: Special conditions may exist on the site of Class 1 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Bozeman.

Class 2. Minimum backflow protection requirement for a Class 2 system is an approved

testable double check valve assembly to prevent water from backflowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Bozeman Standard Drawing 02660-13 for specific requirements.)

Exception: Special conditions may exist on the site of Class 2 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Bozeman.

Class 3. Minimum backflow protection requirement for a Class 3 system is an approved testable double check valve assembly to prevent water from backflowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plan. (Refer to city of Bozeman Standard Drawing 02660-13 for specific requirements.)

Exception: Special conditions may exist on the site of Class 3 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Bozeman.

Class 4. The type of backflow protection for Class 4 systems will depend on the quality of the auxiliary supply. The type of backflow protection will be one of the following approved by the City of Bozeman: air gap or reduced-pressure backflow-prevention assembly. Reduced-pressure backflow-prevention assemblies should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to city of Bozeman Standard Drawing 02660-14 for specific requirements.)

Class 5. The type of backflow protection for Class 5 systems will be either a reduced-pressure backflow-prevention assembly or an air gap. Reduced-pressure backflow-prevention assemblies should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Bozeman Standard Drawing 02660-14 for specific requirements.)

Class 6. Class 6 system protection would depend on the requirements of both industry and fire protection and could only be determined by a survey of the premises.

ATTACHMENT B

Contractor's Material and Test Certificate for Underground Piping

Contractor's Material and Test Certificate for Underground Piping			
PROCEDURE Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job. A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.			
Property name			Date
Property address			
Plans	Accepted by approving authorities (names)		
	Address		
	Installation conforms to accepted plans ☐ Yes ☐ No Equipment used is approved ☐ Yes ☐ No If no, state deviations		
Instructions	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? If no, explain		☐ Yes ☐ No
	Have copies of appropriate instructions and care and maintenance charts been left on premises? If no, explain		☐ Yes ☐ No
Location	Supplies buildings		
Underground pipes and joints	Pipe types and class		Type joint
	Pipe conforms to _____ standard ☐ Yes ☐ No Fittings conform to _____ standard ☐ Yes ☐ No If no, explain		
	Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard ☐ Yes ☐ No If no, explain		
	Test description <u>Flushing:</u> Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at one of the flow rates as specified in 10.10.2.1.3. <u>Hydrostatic:</u> All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.5 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ± 5 psi (0.35 bar) for 2 hours. <u>Hydrostatic Testing Allowance:</u> Where additional water is added to the system to maintain the test pressures required by 10.10.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 10.10.2.2.6): $L = \frac{SD\sqrt{P}}{148,000}$ L = testing allowance (makeup water), in gallons per hour S = length of pipe tested, in feet D = nominal diameter of the pipe, in inches P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)		
Flushing tests	New underground piping flushed according to <u>NFPA-24</u> standard by (company) ☐ Yes ☐ No If no, explain		
	How flushing flow was obtained ☐ Public water ☐ Tank or reservoir ☐ Fire pump		Through what type opening ☐ Hydrant butt ☐ Open pipe
	Lead-ins flushed according to _____ standard by (company) ☐ Yes ☐ No If no, explain		
	How flushing flow was obtained ☐ Public water ☐ Tank or reservoir ☐ Fire pump		Through what type opening ☐ Y connection to flange and spigot ☐ Open pipe

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FIGURE 10.10.1 Sample of Contractor's Material and Test Certificate for Underground Piping.



Hydrostatic test	All new underground piping hydrostatically tested at _____ psi for _____ hours		Joints covered ☐ Yes ☐ No
Leakage test	Total amount of leakage measured _____ gallons _____ hours		
	Allowable leakage _____ gallons _____ hours		
Forward flow test of backflow preventer	~~Forward flow test performed in accordance with 10.10.2.5.2:~~ ☐ Yes ☐ No		
Hydrants	Number installed	Type and make	All operate satisfactorily ☐ Yes ☐ No
Control valves	Water control valves left wide open If no, state reason		☐ Yes ☐ No
	Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm		☐ Yes ☐ No
Remarks	Date left in service		
Signatures	Name of installing contractor		
	Tests witnessed by		
	For property owner (signed)	Title	Date
	For installing contractor (signed)	Title	Date
Additional explanation and notes			
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FIGURE 10.10.1 Continued

ATTACHMENT C

Certificate of Inspection

CERTIFICATE OF INSPECTION
FOR
FIRE SERVICE LINE INSTALLATION

Date: _____ Time: _____

City of Bozeman Water Department Inspector: _____

This is the 1st 2nd 3rd inspection of this installation.

Fire Service Line Installed For:

Owner of Building: _____

Owner's Address: _____

Owner's Phone: _____ Building Phone: _____

Building Address: _____

Building Name: _____

Fire Service Line Installed By:

Name of Contractor: _____

Contractor's Address: _____

Contractor's Phone: _____

Person to Contact: _____

The following were present during this inspection:

The fire service line is installed in accordance with City of Bozeman requirements for the project: **YES** **NO**

Bacteriological Tests have been completed and passed: **YES** **NO**

The "Contractor's Material & Test Certificate for Underground Piping" has been completed and submitted to the City Engineer (i.e. pressure tests have been conducted and passed): **YES** **NO**

If the answer to all the above items is "YES" then the City of Bozeman initially accepts the fire service line and the two year warranty period begins on the date of this inspection.

The fire service line was activated (placed into service) during this inspection: YES NO

(If "NO" indicate below the reason and the date it is to be activated.)

The first interior valve (OS&Y) was left in the OPEN CLOSED position at the completion of this inspection.

OWNER NOTE: When the first control valve (OS&Y) inside of the building is shut off for any reason, the City of Bozeman Fire Department must be notified immediately and informed of the shut down date, time, and duration.

=====

Comments: _____

cc: Owner
Contractor
City Engineer's Office

**CERTIFICATE OF
COMPLETION AND ACCEPTANCE**

OWNER: _____ PROJECT TITLE: _____

DATE OF ACCEPTANCE: _____ PROJECT NO.: _____

PROJECT DESCRIPTION: _____

PROJECT LOCATION: _____

CONTRACTOR: _____

ENGINEER: _____

Substantial Completion Date: _____ Two-year warranty expiration date: _____

The Work performed under the Contract for the above Project has been inspected by a representative of the Owner, Contractor, City of Bozeman, and Engineer and has been found to substantially comply with the approved Contract Documents and is hereby declared complete. Acceptance by the Owner and City of Bozeman and recommendation thereto by the Engineer does not affect the "Contractor's Continuing Obligation" as described in Article 14.15 of the Standard General Conditions of the Construction Contract, or the Owner's contractual obligations.

Maintenance Bond with City of Bozeman named as dual obligee is attached.

ENGINEER'S RECOMMENDATION

On the basis of observation of the Work during construction, final inspection and review of project testing, final application for payment and accompanying documents, the Engineer is satisfied and hereby certifies that the Work has been completed in accordance with the approved Contract Documents. This acceptance shall not relieve the Contractor of his obligations under the Contract Documents.

Engineer

By: _____
Printed Name: _____
P.E. # _____ Date _____

CONTRACTOR'S CONCURRENCE WITH ENGINEER'S RECOMMENDATION

Contractor

By: _____
Printed Name: _____
Title: _____
Date: _____

OWNER'S ACCEPTANCE AND GRANT OF POSSESSION

On the basis of independent observations and inspections and the recommendations of the Engineer, the Owner accepts the Project as complete. This acceptance does not relieve the Contractor of continuing obligations as described above. The Contractor is reminded this Project is under warranty beginning _____ and that bonds shall remain in effect for two years after the Date of Acceptance specified above. The Owner hereby grants possession of all public infrastructure improvements completed by this Project to the City of Bozeman and warrants against defects in these improvements for a period of two years from the Date of Acceptance specified above.

Owner

By: _____
Printed Name: _____
Title: _____
Date: _____

CITY OF BOZEMAN'S ACCEPTANCE

The City of Bozeman hereby accepts possession of all public infrastructure improvements, subject to the above indicated warranty. This acceptance does not relieve the Owner or Contractor of his continuing obligations for this work as described above or otherwise required through Improvement Agreements, conditions of plat approval, or his other contractual commitments.

City of Bozeman _____

By: _____
Title: _____
Date: _____

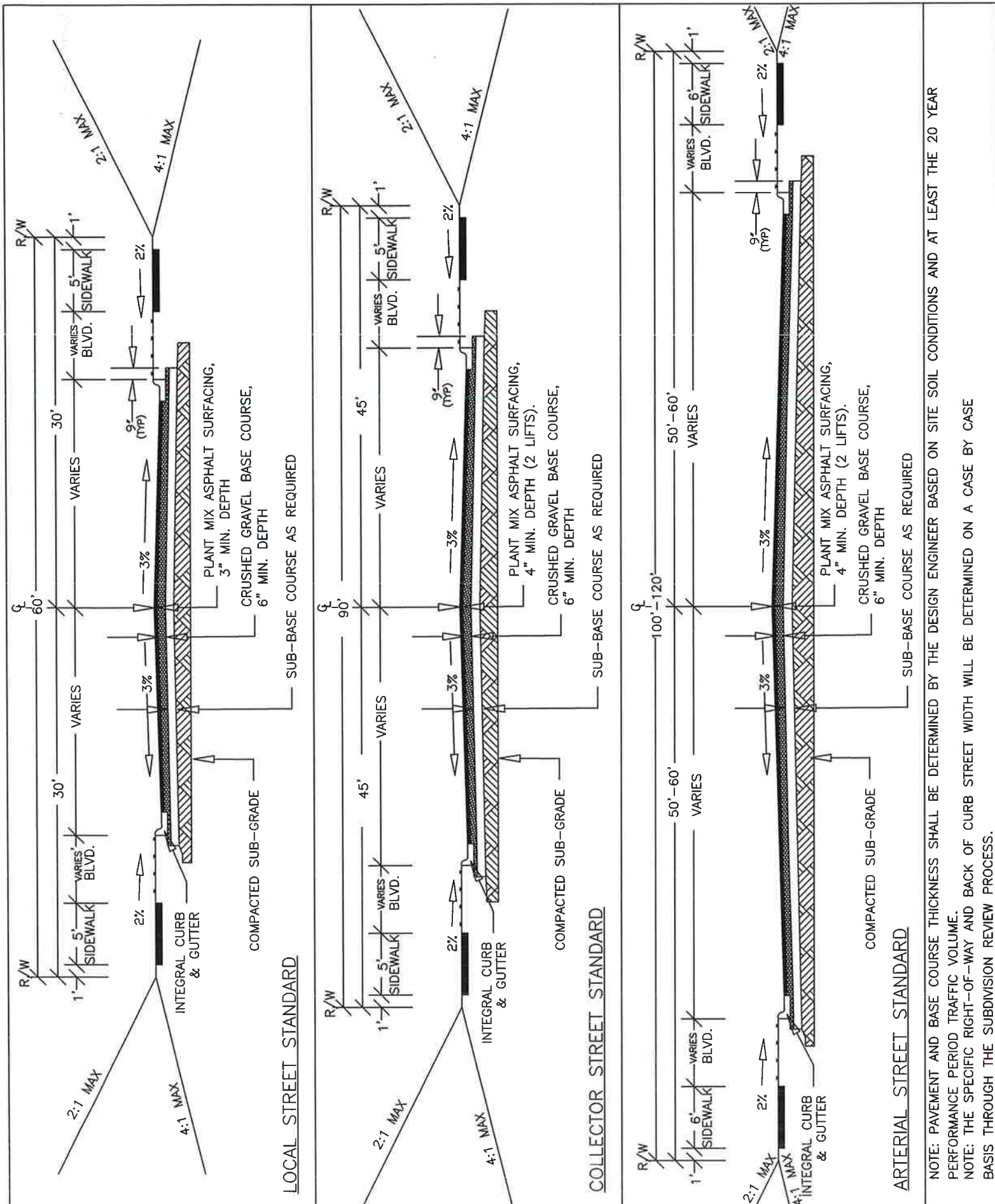
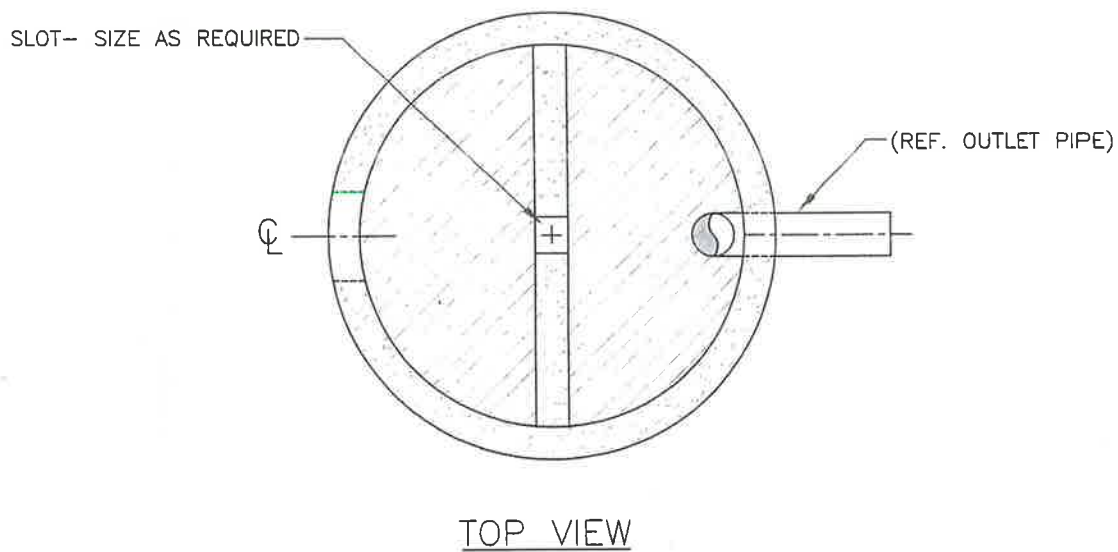


FIGURE A-1: TYPICAL ROADWAY SECTIONS
 CITY OF BOZEMAN DESIGN STANDARDS & SPECIFICATIONS POLICY



SIZING DETENTION BASINS – SAMPLE PROBLEM
(Rational Method)

Given: Existing Land Use:	Agricultural
Proposed Land Use:	Industrial
Drainage Area:	5 Acres
Slope:	1%
Overland Travel Distance to Channel:	120 feet
Channel Time:	4 minutes
Max. Basin Water Depth Allowable:	1 foot

Problem:

Size a detention basin to control runoff to pre-development levels and to remove sediment (40 micron particle).

Solution:

Existing Situation

Land Use:	Agricultural
Area:	5 Acres
C =	0.20 (Table I-1)
Time of Concentration:	16 minutes (Figure I-1) + 4 minutes = 20 minutes
Design Storm Frequency:	10 year (Table I-3) (Based on Future use Design Frequency)
Intensity at Tc:	1.3071 in/hr (Figure I-3)
Peak Runoff Rate:	$(0.20) (1.3071) (5) = 1.31 \text{ cfs}$

Future Situation

Land Use:	Industrial
Area:	5 Acres
C =	0.80 (Table I-1)
Time of Concentration:	6 minutes (Figure I-1) + 4 minutes = 10 minutes
Design Storm Frequency:	10 year (Table I-3)

Detention Basin Sizing

Design Release Rate:	1.31 cfs
----------------------	----------

MINIMUM VOLUME

Storm Duration (Minutes)	Intensity (in/hr)	Future Runoff Rate ($Q = CiA$) (cfs)	Runoff Volume (cf)	Release Volume (cf)	Required Storage (cf)
25	1.1306	4.52	6780	1965	4815
27	1.0755	4.30	6966	2122	4844
29	1.0266	4.11	7175	2279	4872
31	0.9831	3.93	7310	2437	4873
33	0.9439	3.78	7484	2594	4890*
35	0.9085	3.63	7623	2751	4872

* Minimum Volume Required – 4890 cf

- Note: 1. If controlling volume falls at a storm duration less than the future time of concentration, use the volume at the time of concentration.
 2. Based on Minimum Volume and using 1 foot depth, Surface Area = 4890 sf.

MINIMUM AREA

Assumptions:

1. Non-flocculant particles.
2. Settling velocity of 40 micron particles = 0.0069 ft/sec.

Design Release Rate: 1.31 cfs

Minimum Area Required: $1.31 \text{ cfs} \div 0.0069 \text{ ft/sec} = 190 \text{ sf}$

(Since $4890 > 190 \text{ sf}$, use 4890 sf)

BASIN SIZING

Water Depth: 1 foot
 Surface Area: 4890 sf
 Volume: 4890 cf
 Length: 123 ft.
 Width: 40 ft.

PRECONSTRUCTION MEETING CRITERIA CHECKLIST

PROJECT NAME: _____

PROJECT TYPE: _____
(water, sanitary sewer, storm sewer, streets)

OWNER/DEVELOPER: _____

ENGINEER: _____

CONTRACTOR: _____

PRECONSTRUCTION CONFERENCE SUBMITTALS CHECKLIST

REQUIRED SUBMITTAL	REQUIRED	DATE REC.	COMMENTS
Approved Plans & Specifications: DEQ Approval COB Approval			
Executed Easements			
Abandoned Easements			
Shop/Fabrication Drawings ** (submit two days before precon. mtg.)			
Traffic Control Plan (submit one week before precon. mtg.)			
Electronic Plans on CD (.dwg or .PDF) (submit two days before precon.mtg.)			
Copy of Contractor's Bonds			Bonds shall be in effect until 2 yrs after the date of final completion and acceptance by the City.
Copy of Contractor's Insurance			
PERMITS: Dewatering Discharge Permit (MDHES) *			
310 Permit (SCS/FWP) *			
404 Permit (Corps) *			
Stormwater Control Permit (MDHES) *			
Street Cut Permit (COB/County) *			
Utility Occupancy Permit (MDOT/County) *			
Flood Plain (COB) *			

PRECONSTRUCTION MEETING DATE:

(Will not be scheduled until all above applicable submittals are received.)

** Note: Shop/Fabrication Drawings shall bear Engineer's approval when submitted.

* Note: To be determined by design engineer.

**CITY OF BOZEMAN
PLAN AND SPECIFICATION CERTIFIED CHECKLIST**

Project Name:

Engineer:

Reports Received:

- ☐ Utilities Design Report
☐ Traffic Impact Analysis
☐ Stormwater Facilities Design

CHECKLIST SUBMITTAL INSTRUCTIONS

This checklist may be used in lieu of a complete department review when the conditions listed below are met. The department reviews all certified checklists for completeness and accuracy and must approve all deviation requests. Deviation requests will result in slower turn-around by the department. Construction may not begin until approval of the certified checklist is granted by the department, and a preconstruction meeting is held. Department approval will be issued in a letter to the design engineer submitting the plans and specifications.

All sections of the certified checklist must be completed. *The answer yes may be checked when all the requirements of the section being addressed are satisfied.* Where a yes answer cannot be given, a deviation must be requested or the applicant must explain why that section of the standard is not applicable. All deviation requests must be justified by the design engineer and supported with appropriate documentation.

All infrastructure certified checklists must be signed and stamped by the professional engineer responsible for the design of the project. In addition, four sets of plans and specifications signed and stamped by a professional engineer must be included.

The plans and specifications for the above referenced project are in compliance with the following sections of the City of Bozeman Design Standards.

PRELIMINARY REQUIREMENTS				
1.	Project approval obtained from City Commission			
		☐ Yes	☐ Deviation Requested:	
		☐ NA	Explain:	
2.	All conditions of project approval have been addressed			
		☐ Yes	☐ Deviation Requested:	
		☐ NA	Explain:	

I.	CONSTRUCTION PLANS AND SPECIFICATIONS REQUIREMENTS		
A.	General Requirements		
	1.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	3.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	4.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	5.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	6.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	7.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	8.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	9.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
B.	Specification Requirements		
	1.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
C.	Drawing Scales		
	1.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	3.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
D.	Plan Requirements		
	1.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
E.	Utility Plan Requirements		
	1.a.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	1.b.	☐ Yes	☐ Deviation Requested:

			☐ NA	Explain:
		1.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		1.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	F.	Roadway Plan Requirements		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
II.	DRAINAGE POLICY			
	A.	General Design Criteria		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.e.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.f.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	B.	Storm Drainage Plan		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	C.	Storage/Treatment Facilities		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.e.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	D.	Discharge Structures		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

E.	Estimation of Runoff		
	1.a.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	1.b.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	1.c.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	3.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	4.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	5.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	6	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
III.	FLOODPLAIN REGULATIONS		
A.	General		
		☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
IV.	ROADWAY DESIGN AND TECHNICAL CRITERIA		
A.	General		
		☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
B.	Sidewalks, curbs and gutters and driveways		
	1.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	2.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	3.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	4.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	5.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	6.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:
	7.	☐ Yes	☐ Deviation Requested:
		☐ NA	Explain:

		8.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	C.	Drainage		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	D.	Horizontal Alignment		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		9.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	E.	Vertical Alignment		

		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	F.	Median Treatment		
			☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	G.	Roadway Specifications		
			☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	H.	Signs and Markings		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.a	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.b	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.c	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.d	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

		3.e	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	I.	Monumentation		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	J.	Lighting		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	K.	Bike Lanes/Paths		
			☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
V. UTILITY DESIGN CRITERIA				
	A.	Water Distribution Lines		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.a	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.e.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.f.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.g.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

		6.h.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		9.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		10.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		11.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	B.	Sanitary Sewer System Design Criteria		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		9.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		10.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		11.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

		12.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		13.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	C.	Storm Sewers		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		6.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		7.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.e.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

		8.f.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		8.g.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		9.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
	D.	Alignment, Depth, and Easements		
		1.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		2.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		3.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		4.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.a.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.b.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.c.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:
		5.d.	☐ Yes	☐ Deviation Requested:
			☐ NA	Explain:

Certified By: _____
(Signature of Professional Engineer)

Date: _____

Montana P.E. Number: _____

CERTIFIED CHECKLIST FOR TESTING & DOCUMENTATION REQUIREMENTS FOR INFRASTRUCTURE IMPROVEMENTS

All sections of the certified checklist must be completed. *The answer yes may be checked when all the requirements of the section being addressed are satisfied.* Where a yes answer cannot be given, a deviation must be requested or the applicant must explain why that section of the standard is not applicable. All deviation requests must be justified by the design engineer and supported with appropriate documentation. All infrastructure certified checklists must be signed and stamped by a professional engineer licensed in the state of Montana.

A.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
B.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
C.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
D.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
E.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
F.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
G.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
H.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
I.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
J.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:
K.	☐ Yes	☐ Deviation Requested:
	☐ NA	Explain:

Certified By: _____
(Signature of Professional Engineer)

Date: _____

Montana P.E. Number: _____

SAMPLING MATERIALS BY RANDOM NUMBER SAMPLING

1. SCOPE - This method provides a procedure, in the form of several examples, for selecting samples on an approximately random basis using a system of random numbers. To accomplish this selection, choose the random sample so that each unit of material (i.e., cubic yard, square yard, ton, etc.) has the same probability of being selected. Divide each material sampled into lots, and establish a frequency of sampling.
2. PROCEDURE -
 - 2.1. Random numbers can be generated by some calculators by planting a seed number such as date, time of day, etc., expressed as a decimal between 0 and 1. Included in this method are two tables of random numbers for use. Enter the table in a random method, such as a blind placement of a pencil. After choosing the first random number in this manner, choose consecutive numbers, following a column (or row), until the entire table has been used. At that time, repeat the initial process of random entry into the table of numbers. This method will reduce the possibility of using a value from the table more than once.
 - 2.2. Following are examples related to particular phases of highway construction:
 - 2.2.1. EXAMPLE NO. 1

In this example, select station numbers for density coring of a 0.75-in. nominal-maximum mixture. Specifications require four density cores for each 1 000 tons of mixture placed. The subplot size is 1000 tons with a frequency of four cores per subplot. The subplot of mixture in question will be placed on a 12-ft.-wide lane that is 4545 ft. long. The lift thickness of the 0.75-in. nominal-maximum mixture is 3.0 in. The job starts at Station No. 0+00.

Since four density cores are required for the entire 4545-ft. length, obtain one core for each 1136.25 ft. of pavement. Use the following steps to determine the station number and offset for each density core:

- 2.2.1.1. Refer to the random number table (see p. 5 for example).
- 2.2.1.2. Enter the table at any point. Select four consecutive numbers from the random number table. Use these numbers for finding the station number of the core site in each 1136.25-ft. section.

Multiply each random number by 1136.25 to determine the station number at which to obtain the density core. After determining the

location of the first core, for each of the remaining cores, add increments of 1136.25 ft., increasing with each core, to provide locations throughout the entire subplot length.

SAMPLE NO.	RANDOM NUMBER CALCULATION	STATION NUMBER
1	$0.420 \times 1136.25 = 477.23 + 0.00 = 477$	4 + 77
2	$0.859 \times 1136.25 = 976.04 + 1136.25^* = 2112$	21 + 12
3	$0.011 \times 1136.25 = 12.50 + 2272.50 = 2285$	22 + 85
4	$0.762 \times 1136.25 = 865.82 + 3408.75 = 4275$	42 + 75

*1136.25-ft. increments, as determined by the subplot length, provide resultant numbers throughout the entire subplot length.

According to Subsection 402.03.02 of the *Standard Specifications*, obtain cores no closer than three inches from the pavement edge or joint. To select the transverse distance from the pavement edge (left or right), select four additional consecutive numbers from the random number table (see p. 5 for example), and multiply each random number by 11.5 (12-ft. lane width minus the 0.25-ft. offset from each side). For this example, calculate the distance from 0.25 ft. inside of the right edge of the pavement.

SAMPLE NO.	RANDOM NO. CALCULATION	OFFSET FROM RIGHT EDGE
1	$0.062 \times 11.5 + 0.25 =$	1.0 ft.
2	$0.100 \times 11.5 + 0.25 =$	1.4 ft.
3	$0.409 \times 11.5 + 0.25 =$	5.0 ft.
4	$0.784 \times 11.5 + 0.25 =$	9.3 ft.

Therefore, from the calculations above, conform to the coring schedule given below for this subplot:

SAMPLE NO.	STATION NUMBER	OFFSET FROM RIGHT EDGE
1	4 + 77	1.0 ft.
2	21 + 12	1.4 ft.
3	22 + 85	5.0 ft.
4	42 + 75	9.3 ft.

With respect to this example, in other cases, the paving length and width will vary, but use the same procedure for obtaining random locations.

2.2.2. EXAMPLE NO. 2

In this example, select trucks to sample for running air content, slump, and concrete cylinders on Class AA Concrete for a bridge deck pour.

The pour will consist of 250 cubic yards of concrete. The trucks will be hauling 10 cubic yards each. The testing frequency is one test for each 50 cubic yards; therefore, perform five tests. There will be at least five tests required. Use the following steps to select the trucks to sample:

2.2.2.1. Refer to the random number table (see p. 5 for example).

2.2.2.2. Select five consecutive numbers from the random number table. Use these numbers to determine which trucks to sample. Multiply each number by 50 (a lot size of 50 cubic yards), and divide the answer by 10 (cubic yards per truck) to determine which trucks to sample.

SAMPLE NUMBER	RANDOM NUMBER	CALCULATED VOLUME (cubic yards)	TRUCK SAMPLED
1	0.007	$x 50 = 0.35 + 0 = 0.35 \div 10 = 0.04^*$	1st
2	0.922	$x 50 = 46.1 + 50^{**} = 96.1 \div 10 = 9.6$	10th
3	0.729	$x 50 = 36.5 + 100 = 136.5 \div 10 = 13.7$	14th
4	0.949	$x 50 = 47.5 + 150 = 197.5 \div 10 = 19.8$	20th
5	0.606	$x 50 = 30.3 + 200 = 230.3 \div 10 = 23.03$	24th

*When this answer contains a decimal, always round upward to the next highest whole number to determine the truck number.

**Add increments of 50 cubic yards (lot size), increasing with each sample, in order to provide sampling throughout the full 250 cubic yards.

2.2.3. EXAMPLE NO. 3

In this example, select the accumulated tonnage of Crushed Stone Base for gradation testing. The frequency for gradation testing of aggregate bases is one test per 2000 tons of material. Plan quantities show 10,000 tons of Crushed Stone Base exist on this project. This quantity will require five gradation tests.

Again, select five consecutive random numbers from the random number table (see p. 5 for example). Use these numbers to determine the accumulated tonnage at which to select the sample.

Multiply each number by 2000 to determine the accumulated tonnage for sampling. Add increments of 2000 tons (lot size), increasing with each sample, in order to provide sampling throughout the full 10,000 tons.

SAMPLE NUMBER	RANDOM NUMBER CALCULATION	ACCUMULATED TONNAGE
1	$0.658 \times 2000 = 1316 + 0 =$	1316
2	$0.747 \times 2000 = 1494 + 2000 =$	3494
3	$0.270 \times 2000 = 540 + 4000 =$	4540
4	$0.715 \times 2000 = 1430 + 6000 =$	7430
5	$0.418 \times 2000 = 836 + 8000 =$	8836

Obtain samples as near the above-listed accumulated tonnages as possible.

- 2.3. The system of selecting random samples can be related to periods of time, number of pieces, tons, etc. The key to randomness, using this method, relies heavily on the manner of entering the table. Do not use the same set of numbers repeatedly.

km113.doc

TABLE 1
RANDOM NUMBERS

.600	.504	.248	.230	.996	.462	.422	.054	.224	.121
.116	.227	.802	.349	.241	.956	.079	.632	.126	.677
.098	.726	.507	.607	.963	.410	.572	.777	.237	.851
.147	.867	.802	.416	.370	.377	.775	.256	.348	.148
.644	.067	.001	.158	.702	.148	.667	.217	.421	.149
.310	.531	.520	.560	.888	<i>E</i> .287	.567	.251	.593	.571
.493	.235	.886	.178	.490	<i>X</i> .007	.640	.343	.894	.079
.788	.272	.484	.487	.277	<i>A</i> .922	.435	.716	.924	.304
.652	.523	.317	.601	.705	<i>M</i> .729	.669	.435	.984	.239
.816	.045	.423	.943	.227	<i>#</i> .949	.395	.931	.887	.242
.086	.585	.177	.851	.513	<i>2</i> .606	.911	.253	.669	.328
.689	.755	.027	.183	.024	<i>E</i> .658	.041	.512	.518	.910
.117	.029	.309	.017	.926	<i>X</i> .747	.584	.570	.212	.504
.700	.989	.980	.532	<i>E</i> .640	<i>A</i> .270	.610	.257	.996	.978
.321	.431	.370	.814	<i>X</i> .420	<i>M</i> .715	.548	.148	.953	.450
.515	.775	.759	.438	<i>A</i> .859	<i>#</i> .418	.689	.924	.350	.724
.543	.575	.633	.097	<i>M</i> .011	<i>3</i> .170	.357	.429	.899	.087
.629	.502	.503	.036	<i>#</i> .762	.280	.605	.518	.275	.017
.221	.882	.206	.415	<i>1</i> .776	.548	.520	.417	.253	.808
.751	.446	.189	.776	.465	.936	.970	.467	.371	.077
.553	.160	.464	.309	.298	.304	.613	.512	.816	.270
.384	.778	.284	.435	.246	.319	.078	.695	.152	.637
.969	.740	.102	.093	.055	.155	.225	.782	.226	.250
.085	.125	.750	.900	.991	.887	.993	.183	.096	.542
.667	.355	.784	.803	<i>E</i> .072	.206	.508	.385	.691	.127
.076	.968	.527	.749	<i>X</i> .062	.075	.526	.292	.176	.310
.788	.943	.091	.141	<i>A</i> .100	.040	.750	.870	.249	.345
.165	.422	.601	.095	<i>M</i> .409	.897	.963	.271	.770	.100
.472	.201	.558	.725	<i>#</i> .784	.025	.943	.040	.984	.011
.668	.708	.776	.490	<i>1</i> .270	.868	.658	.954	.916	.955

TABLE 1
RANDOM NUMBERS

.600	.504	.248	.230	.996	.462	.422	.054	.224	.121
.116	.227	.802	.349	.241	.956	.079	.632	.126	.677
.098	.726	.507	.607	.963	.410	.572	.777	.237	.851
.147	.867	.802	.416	.370	.377	.775	.256	.348	.148
.644	.067	.001	.158	.702	.148	.667	.217	.421	.149
.310	.531	.520	.560	.888	.287	.567	.251	.593	.571
.493	.235	.886	.178	.490	.007	.640	.343	.894	.079
.788	.272	.484	.487	.277	.922	.435	.716	.924	.304
.652	.523	.317	.601	.705	.729	.669	.435	.984	.239
.816	.045	.423	.943	.227	.949	.395	.931	.887	.242
.086	.585	.177	.851	.513	.606	.911	.253	.669	.328
.689	.755	.027	.183	.024	.658	.041	.512	.518	.910
.117	.029	.309	.017	.926	.747	.584	.570	.212	.504
.700	.989	.980	.532	.640	.270	.610	.257	.996	.978
.321	.431	.370	.814	.420	.715	.548	.148	.953	.450
.515	.775	.759	.438	.859	.418	.689	.924	.350	.724
.543	.575	.633	.097	.011	.170	.357	.429	.899	.087
.629	.502	.503	.036	.762	.280	.605	.518	.275	.017
.221	.882	.206	.415	.776	.548	.520	.417	.253	.808
.751	.446	.189	.776	.465	.936	.970	.467	.371	.077
.553	.160	.464	.309	.298	.304	.613	.512	.816	.270
.384	.778	.284	.435	.246	.319	.078	.695	.152	.637
.969	.740	.102	.093	.055	.155	.225	.782	.226	.250
.085	.125	.750	.900	.991	.887	.993	.183	.096	.542
.667	.355	.784	.803	.072	.206	.508	.385	.691	.127
.076	.968	.527	.749	.062	.075	.526	.292	.176	.310
.788	.943	.091	.141	.100	.040	.750	.870	.249	.345
.165	.422	.601	.095	.409	.897	.963	.271	.770	.100
.472	.201	.558	.725	.784	.025	.943	.040	.984	.011
.668	.708	.776	.490	.270	.868	.658	.954	.916	.955

TABLE 2
RANDOM NUMBERS

.605	.973	.319	.294	.236	.572	.216	.973	.931	.870
.720	.497	.679	.634	.299	.578	.743	.835	.062	.200
.918	.295	.295	.777	.854	.281	.867	.864	.374	.748
.294	.396	.441	.321	.655	.191	.205	.899	.807	.186
.089	.927	.802	.530	.937	.257	.530	.005	.539	.999
.591	.409	.668	.967	.993	.920	.812	.018	.578	.618
.494	.808	.410	.097	.633	.149	.547	.895	.829	.953
.021	.699	.597	.286	.982	.953	.913	.422	.291	.979
.926	.085	.758	.624	.491	.694	.496	.490	.949	.457
.351	.709	.461	.093	.498	.377	.639	.801	.388	.334
.329	.857	.949	.550	.095	.906	.596	.462	.891	.758
.126	.525	.834	.677	.045	.699	.568	.147	.902	.664
.572	.101	.066	.147	.069	.006	.979	.259	.765	.460
.728	.374	.402	.679	.601	.492	.002	.512	.529	.089
.524	.346	.698	.133	.013	.907	.992	.453	.883	.684
.176	.870	.306	.179	.071	.854	.086	.414	.973	.785
.031	.437	.512	.107	.842	.507	.458	.018	.881	.506
.826	.110	.065	.878	.182	.460	.442	.504	.075	.027
.945	.640	.283	.330	.163	.496	.767	.543	.921	.923
.948	.890	.677	.328	.075	.752	.207	.692	.268	.204
.232	.639	.425	.434	.795	.329	.941	.026	.867	.035
.896	.502	.074	.092	.203	.625	.541	.505	.835	.021
.643	.838	.357	.294	.592	.440	.676	.186	.304	.212
.552	.892	.843	.851	.685	.847	.963	.189	.604	.634
.623	.955	.024	.718	.534	.978	.962	.208	.645	.811
.988	.648	.182	.983	.128	.784	.606	.138	.208	.337
.326	.500	.874	.958	.826	.523	.462	.823	.955	.773
.130	.545	.756	.164	.418	.817	.707	.882	.984	.903
.907	.419	.705	.597	.655	.566	.546	.738	.614	.373
.859	.365	.476	.351	.154	.458	.645	.303	.631	.832

City of Bozeman Street Naming and Addressing Policy

- A. All new street names, for both public and private streets, shall be approved by the City Engineering Department and the Gallatin County GIS Department.
- B. Street names will not be reserved. Street names shall be approved prior to preliminary plat and final plat approval. Street names become effective upon filing of the final plat.
- C. Street Name Selection
 - 1. A new street shall assume the name of the street on which it aligns unless the street does not and cannot in the future connect to an existing street segment along the alignment.
 - 2. Duplication of street names will not be permitted. Proposed street names that have the same primary name of an existing street but a different suffix (e.g. Smith Drive and Smith Lane) are considered duplicates and will not be permitted.
 - 3. Similar (text or phonetic) or confusing spelling of street names will not be permitted (e.g. Briar Lane / Brier Lane; Allen Lane / Alan Lane; Beech Street / Peach Street).
 - 4. Only the common spelling of street names will be accepted (e.g. Jane not Jayne, Green not Greene)
 - 5. Names that tend to be slurred or difficult to pronounce shall not be used.
 - 6. Do not use special characters in street names such as hyphens, apostrophes, or dashes.
 - 7. No new street names shall consist of more than two (2) words or contain more than fifteen (15) characters, excluding the suffix (street, avenue, etc.) and directional prefix, if any.
 - 8. Wherever possible, new north-south streets that are west of the east-west zero line (Tracy Ave.) shall be designated as the appropriate numbered avenue.
 - 9. No street name shall begin with an article.
- D. Directional Prefixes
 - 1. All streets that cross the east-west zero baseline shall be designated with the appropriate east or west directional prefix. The east-west zero baseline

is Tracy Avenue as extended and shown on the City of Bozeman's address grid map.

2. All streets that cross the north-south zero baseline shall be designated with the appropriate north or south directional prefix. The north-south zero baseline is Main Street as extended and shown on the City of Bozeman's address grid map.

E. Street Type Designations

1. Street type designations should reflect the size and function of a street. Street types are contained in the suffix of the street name.
2. Approved street type descriptions and abbreviations are as follows:
 - a) Avenue (AVE): a continuous street with a definite north-south directional course.
 - b) Boulevard (BLVD): a wide arterial or collector type roadway, typically with a median.
 - c) Circle (CIR): a street that intersects another street only once and terminates in a closed loop.
 - d) Court (CT): a relatively short, uninterrupted dead-end street.
 - e) Drive (DR): a curvilinear or winding street which continues through to other rights-of-way.
 - f) Lane (LN): a minor roadway within a subdivision.
 - g) Loop (LOOP): a relatively short, uninterrupted street that begins and ends on the same parent street at two different points, or a street that connects to two intersecting perpendicular streets.
 - h) Parkway (PKWY): same as boulevard.
 - i) Place (PL): a relatively short, uninterrupted dead-end street.
 - j) Road (RD): an arterial or collector type roadway that may run in any direction. This street type designation should not be used for new streets in the City of Bozeman, unless the new street is an extension of an existing street designated as a road.
 - k) Street (ST): a continuous street with a definite east-west directional course.

l) Way (WAY): a minor roadway within a subdivision.

3. Private roads should use the designations Place or Way.

F. Cul-de-sacs and bubbles

1. When a cul-de-sac is located at the end of an existing street right-of-way or alignment, it shall be given the name of that street, including the suffix, whether the cul-de-sac is straight, curves, or meanders.
2. When two cul-de-sacs approach each other from opposite directions and are in the same alignment but do not join in any manner, they shall be assigned different street names.
3. Cul-de-sac or bubble streets less than 100 feet in length that provide frontage for three or fewer lots shall not be named, but shall take the name and numbering of the street adjoining.

G. Addressing

1. Subdivision developers shall make arrangements with the Engineering Department to assign addresses for all individual lots in the subdivision prior to filing of the final plat. A copy of the proposed final plat showing approved street names shall be submitted for use in assigning addresses. Unless the proposed project has been designated for concurrent construction, the lot addresses will not be entered into the City address database until the final plat has been filed.
2. One street address number will be assigned for each separate building by the Engineering Department. For projects with multiple buildings on a single lot, a site plan showing the proposed buildings shall be submitted to the Engineering Department for address assignment prior to site plan approval. Developers of multi-unit buildings shall assign the unit or suite numbers. A floor plan showing the proposed unit or suite designations shall be submitted for approval to the City Engineer's office prior to site plan or building permit approval. Unit/suite numbers shall be assigned based on the following guidelines:
 - a) Multi-unit residential buildings (including condominiums) on separate lots: assign consecutive unit numbers (Unit 1, Unit 2, etc.) or unit letters (Unit A, Unit B, etc.) for each unit.
 - b) Multi-unit residential buildings (including condominiums) on one lot: assign consecutive unit numbers for all the units in the

development, beginning at the building closest to the main roadway entrance and continuing in a logical manner through all of the buildings (i.e.: first building: 2301 Smith Street, Units 1, 2, 3, 4; second building: 2305 Smith Street, Units 5, 6, 7, 8). Use a counter-clockwise circular sweep starting from the right side of the primary entryway as you enter. Systematically increment numbers throughout all buildings on the site so as to end at the left side of the same entryway. Avoid oscillating back and forth across the site as much as possible. If the buildings have dwelling units on separate floors, use 3-digit numbers for all of the units, with the first number being the floor level. All building accesses shall clearly identify which units are served by the access.

- c) Multi-unit commercial buildings: use 3-digit numbers for the units or suites, with the first number being the floor level of the unit.
- d) Accessory dwelling units shall be assigned a separate street number, however if there are no remaining street numbers available, the main dwelling unit on the property shall be designated unit A and the accessory dwelling unit shall be designated Unit B.

BOZEMAN LIGHTING AND ELECTRICAL SPECIFICATIONS

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City of Bozeman

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Section I. General

These specifications for the provision of lighting installations are intended to provide a set of minimum standards that shall be followed for street lighting, pedestrian lighting and pathway lighting installations within the City of Bozeman public right-of-way or property. These standards, plans, and any special provisions shall apply to all materials supplied, methods, and procedures of work to be followed, and other general minimum requirements that shall be complied with before work is accepted by the City of Bozeman.

The City of Bozeman has adopted the following as part of these standard specifications:

- A Standard Specifications for Road and Bridge Construction (latest edition), Montana Department of Transportation, and all amendments and revisions pertaining thereto.
- B Manual on Uniform Traffic Control Devices (latest edition), Federal Highway Administration.
- C NFPA 70 - National Electrical Code (latest edition)
- D NESC - National Electrical Safety Code

The standard specifications outlined in this document are revisions and amendments to the Montana Department of Transportation Standard Specifications for Road and Bridge Construction. In situations where there is a conflict or question of interpretation, these specifications and any special provisions shall prevail.

These specifications, the plans, any special provisions, and all supplemental documents are essential parts of a contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for the complete work. In case of a discrepancy, figured dimensions shall govern over scaled dimensions; plans shall govern over standard specifications; and special provisions shall govern over plans and standard specifications.

Section II. Definitions

Special Improvement Lighting District (SILD) an improvement district embracing street or streets or public highway therein or portions thereof and property adjacent thereto or property which may be declared by said council to be benefitted by the improvement to be made for the purpose of lighting such street or streets or public highway. All or any portion of the cost of installing and maintaining such lighting system is required to be paid by the owners of the property embraced within the boundaries of such districts.

Development Review Committee (DRC) evaluates all proposals subject to the provisions of Chapter 38, the Unified Development Code within the Bozeman Municipal Code. The DRC is charged with reviewing items related to public health and safety.

High Pedestrian Conflict occurs in areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples include downtown retail areas, near theatres, concert halls, stadiums and transit terminals.

Medium Pedestrian Conflict occurs where lesser numbers of pedestrians utilize the streets

at night. Typical are downtown office areas, blocks with libraries, apartments, neighborhood shopping, industrial, parks, and streets with transit lines.

Low Pedestrian Conflict areas with very low volumes of nighttime pedestrian usage. These can occur in any of the cited street classifications but are typically suburban streets with single family dwellings, very low density residential developments, and rural or semi-rural areas.

Street lighting is provided for arterial, collector, and local streets where pedestrians and cyclists are generally present. The primary purpose of street lighting is to help the motorist identify obstacles, provide adequate visibility of pedestrians and cyclists, and assist in visual search tasks, both on and adjacent to the street. Street lighting assemblies are typically between 25 feet and 40 feet. The distribution of the light is directed towards the street.

Pedestrian lighting is provided to light the sidewalk (attached or detached) along arterial, collector, local streets, public plazas, trails or other pedestrian areas. Pedestrian lighting assemblies are typically between 12 feet to 18 feet. The distribution of the light is directed towards the sidewalk.

Pathway lighting is provided to light trails and pathways that are not adjacent to streets. Pathway lighting assemblies are typically 36 inches to 48 inches. The distribution of the light is directed towards the trail or pathway.

Section III. Scope of Work.

A. General

The design engineer shall consider the need for street lighting, pedestrian lighting and pathway lighting, as specified in Section XII Lighting Criteria, in the development plans for any new or reconstructed roadways. The guidelines and specifications outlined here shall be applicable to lighting located within the City's Right of Way.

All street, pedestrian and pathway lighting shall be operated and maintained through the creation of a new SILD, through the annexation to an existing SILD or through some other equivalent means approved by the City of Bozeman. The application to create or annex to an existing SILD shall be submitted to the City within two months of preliminary approval of the development. The approval to create or annex to an SILD shall be granted prior to final plat for a subdivision or Occupancy if a final plat is not required.

Street lighting shall be installed per 38.39.030 B, BMC (in regards to completion time for improvements).

Individual yard lights on private property shall not be used for street lighting.

Section IV. Control of Work

A. General

Record drawings shall be provided to the City for all new and re-constructed lighting systems that are to be maintained by the City. Cut sheets of all equipment shall be provided with the record drawings.

For lighting projects in new subdivisions, record drawings shall be provided and a final inspection done before building permits will be approved.

Contractor is required to submit record drawings and equipment cut sheets for any electrical

work that alters an existing lighting system, prior to receiving full payment for project work.

B. Deviation Request

Deviations may be granted by the City Engineer. Appeals to denials of deviation requests shall be to the Director of Public Works. Refer to Section 38.35.050 for additional information.

Section V. Utility Clearances

A. Overhead Powerline Clearances

Light standard assembly locations must comply with National Electrical Safety Code (NESC) Rules regarding clearance requirements between phase conductor and streetlight and between primary conductor and streetlight.

Light standard assembly locations must comply with the Occupational Safety and Health Administration (OSHA) 1926.1408 minimum clearance distances to overhead power lines.

The City will not accept work that does not meet these clearance requirements or requires a qualified worker to maintain the lighting system.

B. Below-grade Utility Clearances

Light standard foundations shall be located to maintain a minimum horizontal clearance of 10 feet from the edge of foundation to the edge of any water line, sewer line, storm drain line or gas line. When paralleling water, sewer, storm and gas lines with lighting conduit, a 10-foot horizontal separation is preferred. Where 10 foot separation is impractical, a minimum of 5-foot horizontal separation will be allowed.

Section VI. Conduit

A. Plastic Conduit - PVC

All PVC conduits located under roadways, driveways, and other vehicular access areas shall be schedule 80 type EPC-80-PVC.

Conduits under non-vehicular locations may be schedule 40 type EPC-40-PVC.

PVC conduit shall be manufactured of high-impact PVC, and shall conform to industry standards and commercial standard CS-207-60 and NEMA TC 2.

When bending PVC conduit, a water bending process may be used. This shall consist of a water filled steel pipe 4' long, heated to the temperature that will render the PVC conduit pliable in 30 seconds after insertion in the pipe. The conduit may then be bent to the desired angle and held in an appropriate jig for a cooling period.

The Contractor may use other methods of bending PVC conduit if the preceding method is found unsuitable due to climatic conditions, but only after demonstrating the proposed method to the Engineer and receiving his approval.

Bends in PVC conduit shall be made and conform to all appropriate sections of the National Electric Code or local codes governing bending radius, and the number of bends allowed as applicable for rigid conduit.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit.

B. Plastic Conduit – HDPE

All HDPE conduit shall be factory lubricated, low friction, high-density conduit constructed of virgin high density conduit constructed of virgin high-density polyethylene resin. Conduit shall be capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation, without affecting its properties or performance.

Bored electrical conduit shall be HDPE and installed using trenchless technology of either jacked conduit or directional boring.

C. Steel Conduit

Steel conduit for exterior, surface mounted, above grade installations shall be Galvanized Rigid Conduit (GRC). Polyvinyl Chloride coated Galvanized Rigid Conduit (PVC coated GRC) may be used for below grade installations, encased in concrete and above grade where exposure to water is imminent.

GRC conduit shall comply with ANSI C80.1 and UL 6.

PVC coated GRC shall comply with NEMA RN 1. Coating thickness shall be a minimum of 0.040 inch (1mm), both inside and out.

D. Conduit Installation

All conduit direct buried in contact with earth shall be PVC, HDPE or PVC coated GRC. PVC conduit Installation through foundations (other than light standard foundations) shall have transition to GRC or PVC coated GRC prior to exposure above foundation.

Underground conduit shall have the following minimum diameter (ID) trade size conduit, unless otherwise approved by the Engineer.

1. Conduit Sleeves Under Roadways: 3 inch minimum
2. Conduit in Typical Trench: 2 inch minimum
3. Conduit from Pull Box / Splice Box to Foundation: 1 inch minimum
4. Conduit to Pathway Luminaires: 3/4 inch minimum

Conduits shall be placed two feet from back of curb.

All existing conduits shall be cleaned with a mandrel or cylindrical wire brush and all conduits (existing or new) shall be blown out with compressed air, before conductors or signal facilities are installed. All conduits shall contain a nylon or polyester pull tape of at least 1250 lbs strength with footage marking tape. In occurrences that require complete intersection rewiring or new construction, a 12 AWG tracer wire shall be installed across every conduit leg, and conduit plugs shall be installed in all conduits. Pull rope with footage tape, tracer wire, and conduit plugs shall be included in the price of electrical conduit.

When conduit is specified to be installed under existing pavement by directional line boring, the boring pits shall be kept a minimum of 2 feet clear of the edge of pavement whenever possible.

Conduit installed under pavement, sidewalk, dirt, sod or any condition other than under an existing roadway shall be installed with not less than 24 inches of cover to the top of the conduit.

Under existing roadway, conduit shall be installed with not less than 30 inches of cover to the top of the conduit. Conduit installed under railroad tracks shall be installed not be less than 42 inches below the bottom of the tie to the top of the conduit. [Refer to Figure 1 – Typical Conduit Burial Standard Detail].

Section VII. Pull Boxes / Splice Boxes

A. General

All pull / splice boxes and covers must be made of polymer concrete with fiberglass reinforcement with a traffic rating of TIER 22.

Pull / splice boxes shall be labeled "ELECTRIC" on pull / splice boxes containing electrical power or "LIGHTING" on all pull / splice boxes containing street lighting conductors. The labeling must be cast into the cover and not a separate independent tag. [Refer to Figure 2 – Typical In-Grade Pull Box / Splice Box Dimensions Standard Detail]

B. Pull Box / Splice Box Installation

When pull / splice boxes are located behind sidewalk or in non-pavement areas, they shall be surrounded by a 12 inch wide collar of class B concrete 6 inches deep. [Refer to Figure 3 – Typical In-Grade Composite Pull Box / Splice Box Detail]

Maximum distance between pull / splice boxes is 200 feet for street and pedestrian lights, and 100 feet for pathway lights.

Street crossings for conduit runs need to have a pull / splice box at each side of the street crossing.

Pull / splice boxes are to be installed at each street corner where conduit takes a 90 degree bend around the corner of the block.

Provide a Type 1 or Type 2 pull / splice box by each street light or pedestrian light with smaller 1.5 inch diameter conduit allowed going into light base from pull / splice box.

For pathway lights, conduit may be routed in and out of the foundation, with a minimum conduit size of 1 inch. Pull / splice boxes for pathway lights shall be placed at 90-degree bends around a corner, and at the minimum spacing listed above.

Box size shall be determined by the diameter of the Largest Trade Size Conduit (LTSC) installed in the box. For conductors 6 AWG or smaller, the box shall be sized (6) six times LTSC in width or length dimension. For conductors 4 AWG and larger, the box shall be sized (8) eight times LTSC in width or length dimension.

For future expansion, empty conduit, with nylon or polyester tape pull tape of at least 1250 lbs strength with footage marking tape, shall terminate in a pull / splice box. Stub spare conduit(s) out of the box and cap below grade at 2 feet from the box, in the direction of future expansion. Label conduit stub out(s) in pull / splice box "for future expansion to the *direction of expansion*".

Wire connections in pull / splice boxes should use water-proof, insulated multi-tap connectors, by Burndy, or IlSCO, or equivalent.

Section VIII. Concrete Foundations

A. Light Standard Foundations

In locations where the roadway is not curbed, and/or in dirt, the top of the foundation shall be six inches above the grade of the edge of the pavement or as directed by the Engineer. The top of the foundation shall be finished smooth and have a 3/4 inch chamfered edge. [Refer to Figures 4, 5 and 6 – Typical Light Standard Foundation Electrical Details]

Where caisson foundations are located in the sidewalk, the caisson foundation shall be installed to 6 inch under finished curb or sidewalk grade or as directed by the Engineer. [Refer to Figure 4 – Typical Light Standard Foundation Electrical Details]

Where foundations are to be installed in dirt, landscaped areas, or any other situation where the top of the caisson is not being installed with an existing sidewalk or concrete improvement, the contractor shall use sono-tube on the top section of the caisson for finished appearance.

A structural engineer licensed in the state of Montana shall determine the foundation size (depth and diameter) and concrete reinforcement for the specific light standard configuration.

B. Concrete Foundation Pads

All lighting control center cabinets that are to be installed in concrete, shall have either, an approved anchor bolt template with bolts installed before concrete pour, or upon approval of the Engineer, be installed using approved concrete drop in style anchors. All lighting control center cabinets installed in areas other than concrete, shall be installed to their marked grade on a concrete foundation pad with 24" depth, sized to fit cabinet dimensions with 3 inch minimum to 6 inch maximum offset of concrete on all sides of the enclosure. Provide 3 foot x 3 foot step pad with a maximum slope of 1:24. [Refer to Figures 7a, 7b, 8 and 9 – Typical Lighting Control Center Standard Details]

C. Concrete Fill for Pedestal Type Cabinets

All pedestal type cabinets mounted on galvanized strut-channel supports shall have concrete filled post holes with a minimum depth of 36-inches and minimum diameter of 9-inches. [Refer to Figure 8 – Typical Lighting Control Center Pedestal Standard Detail]

Section IX. Wiring

A. General

All wiring shall be copper conductors installed in conduit to meet the National Electric Code.

Minimum size current carrying conductor for exterior installations shall be #10 AWG copper.

Furnish conductors of solid or stranded copper of the gauge shown in the contract.

Insulation for conductors must be Type THW, XHHW, XHHW-2, USE, RHH, RHW, THWN, and THWN-2. All insulation must be designed for 600 volts and meet NEC requirements.

Metal Clad cable (MC) or Armored Cable (AC) shall not be allowed in exterior applications.

Exterior lighting shall be powered at 120/240V-1PH-3W unless otherwise noted on the plans. Wiring color code shall be as follows:

Line 1 = Black

Line 2 = Red

Neutral = White

Ground = Green

Section X. Bonding and Grounding

A. General

All PVC or PVC coated GRC conduits from a metered power source shall have a raceway ground conductor installed with the current carrying conductors, sized to the NEC. Ground conductor shall have the size increased to match current carrying conductor size increase for voltage drop purposes.

All light standard foundations for street lights and pedestrian lights shall have a 5/8 inch diameter x 8 foot long, copper clad driven ground rod installed in the pull / splice box next to the light standard. Top of rod shall be a minimum of 4 inches below grade. Exothermic weld or underground rated lug connect a #6 AWG soft drawn bare copper conductor from rod through 1/2 inch trade size conduit in the foundation to the lug on the pole in the back of the hand hole.

Pathway lights shall have the system grounding conductor bonded to the grounding lug inside each bollard.

All grounding electrodes shall be bonded together per the NEC.

Section XI. Lighting Control Centers and Metered Pedestals

A. General

All street lighting systems shall be metered separately from other uses, with the exception of street lights installed in conjunction with traffic signal poles.

Lighting control centers and metered pedestals shall be located away from intersection corners, behind the sidewalk, outside of the sight triangle and within the public right of way or easement.

B. Installation

Electric services shall use NEMA Type 3R cabinets with hinged, lockable covers and 3/8" holes for a padlock.

Services shall be equipped with 3-way switches for hand-off-auto (HOA) operation. Wire photocell on/off control in the auto position.

Lighting control centers shall house electrically held lighting contactors that are 12-pole with 30 amp contacts rated at 600V, and 120V coils.

Street lighting circuits shall be automatically controlled with turn lock mounting delayed response photo cells. Lighting control centers shall have a 120V twist-lock receptacle type photoelectric cell with matching receptacle base attached to the assembly with heavy duty galvanized c-channel structure using 1 inch galvanized rigid conduit, mounted 8 feet above grade. Orient window of photocell to face north. Photocell to operate the lighting contactors for on/off control when HOA is in the auto position.

Meters shall be installed a minimum of 4 feet and maximum of 5 feet above grade to the center of the meter.

Section XII. Lighting Design Criteria

A. General

The following design criteria shall be used for lighting within the City's right of way.

B. Correlated Color Temperature (CCT)

All luminaires shall have a Correlated Color Temperature (CCT) of 3000K (+/- 275K).

C. Photometric Calculations

Photometric calculations shall be performed using light loss factors that reduce the lumen output of luminaires to ensure that adequate luminance is provided through the life of the lighting system as the light source ages and dirt accumulates on the luminaire. A lighting calculation using light loss factors results in the "maintained luminance" of the street. The following light loss factors shall be used in the photometric calculations:

1. Lamp Lumen Depreciation (LLD): For maintained lighting calculations, the Lamp Lumen Depreciation (LLD) factor for LED luminaires shall be 0.9.
2. Luminaire Dirt Depreciation (LDD): For maintained lighting calculations, the Luminaire Dirt Depreciation (LDD) factor for LED luminaires shall be 0.9.
3. Total Light Loss Factor (LLF): Multiplying the LLD(0.9) x LDD(0.9) results in a total Light Loss Factor (LLF) of 0.81.

D. Non-Signalized Intersection

A streetlight shall be installed at each non-signalized street intersection, except at intersections where the width of one or more of the approaches is greater than or equal to 50 feet, as measured to the back of curb or edge of pavement, then two streetlights shall be installed on diagonally opposite corners.

E. Signalized Intersections

At signalized intersections where all approaches are narrower than 50 feet, as measured to the back of curb or edge of pavement, two street lights shall be installed on the diagonally opposite corners. At signalized intersections where the width of one or more of the approaches is greater than or equal to 50 feet, four street lights shall be installed, one on each corner.

F. Intersections of Pathways and Streets

A street light shall be installed at all intersections of pathways and collector streets located within the proposed development or along existing streets or roads abutting the development,

unless the pathway intersects the street at a lighted intersection.

G. Continuous Lighting on Streets

Provide continuous lighting for all arterial and collector streets as specified in Table 1.

Table 1. New Construction Lighting Design Guidance.

Functional Classification	Pedestrian Conflict	Luminance Criteria (cd/m ²)	Mounting Height (feet)	Arrangement	Spacing (feet)*	Lumen Output Range	Maximum Wattage (W)	Maximum B.U.G. Rating
Principal Arterial	Med	0.9	35-40	Staggered	200-250	21,700-22,000	270	B3-U0-G3
	Low	0.6	35-40	Staggered	300-350	15,000-15,300	180	B3-U0-G2
Minor Arterial	Med	0.9	30-35	Staggered	200-250	15,000-15,300	180	B3-U0-G2
	Low	0.6	30-35	Staggered	300-400	11,500-11,800	135	B3-U0-G2
Collector	Med	0.6	25-30	Staggered	200-225	13,000-13,300	155	B3-U0-G2
	Low	0.4	25-30	Staggered	250-300	8,300-8,600	100	B2-U0-G1
Local - Intersections	Low	0.6	25-30	Intersections	n/a	10,000-10,300	120	B3-U0-G1
Local - Continous	Low	0.3	25-30	Single Sided	400-600	5,000-5,300	65	B2-U0-G1

* Spacing is measured by distance between light standards on the same side of the street.

Table 2. LED Replacement Lighting Design Guidance.

Functional Classification	Mounting Height (feet)	Lumen Output Range	Maximum Wattage (W)	Maximum B.U.G. Rating
Principal Arterial	40+	21,700-22,000	270	B3-U0-G3
	25-39	15,000-15,300	180	B3-U0-G2
Minor Arterial	30-35	11,500-11,800	135	B3-U0-G2
Collector	25-30	8,300-8,600	100	B2-U0-G1
Local	25-30	5,000-5,300	65	B2-U0-G1

H. Design Considerations.

In addition to spacing requirements outlined in Table 1, the following layout criteria shall be used:

- When a street light location falls near an unlit intersection, the light shall be located at the intersection;
- Street lights shall be located at property lines to the greatest extent possible, but not in conflict with other utility service providers;
- Pole spacing along a street may vary from the criteria of Table 1 by up to 15 percent. For the uniformity of appearance, the variance in spacing between adjacent spans should not be more than 15 percent;
- All proposed local streets within the proposed subdivision, having a curve of 300 feet or longer in length, shall have a street light in the middle of the horizontal curve or as required by the City Engineer;
- A street light shall be placed at the terminal ends of center median islands having trees and/or other fixed objects not having a breakaway design for speeds of 25 miles per hour or greater;
- Additional street lights may be required by the DRC when potential traffic hazards are identified during plan review; and
- Street and pedestrian lighting arrangements with poles aligned on opposite sides of the street, rather than staggered are allowed. For opposite arrangements, the engineer shall submit lighting calculations to meet the luminance criteria per Section XII.D.

- Mounting heights shall be measured from the grade of the street at the edge of the travelled way and shall comply with the requirements of Table 1.

I. Pedestrian Lighting.

Pedestrian lighting shall be installed at 80 feet to 100 feet on center, as appropriate to coordinate with landscape and hardscape features. Two pedestrian lights shall be installed on opposite sides of the street at all intersections of pathways and local streets located within the proposed development or along existing streets or roads abutting the development, unless the pathway intersects the street at a lighted intersection. Pedestrian lights shall have a lumen output range of 3,000 – 3,500 lumens, a maximum wattage of 45 watts, and a maximum B.U.G. rating of B1-U0-G1. Spacing of pedestrian lights shall be determined by meeting the illuminance requirements outlined in Table 3.

Table 3. Pedestrian Lighting Guidance.

	Average Horizontal Illuminance for Pedestrian Walkways in Maintained Footcandles	Illuminance Uniformity Ratio (avg/min)
Medium Pedestrian Conflict	0.5	4.0
Low Pedestrian Conflict	0.3	6.0

Source: Roadway Lighting (RP-8), Illuminating Engineering Society of North America.

J. Pathway Lighting.

Pathway lights shall be installed along pathways through parks and other pathways that are detached from the street. All pathway lights shall comply with City of Bozeman specifications. Pathway lights shall have a height range of 40 - 48 inches, a lumen output range of 500 - 1,000 lumens, and a maximum wattage of 25 Watts.

Section XIII. Streetlight Luminaires

A. General

- All luminaires shall be light emitting diode (LED).
- Color temperature 3000K maximum, per ANSI C78.377-2011 standard.
- All luminaires shall be equipped with a surge suppression device with a minimum immunity level of 10kV.
- All luminaires shall have a minimum ingress protection (IP) rating of IP66, and shall be UL/ETL listed for wet locations.
- All luminaires shall be equipped with a 0-10V or DALI dimming driver, capable of receiving input line voltage 120V-277V. Driver shall comply with Federal Communication Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards. Minimum power factor (PF) shall be no less than 0.9 at full input power. Maximum total harmonic distortion (THD) shall be no greater than 20 percent

- at full input power.
- A minimum 10 year warranty is required for all parts, materials, and shipping required to repair or replace luminaire.
- All luminaires are to be equipped with an ANSI C136.41 7-pin receptacle. Shorting caps are to be installed on each luminaire.
- Luminaires are to have either a Type II or Type III distribution.
- Access to all internal parts requiring replacement shall not require tools (i.e., "tool-less entry").
- Luminaire shall be tested in accordance with IES LM79 and TM21 certifying photometric performance and rated life, respectively. LM79 (performance) and TM21 (predicted life) testing shall both be for the same luminaire's operating drive current as specified.
- Luminaires shall have a minimum L70 life of 100,000 hours based on IES TM21 testing.
- Luminaire system efficacy shall be no less than 80 lumens per input watt.
- Luminaire shall have an external label per ANSI C136.15 and internal label per ANSI C136.22.
- Luminaires shall be equipped with internal leveling bubble.
- Breakaway connections using sheer bolts must have a skirt to protect the bolts.
- Luminaires shall be powder coat finished black or powder coat finished to match pole, unless installed on a local street, then either dark brown or hunter green.
- Luminaire distribution shall be equal or less than the Illuminating Engineering Society of North America's (IES) TM 15-11 Backlight, Uplight, and Glare (BUG) ratings as follows:
 - Local streets: B2 U0 G1
 - Collector and Arterial streets: B3 U0 G2

B. Installation

Luminaires shall be mounted in accordance with the manufacturer's specifications.

Plumb or level all elements, symmetrically arrange, and securely assemble. Conceal all conductors in the poles and assembly.

Luminaires shall have an adjustable slipfitter-type mounting system for the installation on 1.25 inch (1.66 inch o.d.) to 2 inch (2.375 inch o.d.) outside diameter pipe tenons. Slipfitter shall consist of a two-piece clamp and four 9/16 inch hex bolts. Slipfitter shall allow for a vertical tilt adjustment of +/- 5 percent in order to mount plumb for a U0 rating.

C. Approved Manufacturers – Cobrahead Style [Refer to Figure 10 – Typical Street Light Standard Detail]

- Cree XSP
- Lumec Roadfocus
- GE Evolve LED Cobrahead
- Or approved equal

D. Approved Manufacturers – Bell Style [Refer to Figure 10 – Typical Street Light Standard Detail]

- Lumec Domus
- Architectural Area Lighting Universe

- Or approved equal

Section XIV. Pedestrian Luminaires

A. General

- All luminaires shall be light emitting diode (LED).
- Color temperature 3000K +/- 275K, per ANSI C78.377-2011 standard.
- All luminaires shall be equipped with a surge suppression device with a minimum immunity level of 10kV.
- All luminaires shall be equipped with a 0-10V or DALI dimming driver, capable of receiving input line voltage 120V-277V. Driver shall comply with Federal Communication Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards. Minimum power factor (PF) shall be no less than 0.9 at full input power. Maximum total harmonic distortion (THD) shall be no greater than 20 percent at full input power.
- A minimum 10 year warranty is required for all parts, materials, and shipping required to repair or replace luminaire.
- All luminaires are to be equipped with an ANSI C136.41 7-pin receptacle. Shorting caps are to be installed on each luminaire.
- Luminaires are to have either a Type III distribution. Type V distributions will be considered for special use through DRC review.
-
- Access to all internal parts requiring replacement shall not require tools (i.e., "tool-less entry").
- Luminaire shall be tested in accordance with IES LM79 and TM21 certifying photometric performance and rated life, respectively. LM79 (performance) and TM21 (predicted life) testing shall both be for the same luminaire's operating drive current as specified.
- Internal house-side shield must be available.
- Luminaire system efficacy shall be no less than 60 lumens per input watt.
- Luminaire shall have an external label per ANSI C136.15 and internal label per ANSI C136.22.
- Luminaires shall be powder coat finished black or powder coat finished to match pole, unless installed on local street, then either dark brown or hunter green.
- Luminaire distribution shall be equal or less than the Illuminating Engineering Society of North America's (IES) TM 15-11 Backlight, Uplight, and Glare (BUG) rating of B2 U1 G1

B. Installation

Luminaires shall be mounted in accordance with the manufacturer's specifications.

Plumb or level all elements, symmetrically arrange, and securely assemble. Conceal all conductors in the poles and assembly.

C. Approved Products – Traditional Post-top Style [Refer to Figure 11 – Typical Post-Top Pedestrian Light Standard Detail]

- Sternberg Euro
- Architectural Area Lighting Providence
- Or approved equal

D. Approved Products – Bell Style [Refer to Figure 12 – Typical Arm-Mount Pedestrian Light Standard Detail]

- Lumec Domus
- Architectural Area Lighting Universe
- Or approved equal

Section XV. Pathway Luminaires

A. General

- All luminaires shall be light emitting diode (LED).
- Color temperature 3000K, per ANSI C78.377-2011 standard, +/- 275K.
- All luminaires shall be equipped with a surge suppression device with a minimum immunity level of 10kV.
- All luminaires shall be equipped with a 0-10V dimming or DALI driver, capable of receiving input line voltage 120V-277V. Driver shall comply with Federal Communication Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards. Minimum power factor (PF) shall be 0.9 at full input power. Maximum total harmonic distortion (THD) shall be 20 percent at full input power.
- A minimum 10 year warranty is required for all parts, materials, and shipping required to repair or replace luminaire.
- All luminaires are to be equipped with an ANSI C136.41 7-pin receptacle. For luminaires that are not supplied with integral 7-pin receptacles, provide the 7-pin receptacle in pole cap on the top of the pole. Shorting caps are to be installed on each luminaire.
- Luminaires are to have either a Type III or Type V distribution. Type V distributions will be considered for special use through DRC review.
- Luminaire shall be tested in accordance with IES LM79 and TM21 certifying photometric performance and rated life, respectively. LM79 (performance) and TM21 (predicted life) testing shall both be for the same luminaire's operating drive current as specified.
- Luminaire system efficacy shall be no less than 30 lumens per input watt.
- Luminaires shall be powder coat finished black.
- Vandal proof. Not flat heads, rounded heads.
- Concrete base, no direct burial
- Luminaire distribution shall be equal or less than the Illuminating Engineering Society of North America's (IES) TM 15-11 Backlight, Uplight, and Glare (BUG) ratings as follows:
 - B2 U1 G1
 - For applications approved for Type V distribution, the Backlight rating shall not apply.

B. Installation

Luminaires shall be mounted in accordance with the manufacturer's specifications.

Plumb or level all elements, symmetrically arrange, and securely assemble. Conceal all conductors in the assembly. [Refer to Figure 13 – Typical Pathway Light Standard Detail]

C. Approved Products

- Lithonia Lighting KBR8 LED Bollard

- Lithonia Lighting D-Series LED Bollard
- Or approved equal

Section XVI. Poles.

A. General

Unless specifically approved by the City Commission, the use of "Montana Angle", "Budget Angle", or similar style street light poles is prohibited.

All poles, mast arms, and luminaires for street lights and signal poles shall be round, tapered steel with galvanized, or galvanized and painted finish.

Poles for pedestrian lights shall be round, non-tapered steel, with optional decorative fluting, and galvanized and painted finish.

Unless a variance is granted, all future ARTERIAL AND COLLECTOR street and signal light poles shall be "Hunter Green" (RAL#6005) or similar in color, excepting that all future street and signal light poles in the Downtown Business District and North 7th Avenue TIF District shall be black, and further excepting that entryway streets into Montana State University (i.e. S. 8th Avenue, College Street, Kagy Boulevard, and S. 11th Avenue) may be dark Bobcat Blue.

The height of street light poles shall be determined based upon the lumen output and application. Refer to Section XII Lighting Design Criteria.

Street light luminaires shall have a mast arm of 6 feet for local and collector streets, or 10 feet for principal and minor arterials.

All street light poles shall be installed on a concrete foundation with the appropriate base for the application. [Refer to Figure 9 – Typical Street Light Standard Details]

All poles, foundations, and breakaway bases shall meet the criteria set forth in the AASHTO publication Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

B. Installation

Street light poles shall be placed typically at five feet from back of curb.

Street light standards, pedestrian light standards and pathway lights shall have an access panel and cover near base for access to wiring, fusible, in-line, water tight, breakaway connectors on wiring in pole hand hole area such as Bussman type water tight fuse holders. [Refer to Figures 14, 15 and 16 – Typical Pole Base Standard Details]

Section XVII. Pole bases

A. General

Unless otherwise protected, a breakaway base should be provided for all street light standards within the clear zone along rural and high-speed urban highways, except where located within 1.5 times pole height from a bus stop. Non-breakaway bases shall be used for all pedestrian lights and pathway lights.

B. Breakaway Bolt Couplings.

Breakaway bolt couplings are aluminum connectors or sleeves that are designed to shear when the pole is hit. The bottom of the coupling is threaded onto the foundation anchor bolts, and the light standard is attached to the top of the coupling. Four couplings are used with each light standard. Where breakaway supports are required, use the breakaway bolt coupling unless it will not function with the approved light standard. [Refer to Figure 14 – Typical Breakaway Bolt Coupling Standard Details]

C. Frangible Transformer Base.

The frangible transformer base consists of a cast aluminum apron between the concrete foundation and the base of the pole. It is designed to deform and breakaway when hit by a vehicle bumper. Use the frangible transfer base where a breakaway base is justified but breakaway bolt couplings cannot be used. [Refer to Figure 15 – Typical Frangible Transformer Base Detail]

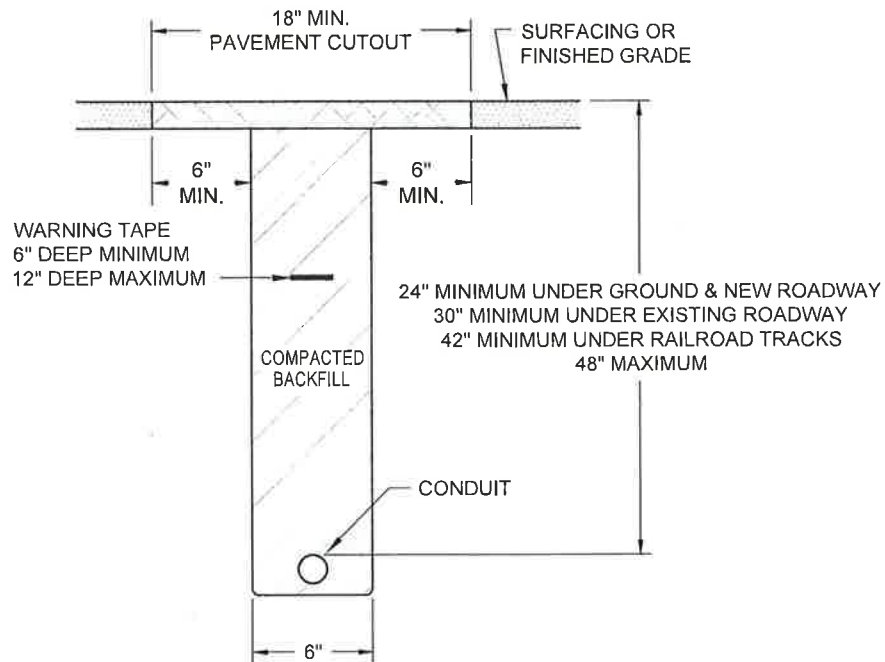
D. Non-Breakaway Anchor Base.

A non-breakaway anchor base consists primarily of a metal plate that is welded to the bottom of the light standard. The plate allows the light standard to be bolted directly to the foundation without an intermediate breakaway device. It does not meet AASHTO breakaway base criteria. [Refer to Figure 16 – Typical Non-Breakaway Pole Base Detail]

Section XVIII. Submittal Requirements

A. General

- Plan sheets showing pole locations, conduit locations, pull / splice box locations, and meter locations are required.
- For Street Lighting submittals, provide luminaire cutsheets showing compliance with *Table 1. New Construction Lighting Design Guidance* and Section XIII. Streetlight Luminaires,
- For Pedestrian Lighting submittals, provide a Photometric Plan for new installations showing compliance with *Table 3. Pedestrian Lighting Guidance*. Also provide luminaire cutsheets showing compliance with Section XIV. Pedestrian Luminaires.
- For Pathway Lighting submittals, provide luminaire cutsheets showing compliance with Section XII.J. Lighting Design Criteria – Pathway Lighting, and Section XV. Pathway Luminaires.
- Details of point of service, lighting control center, electrical one-line diagrams, pole foundations, poles, and luminaires are required.
- Prior to construction, submit shop drawings (cut sheets) for all material and equipment.



DETAIL NOTES

1. CONTRACTOR SHALL COORDINATE TRENCHING WITH OTHER UNDERGROUND UTILITIES. CONTRACTOR SHALL USE COMMON TRENCHES AT ALL ROAD CROSSINGS WHEREVER POSSIBLE.
2. 1-#12 AWG LOCATE WIRE AND A NYLON OR POLYESTER PULL TAPE WITH 1,250 LBS TEST STRENGTH AND FOOTAGE MARKINGS IN ALL EMPTY CONDUITS.

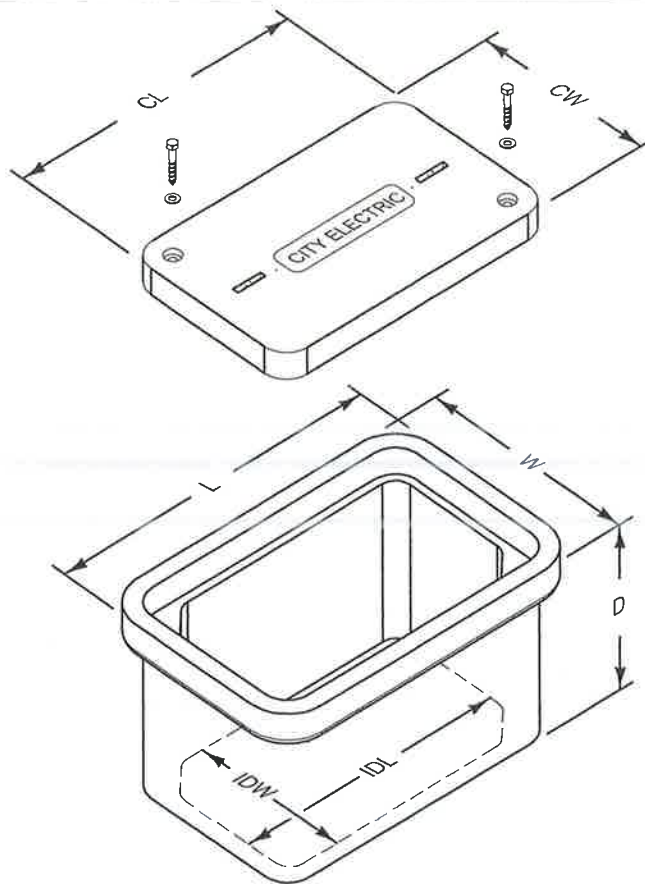
CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05

Scale: N.T.S.

TYPICAL CONDUIT BURIAL
STANDARD DETAIL

FIGURE 1



**PULL BOX / SPLICE BOX - COMPOSITE
MINIMUM DIMENSIONS**

TYPE 1		TYPE 2		TYPE 3	
L	= 20"	L	= 25"	L	= 32"
W	= 13"	W	= 15"	W	= 19"
D	= 12"	D	= 12"	D	= 12"
IDL	= 17"	IDL	= 21"	IDL	= 28"
IDW	= 10"	IDW	= 11"	IDW	= 15"
CL	= 18"	CL	= 23"	CL	= 30"
CW	= 11"	CW	= 13"	CW	= 17"

DETAIL NOTES

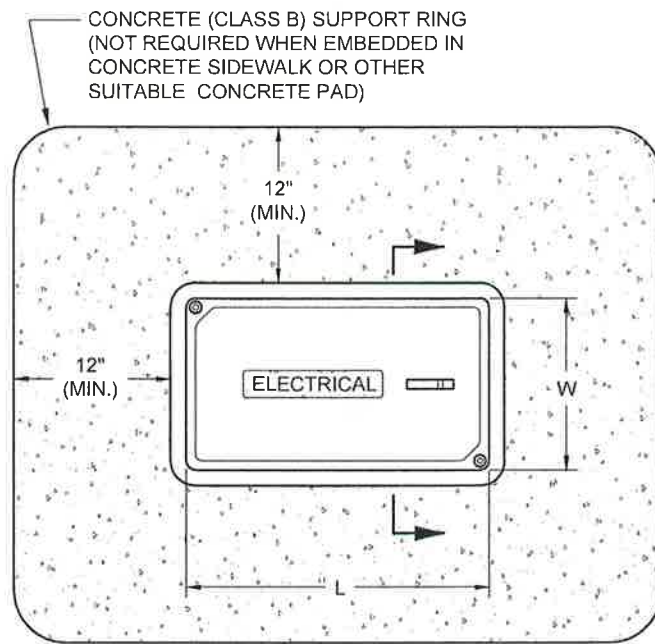
- BOX COVERS MUST BE POLYMER CONCRETE WITH FIBERGLASS REINFORCEMENT, TRAFFIC RATED TO TIER 22 AND BOLTED.
- BOX COVERS SHALL BE LABELED AS FOLLOWS:
 - "CITY ELECTRIC" ON ALL PULL BOXES CONTAINING CITY ELECTRICAL POWER.
 - "UTILITY ELECTRIC" ON ALL PULL BOXES CONTAINING UTILITY ELECTRICAL POWER.
 - "CITY LIGHTING" ON ALL PULL BOXES CONTAINING CITY OWNED STREET LIGHTING CONDUCTORS.
 - "UTILITY LIGHTING" ON ALL PULL BOXES CONTAINING UTILITY OWNED STREET LIGHTING CONDUCTORS.
 LABELING MUST BE CAST INTO THE COVER AND NOT A SEPARATE INDEPENDENT TAG.
- REFER TO N.E.C. ARTICLE 314 "PULL AND JUNCTION BOXES AND CONDUIT BODIES MINIMUM SIZE" FOR BOX SIZE REQUIREMENTS BASED ON CONDUIT AND WIRE SIZES

CITY OF BOZEMAN
STANDARD DRAWING

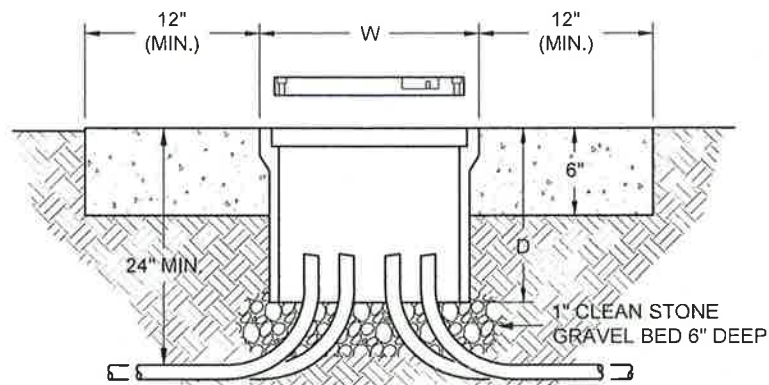
Date: 2016-08-05
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TYPICAL PULL BOX / SPLICE BOX
MINIMUM DIMENSIONS
STANDARD DETAILS

FIGURE 2



PLAN VIEW



SECTION A-A

TYPICAL PULL BOX / SPLICE BOX

DETAIL NOTES

1. ALL PULL OR SPLICE BOXES SHALL BE TRAFFIC RATED TO TIER 22 MINIMUM.
2. REFER TO FIGURE 2 FOR PULL BOX SIZE REQUIREMENTS.

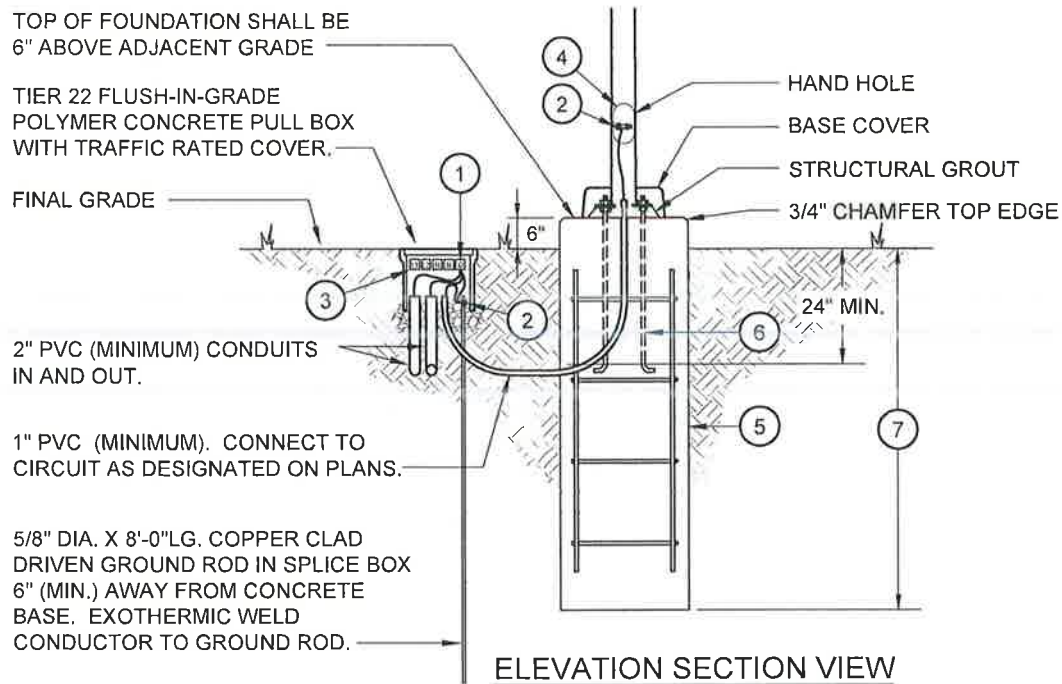
CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05

Scale: N.T.S.

TYPICAL IN-GRADE COMPOSITE
PULL BOX / SPLICE BOX DETAIL

FIGURE 3



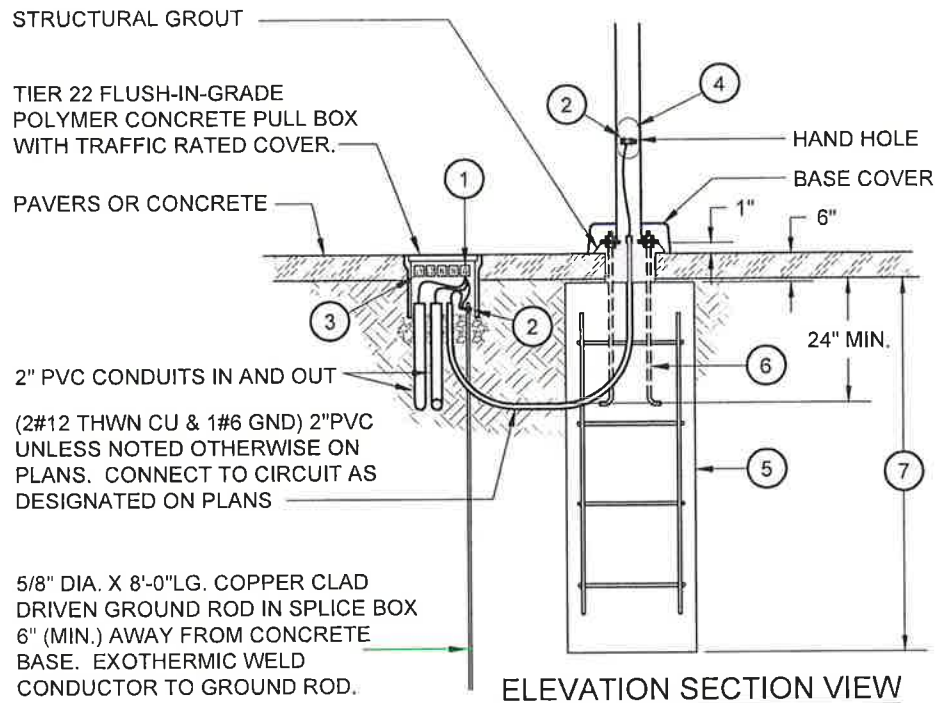
FOUNDATION DETAIL NOTES

- ① BOND RACEWAY GROUND TO GROUND ROD IN PULL BOX / SPLICE BOX.
- ② BOND (1-#6 SOFT DRAWN BARE CU) TO GROUND ROD IN PULL BOX / SPLICE BOX AND GROUNDING LUG IN POLE BASE HAND HOLE.
- ③ PROVIDE 3-TERMINAL UNDERGROUND RATED LUG CONNECTORS TO FIT #14AWG - #4AWG COPPER WIRE, BY BURNDY OR ILSCO NIMBUS OR APPROVED EQUAL. MAXIMUM OF (5) REQUIRED OR (1) FOR EACH CONDUCTOR IN HOME RUN.
- ④ AT EACH POLE BASE HAND HOLE, PROVIDE A BREAKAWAY, WATERPROOF, IN-LINE FUSE HOLDER BY EATON OR APPROVED EQUAL WITH FNQ-R 15A FUSE FOR EACH HOT AND A BREAKAWAY, WATERPROOF CONNECTOR ON NEUTRAL (IF REQUIRED).
- ⑤ LIGHT STANDARD FOUNDATION EMBEDMENT DEPTH, DIMENSIONS AND REINFORCEMENT SHALL BE DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF MONTANA.
- ⑥ DIMENSION FOR ANCHOR BOLT SPACING BY POLE MANUFACTURER.
- ⑦ DEPTH OF FOUNDATION PER STRUCTURAL ENGINEER.

GENERAL NOTE

FOUNDATION DETAILS ARE INCLUDED ONLY TO SHOW ELECTRICAL COMPONENTS.

CITY OF BOZEMAN STANDARD DRAWING	Date: 2016-08-05	TYPICAL STREET LIGHT STANDARD FOUNDATION ELECTRICAL DETAIL IN SOFTSCAPE	FIGURE 4
	Scale: N.T.S.		



FOUNDATION DETAIL NOTES

- ① BOND RACEWAY GROUND TO GROUND ROD IN PULL BOX / SPLICE BOX.
- ② BOND (1-#6 SOFT DRAWN BARE CU) TO GROUND ROD IN PULL BOX / SPLICE BOX AND GROUNDING LUG IN POLE BASE HAND HOLE.
- ③ PROVIDE 3-TERMINAL UNDERGROUND RATED LUG CONNECTORS TO FIT #14AWG - #4AWG COPPER WIRE, BY BURNDY OR ILSCO NIMBUS OR APPROVED EQUAL. MAXIMUM OF (5) REQUIRED OR (1) FOR EACH CONDUCTOR IN HOME RUN.
- ④ AT EACH POLE BASE HAND HOLE, PROVIDE A BREAKAWAY, WATERPROOF, IN-LINE FUSE HOLDER BY EATON OR APPROVED EQUAL WITH FNQ-R 15A FUSE FOR EACH HOT AND A BREAKAWAY, WATERPROOF CONNECTOR ON NEUTRAL (IF REQUIRED).
- ⑤ LIGHT STANDARD FOUNDATION EMBEDMENT DEPTH, DIMENSIONS AND REINFORCEMENT SHALL BE DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF MONTANA.
- ⑥ DIMENSION FOR ANCHOR BOLT SPACING BY POLE MANUFACTURER.
- ⑦ DEPTH OF FOUNDATION PER STRUCTURAL ENGINEER.

GENERAL NOTE

FOUNDATION DETAILS ARE INCLUDED ONLY TO SHOW ELECTRICAL COMPONENTS.

CITY OF BOZEMAN
STANDARD DRAWING

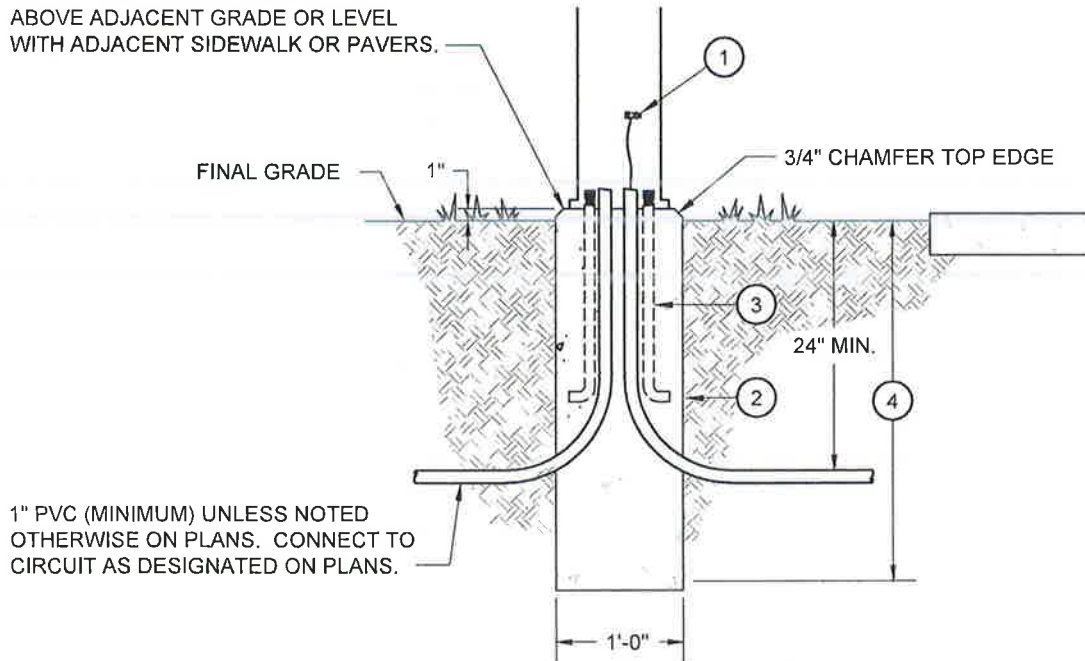
Date: 2016-08-05

Scale: N.T.S.

TYPICAL STREET LIGHT STANDARD
FOUNDATION ELECTRICAL DETAIL
IN HARDSCAPE

FIGURE 5

TOP OF FOUNDATION SHALL BE 1"
ABOVE ADJACENT GRADE OR LEVEL
WITH ADJACENT SIDEWALK OR PAVERS.



1" PVC (MINIMUM) UNLESS NOTED
OTHERWISE ON PLANS. CONNECT TO
CIRCUIT AS DESIGNATED ON PLANS.

ELEVATION SECTION VIEW

FOUNDATION DETAIL NOTES

- ① BOND (1-#6 SOFT DRAWN BARE CU) TO GROUNDING LUG IN POLE BASE.
- ② LIGHT STANDARD FOUNDATION EMBEDMENT DEPTH, DIMENSIONS AND REINFORCEMENT SHALL BE DESIGNED BY A STRUCTURAL ENGINEER LICENSED IN THE STATE OF MONTANA.
- ③ DIMENSION FOR ANCHOR BOLT SPACING BY POLE MANUFACTURER.
- ④ DEPTH OF FOUNDATION PER STRUCTURAL ENGINEER.

GENERAL NOTE

FOUNDATION DETAILS ARE INCLUDED ONLY TO SHOW ELECTRICAL COMPONENTS.

CITY OF BOZEMAN
STANDARD DRAWING

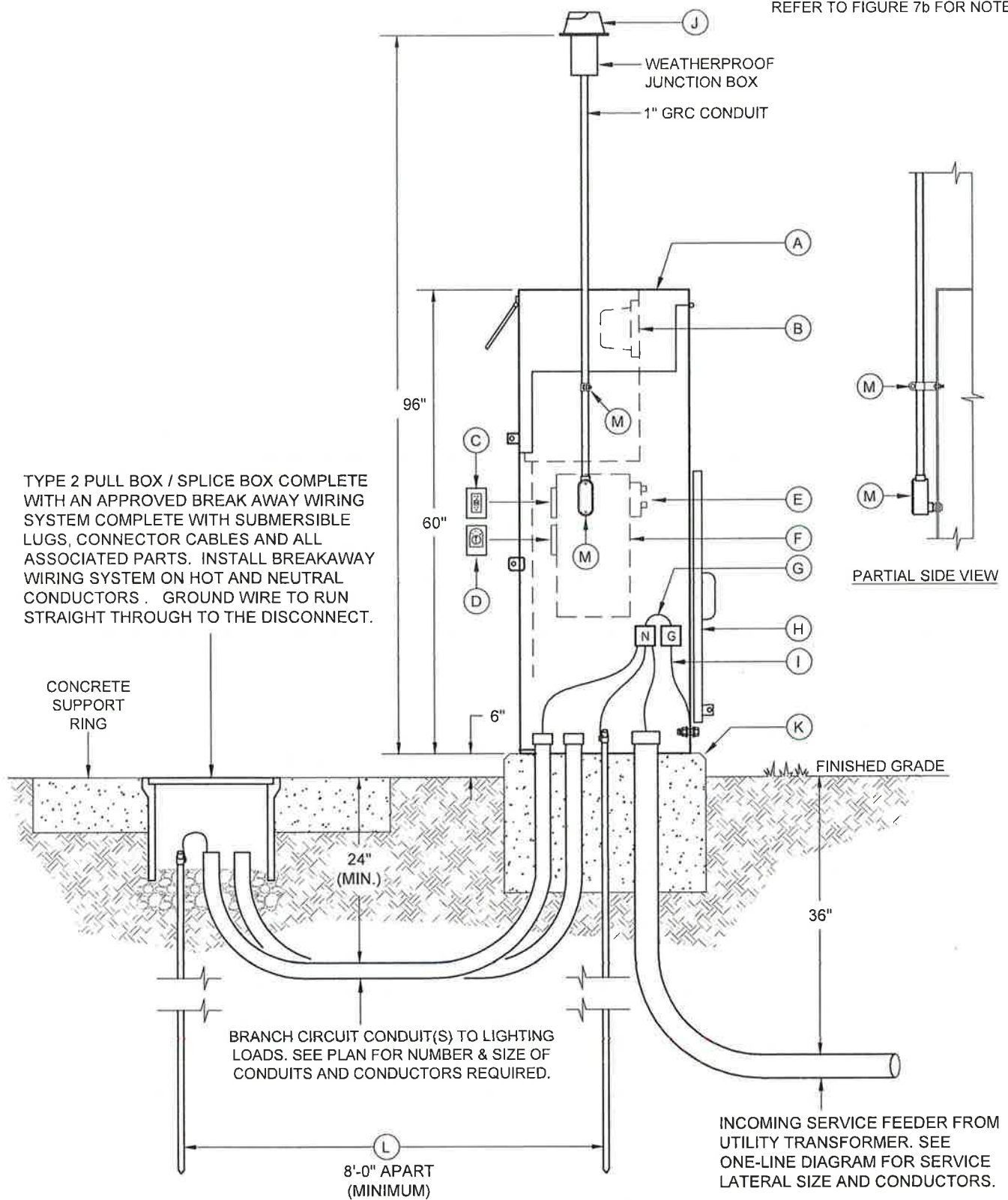
Date: 2016-08-05

Scale: N.T.S.

TYPICAL PATHWAY LIGHT
STANDARD FOUNDATION
ELECTRICAL DETAIL

FIGURE 6

NOTE:
REFER TO FIGURE 7b FOR NOTES.



CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05
Scale: N.T.S.

TYPICAL LIGHTING
CONTROL CENTER CABINET
STANDARD DETAIL

FIGURE 7a
1 of 2

CABINET COMPONENT LIST

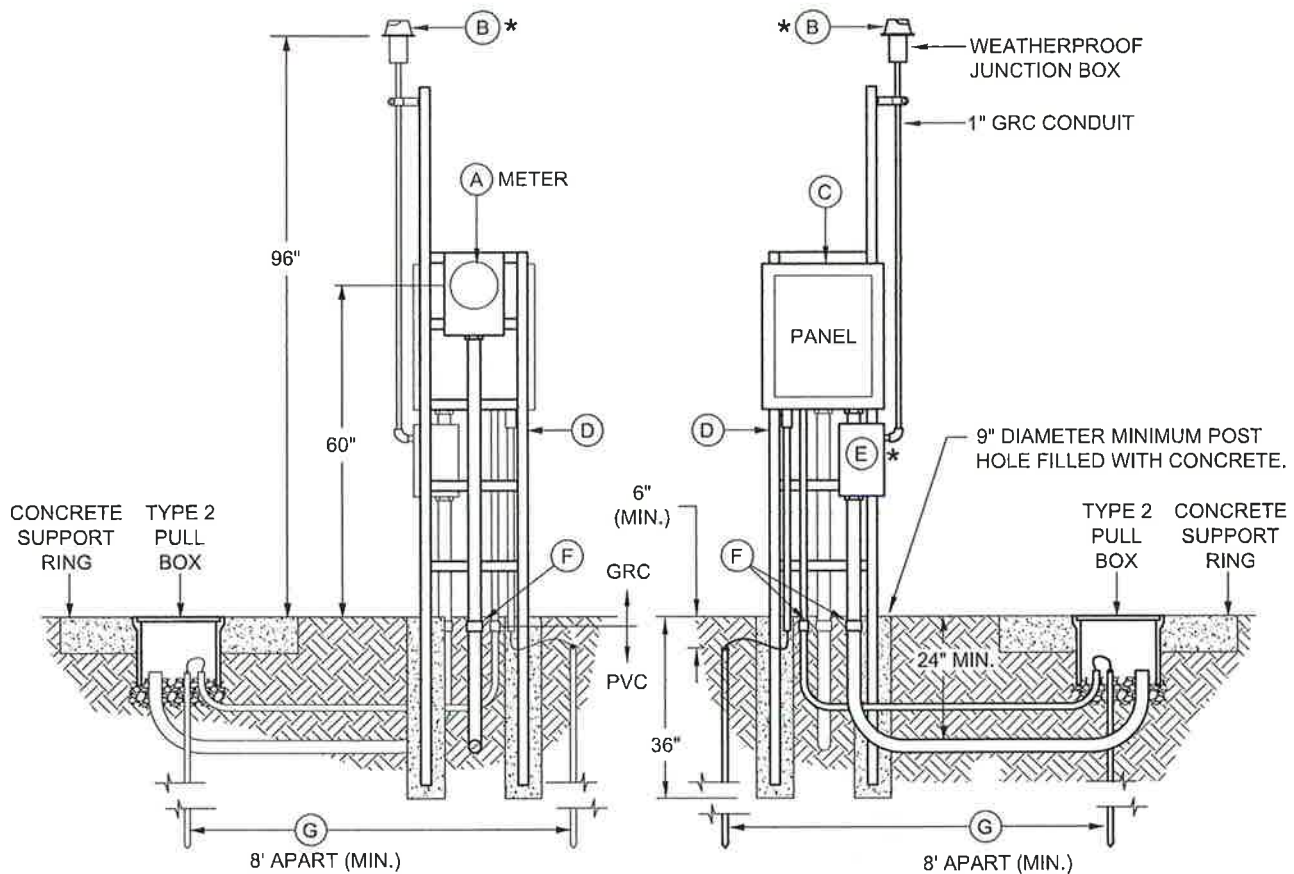
- (A) FULLY HINGED METER/TEST SECTION LOCKABLE COVER WITH HOLD OPEN ARM TO KEEP COVER FROM BLOWING SHUT. COMBINATION ALL-IN-ONE COMMERCIAL METER POWER PEDESTAL IN A NEMA 3R STAINLESS STEEL ENCLOSURE.
- (B) UTILITY METER INSIDE NEMA 3R ENCLOSURE. METER SHALL HAVE LEVER BYPASS AND INTERNAL LOCKING TAB ON METER COVER.
- (C) GFCI MAINTENANCE RECEPTACLE FLUSH MOUNTED IN PANEL DEAD FRONT INSIDE OF THE NEMA 3R ENCLOSURE.
- (D) HAND-OFF-AUTO SWITCH - 15A-2P, HOA SWITCH WITH LEGEND FLUSH MOUNTED IN PANEL DEAD FRONT INSIDE OF THE NEMA 3R ENCLOSURE.
- (E) UTILITY TERMINATION LANDING LUGS.
- (F) LOAD CENTERS WITH SERVICE MAIN AND BRANCH BREAKERS. ENGINEER SHALL PROVIDE PANEL SCHEDULE FOR BREAKERS REQUIRED.
- (G) PROVIDE NEUTRAL TO GROUND BONDING JUMPER.
- (H) LIFT OFF SERVICE COVER WITH PAD LOCK HASP.
- (I) CABINET GROUND BOND #6 BARE COPPER CONDUCTOR.
- (J) NEMA 3R 120V PHOTOELECTRIC CONTROL WITH 3-PRONG TWIST-LOCK RECEPTACLE BASE WIRED THROUGH THE H.O.A. SWITCH. THE PHOTOELECTRIC CONTROL SHALL BE MOUNTED TO A WEATHERPROOF JUNCTION BOX ON TOP OF A 1" GRC CONDUIT AT 96" ABOVE FINISHED GRADE. ORIENT PHOTOCELL WINDOW NORTHWARD TO MINIMIZE THE SUN'S INTERFERENCE.
- (K) REINFORCED CONCRETE (CLASS B) FOUNDATION PER STRUCTURAL ENGINEER LICENSED IN THE STATE OF MONTANA. MINIMUM 6" ABOVE GRADE, 3/4" CHAMFER ALL EXPOSED EDGES, 4" OVERLAP ON ALL SIDES.
- (L) 3/4" X 8'-0" Lg. COPPER CLAD DRIVEN GROUND ROD. EXOTHERMIC WELD OR UNDERGROUND RATED LUG CONNECT CONDUCTOR TO GROUND ROD. (2) REQUIRED - 8'-0" APART (MIN.)
- (M) PROVIDE 1" GRC LB AND THREADED CONNECTION FOR CABINET ENTRY. INSTALL CONDUIT HANGER WITH BOLT, BOLTED TO CABINET TO PREVENT CONDUIT MOVEMENT. ENSURE CONDUIT DOES NOT INTERFERE WITH OPERATION OF HINGED COVER.

TYPICAL CABINET REQUIREMENTS:

200AMP MCB, 120/240V-1Ø-3W STAINLESS STEEL, NEMA 3R, METER/ POWER PEDESTAL WITH SEPARATE SEALABLE AND LOCKABLE CUSTOMER SECTION WITH:

1. LOAD CENTER (ENGINEER SHALL PROVIDE SCHEDULE FOR # OF CIRCUITS) FOR ALWAYS ON LOADS THAT INCLUDE:
(APPLIES TO STREET LIGHTS AND PEDESTRIAN LIGHTS)
 - SERVICE ENTRANCE M.C.B. - ENGINEER TO PROVIDE SIZE ON THE PANEL SCHEDULE.
 - CONTROL POWER CIRCUIT BREAKER - ENGINEER TO PROVIDE SIZE ON THE PANEL SCHEDULE.
 - SWITCHED LOAD CENTER MAIN BREAKER - ENGINEER TO PROVIDE ON THE PANEL SCHEDULE.
 - BRANCH BREAKERS AS SHOWN - ENGINEER TO PROVIDE SIZE AND QUANTITY ON THE PANEL SCHEDULE.
 - CIRCUIT DIRECTORY TO DOCUMENT CONFIGURATION IN POCKET ON HINGED DOOR.
 - MAINTENANCE RECEPTACLE FLUSH MOUNTED IN DEAD FRONT INSIDE ENCLOSURE.
2. CONTROL CIRCUIT INCLUDING:
(ONLY APPLIES TO PATHWAY AND PEDESTRIAN LIGHTS THAT DO NOT HAVE INDIVIDUAL ANSI 7-PIN RECEPTACLES.)
 - PHOTOCELL RECEPTACLE, MOUNTED EXTERNALLY ON NEMA-3R ENCLOSURE.
 - ONE HAND-OFF-AUTO (HOA) SWITCH FLUSH MOUNTED IN DEAD FRONT.
 - ONE LIGHTING CONTACTOR CONTROLLING ONE LOAD CENTER IN THIS SECTION.
 - ONE 12-CIRCUIT LOAD CENTER PHOTOCELL ON/OFF CONTROLLED.
 - A CIRCUIT DIRECTORY TO DOCUMENT CONFIGURATION IN POCKET ON HINGED DOOR.

CITY OF BOZEMAN STANDARD DRAWING	Date: 2016-08-05	TYPICAL LIGHTING CONTROL CENTER CABINET STANDARD DETAIL	FIGURE 7b 2 of 2
	Scale: N.T.S.		



FRONT ELEVATION

REAR ELEVATION

LIGHTING CONTROL CENTER (PEDESTAL)

PEDESTAL COMPONENT LIST

- (A) 200A, 120/240V, NEMA 3R METER HOUSING CONFORMING TO UTILITY PROVIDER REQUIREMENTS.
 - * (B) NEMA 3R 120V PHOTOELECTRIC CONTROL WITH 3-PRONG TWIST-LOCK RECEPTACLE BASE WIRED THROUGH THE H.O.A. SWITCH. THE PHOTOELECTRIC CONTROL SHALL BE MOUNTED TO A WEATHERPROOF JUNCTION BOX ON TOP OF A 1" GRC CONDUIT AT 96" ABOVE FINISHED GRADE ORIENTED NORTHWARD TO MINIMIZE THE SUN'S INTERFERENCE.
 - (C) 200A, 120/240V-1Ø-3W, NEMA 3R SERVICE ENTRANCE RATED LOAD CENTER WITH COPPER BUS, SERVICE MAIN AND BRANCH BREAKERS AS LISTED ON ENGINEER PROVIDED PANEL SCHEDULE. PROVIDE SPACES FOR CIRCUITS AS DESIGNED PLUS A MINIMUM OF TWO AVAILABLE SPACES FOR FUTURE USE. PROVIDE NEUTRAL TO GROUND SERVICE ENTRANCE BOND PER N.E.C.
 - (D) HEAVY DUTY, GALVANIZED C-CHANNEL TYPE RACKING SET IN CONCRETE. PAINT TO MATCH PANEL COLOR. PROVIDE A MINIMUM OF (5) C-CHANNEL CROSS MEMBERS.
 - * (E) 30-AMP, 12-POLE, ELECTRICALLY HELD, LIGHTING CONTACTOR FURNISHED WITH 120-VOLT COIL, NEMA 3R ENCLOSURE WITH PAD LOCKABLE COVER AND HOA SWITCH MOUNTED INSIDE ENCLOSURE.
 - (F) PROVIDE TRANSITION FITTING (JUST BELOW GRADE) FROM PVC CONDUIT IN EARTH TO GRC CONDUIT ABOVE GRADE. PROVIDE 2-HOLE CONDUIT STRAPS ON ALL C-CHANNEL CROSS MEMBERS.
 - (G) (2) 3/4" x 8'-0" COPPER-CLAD DRIVEN GROUND RODS WITH APPROVED GROUND ROD CLAMP. 8'-0" (MIN.) APART AND 6" (MIN.) BELOW GRADE.
- * THESE TWO DEVICES (B & E ABOVE) ARE ONLY REQUIRED FOR PROJECTS WITH PATHWAY AND PEDESTRIAN LIGHTS THAT DO NOT HAVE INDIVIDUAL ANSI 7-PIN RECEPTACLES ON THE LUMINAIRES.

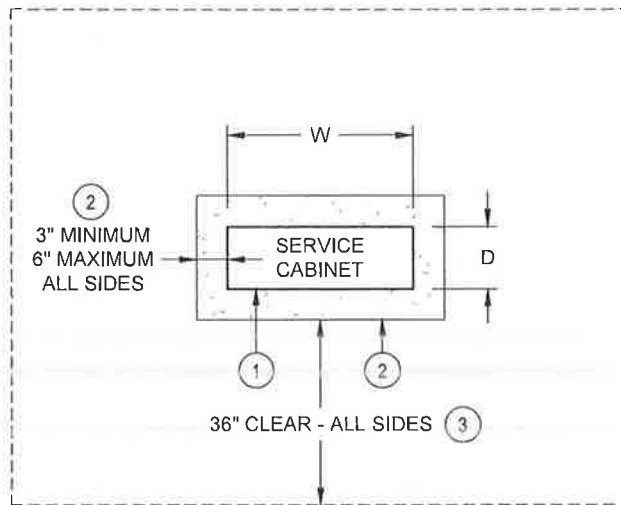
CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05

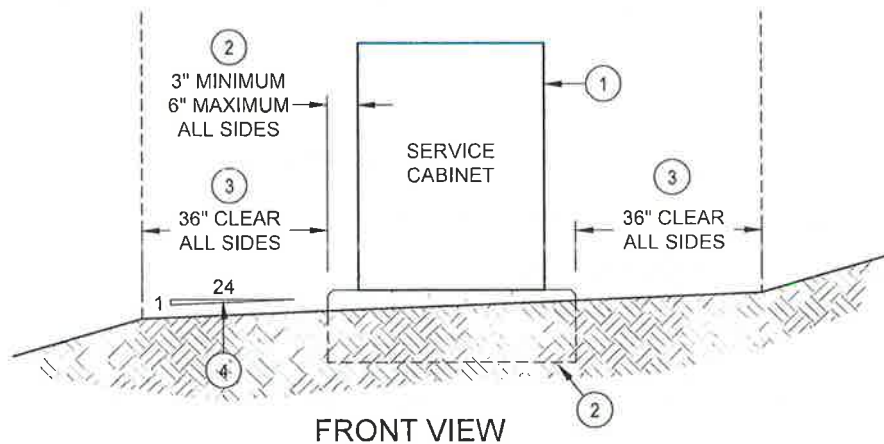
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TYPICAL LIGHTING CONTROL
CENTER METERED PEDESTAL
STANDARD DETAILS

FIGURE 8



PLAN VIEW



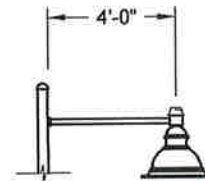
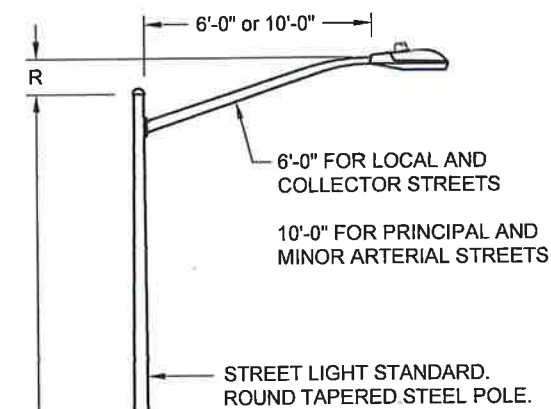
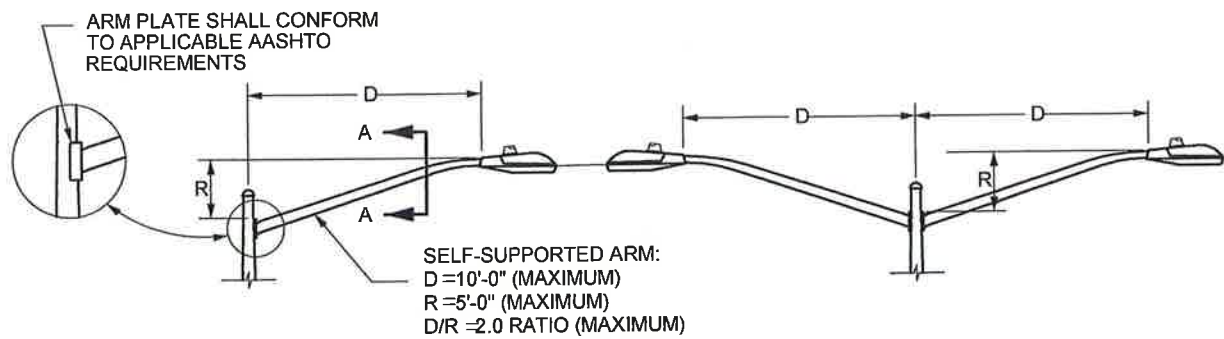
FRONT VIEW

TYPICAL SERVICE CABINET DETAIL

DETAIL NOTES

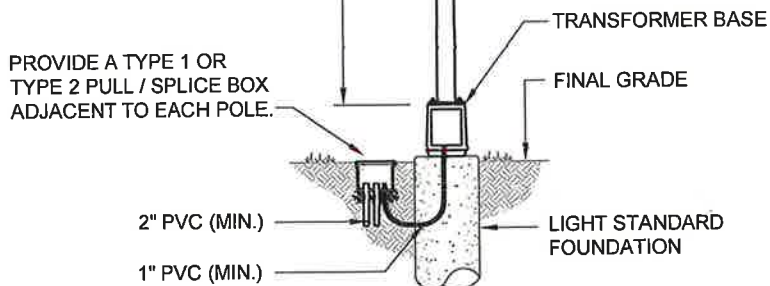
- ① PREBUILT NEMA 3R SERVICE CABINET. REFER TO SERVICE CABINET DETAILS FOR MORE INFORMATION.
- ② REINFORCED CONCRETE (CLASS B) FOUNDATION PAD, PER STRUCTURAL ENGINEER LICENSED IN THE STATE OF MONTANA, WITH 1" CHAMFER ON ALL EXPOSED EDGES. EDGE OF CONCRETE TO EXTEND 3" (MINIMUM) OR 6" (MAXIMUM) BEYOND EDGE OF CABINET.
- ③ MINIMUM OF 36" CLEAR ZONE ON ALL SIDES OF CONCRETE PAD.
- ④ MAXIMUM OF 1:24 SLOPE IN CLEAR ZONE AREA.

CITY OF BOZEMAN STANDARD DRAWING	Date: 2016-08-05	TYPICAL LIGHTING CONTROL CENTER METERED PEDESTAL STANDARD DETAILS	FIGURE 9
	Scale: N.T.S.		



NOTES

1. ALL LUMINAIRES SHALL BE LED.
2. COLOR TEMPERATURE 3000K, PER ANSI C78.377-2011 STANDARD.
3. ALL LUMINAIRES SHALL BE EQUIPPED WITH A SURGE SUPPRESSION DEVICE WITH A MINIMUM IMMUNITY LEVEL OF 10kV.
4. ALL LUMINAIRES SHALL BE EQUIPPED WITH A 0-10V DIMMING DRIVER.
5. ALL LUMINAIRES SHALL BE EQUIPPED WITH AN ANSI C136.41 7-PIN RECEPTACLE AND PHOTOCCELL.
6. ALL LUMINAIRES SHALL HAVE EITHER TYPE II OR TYPE III DISTRIBUTION.



25 FT. TO 40 FT. STANDARD

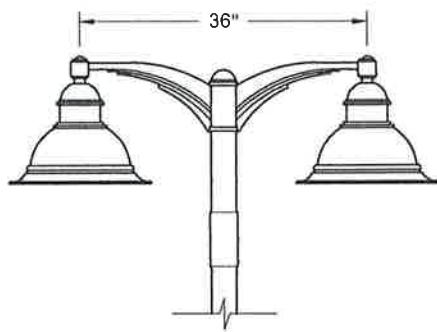
CITY OF BOZEMAN
 STANDARD DRAWING

Date: 2016-08-05

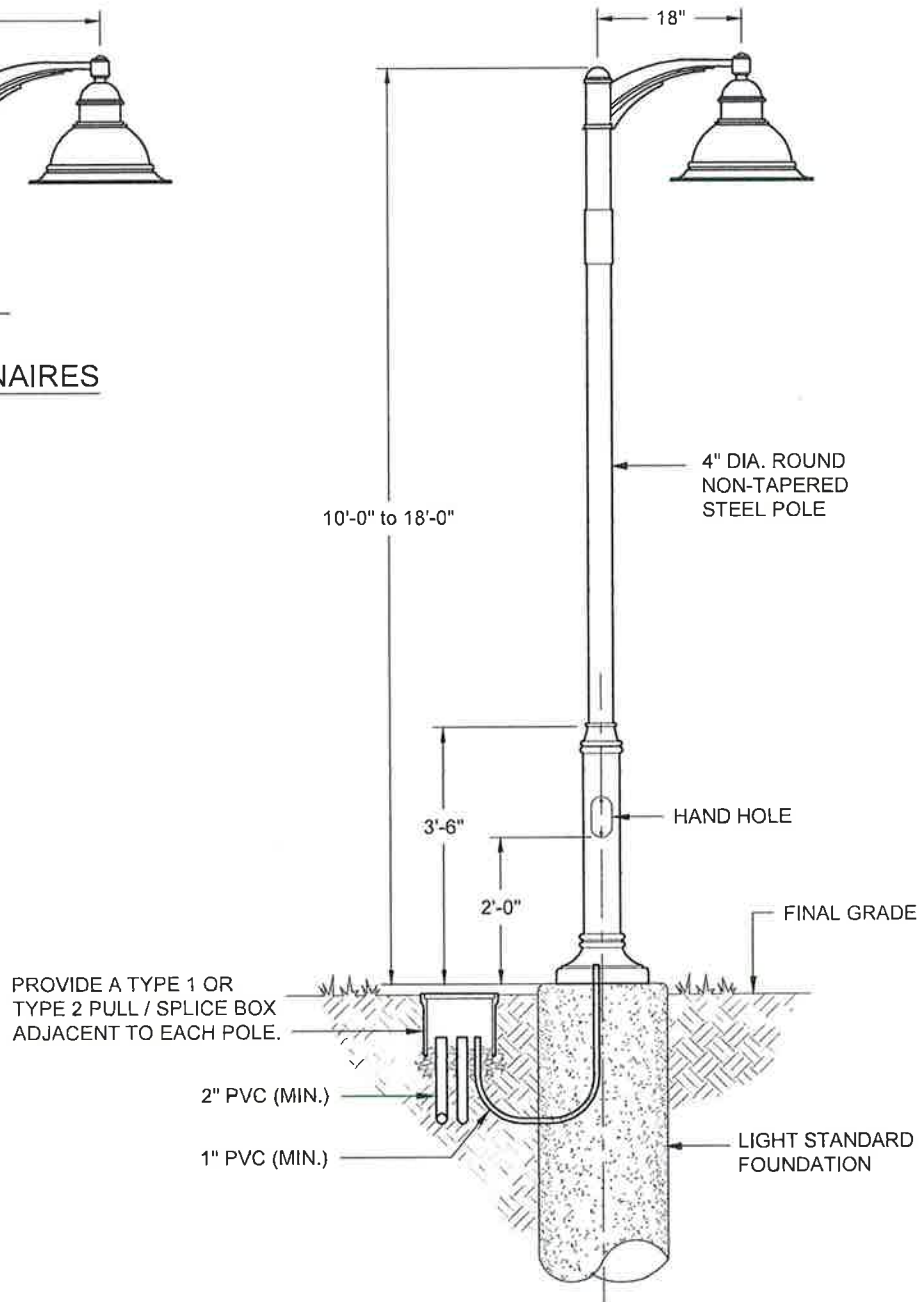
Scale: N.T.S.

TYPICAL STREET LIGHT
 STANDARD DETAILS

FIGURE 10



TWIN LUMINAIRES



NOTES

1. ALL LUMINAIRES SHALL BE LED.
2. COLOR TEMPERATURE 3000K, PER ANSI C78.377-2011 STANDARD.
3. ALL LUMINAIRES SHALL BE EQUIPPED WITH A SURGE SUPPRESSION DEVICE WITH A MINIMUM IMMUNITY LEVEL OF 10KV.
4. ALL LUMINAIRES SHALL BE EQUIPPED WITH A 0-10V DIMMING DRIVER.
5. ALL LUMINAIRES SHALL BE EQUIPPED WITH AN ANSI C136.41 7-PIN RECEPTACLE AND PHOTOCELL.
6. ALL LUMINAIRES SHALL HAVE TYPE III DISTRIBUTION.

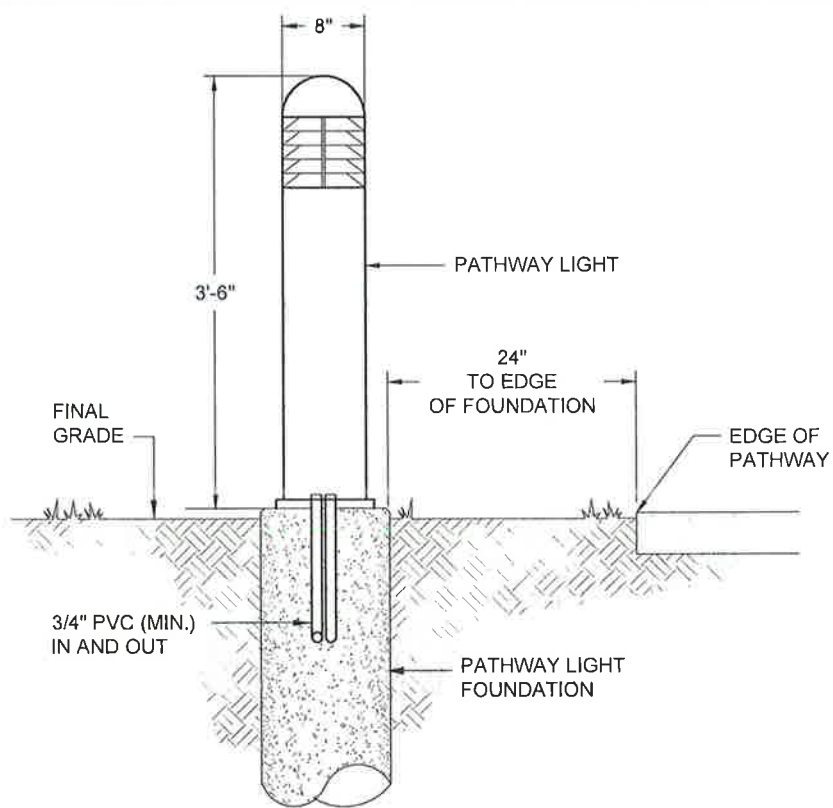
CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05

Scale: N.T.S.

TYPICAL ARM MOUNT PEDESTRIAN
LIGHT STANDARD DETAIL

FIGURE 12

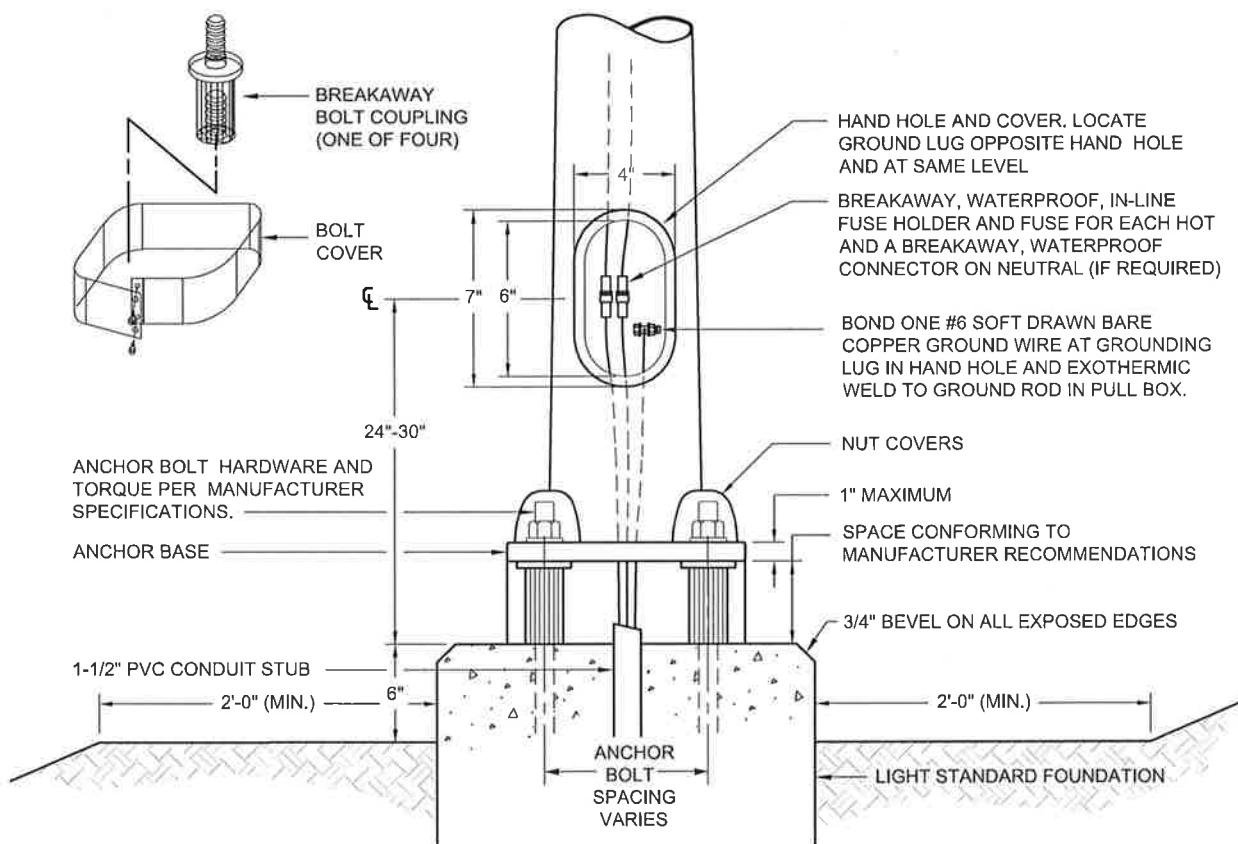


CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05
Scale: N.T.S.

TYPICAL PATHWAY LIGHT
STANDARD DETAILS

FIGURE 13



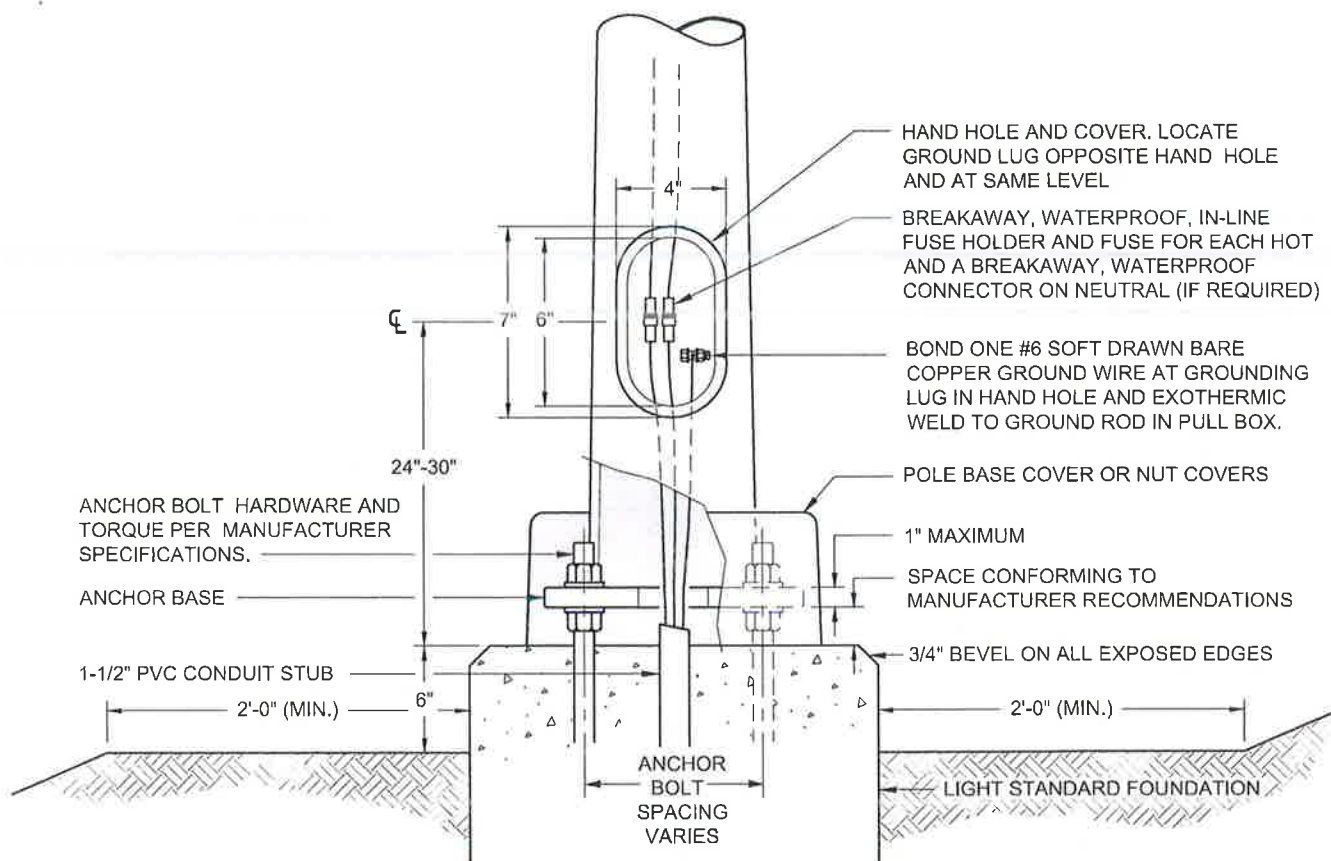
TYPICAL - BREAKAWAY BASE DETAIL

FOR USE ONLY OUTSIDE CLEAR ZONE OR IN PROTECTED INSTALLATIONS.

NOTES

1. LIGHT STANDARD FOUNDATIONS MAY BE PRECAST CONCRETE OR CAST-IN-PLACE CONCRETE.
2. ALL CONDUCTORS SHALL BE SIZED IN CONFORMANCE WITH N.E.C. REQUIREMENTS IMA 19-1 3 CONDUCTOR #14 AWG MINIMUM

CITY OF BOZEMAN STANDARD DRAWING	Date: 2016-08-05	TYPICAL POLE BASE STANDARD DETAILS	FIGURE 14
	Scale: N.T.S.		



TYPICAL NON-BREAKAWAY BASE DETAIL

FOR USE ONLY OUTSIDE CLEAR ZONE OR IN PROTECTED INSTALLATIONS.

NOTES

1. LIGHT STANDARD FOUNDATIONS MAY BE PRECAST CONCRETE OR CAST-IN-PLACE CONCRETE.
2. ALL CONDUCTORS SHALL BE SIZED IN CONFORMANCE WITH N.E.C. REQUIREMENTS IMSA 19-1 3 CONDUCTOR #14 AWG MINIMUM.

CITY OF BOZEMAN
STANDARD DRAWING

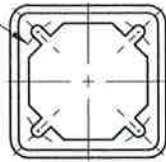
Date: 2016-08-05

Scale: N.T.S.

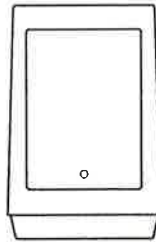
TYPICAL NON-BREAKAWAY POLE
BASE STANDARD DETAIL

FIGURE 15

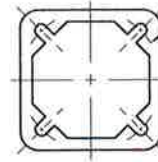
BOLT CIRCLE SHALL
MATCH FOUNDATION



BOTTOM PLATE



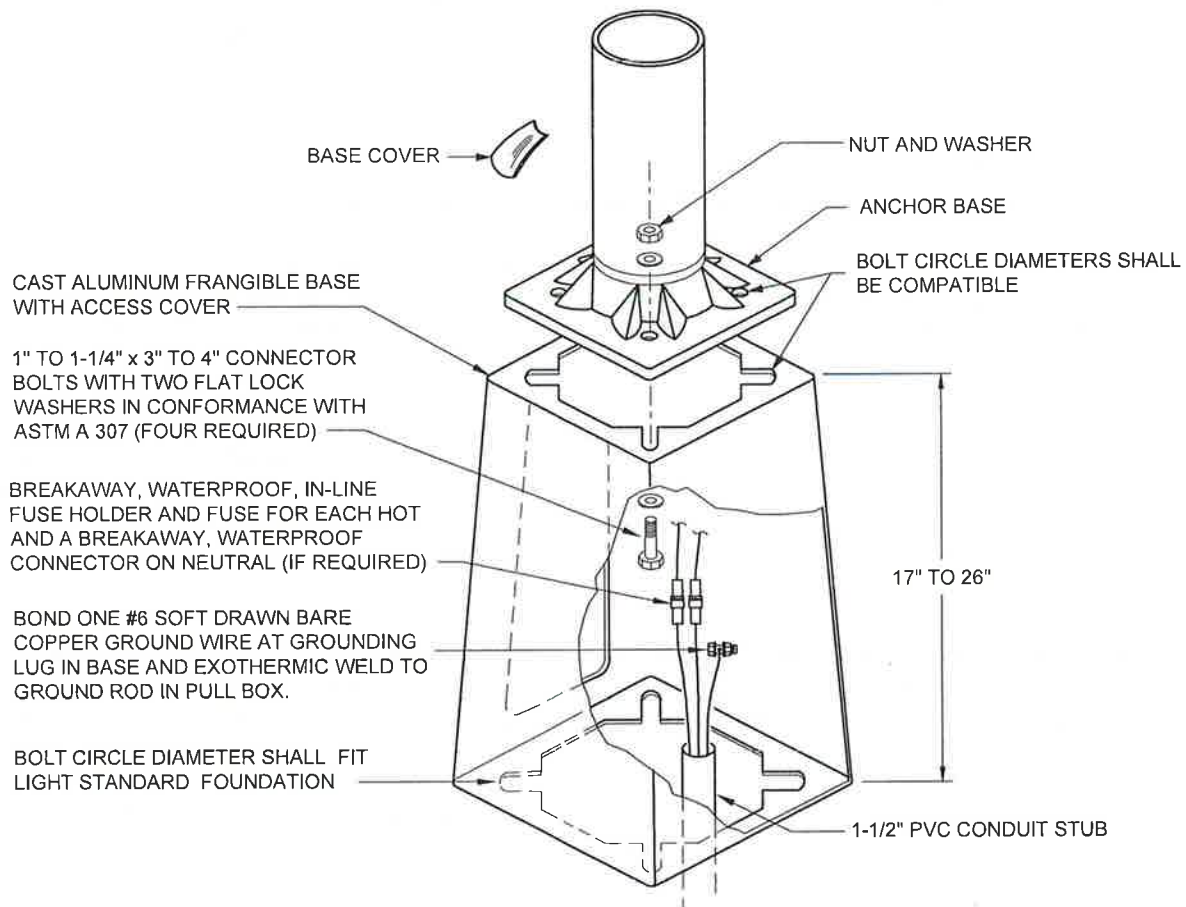
FRONT VIEW



BOLT CIRCLE SHALL
MATCH LIGHT
STANDARD BASE

TOP PLATE

NOTE: MATCH EXISTING BREAKAWAY TRANSFORMER BASE AS CLOSELY AS POSSIBLE.



NOTES

1. ALL BREAK-AWAY TRANSFORMER BASES SHALL CONFORM TO AASHTO "STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS".
2. LIGHT STANDARD FOUNDATIONS MAY BE PRECAST CONCRETE OR CAST-IN-PLACE CONCRETE.
3. ALL CONDUCTORS SHALL BE SIZED IN CONFORMANCE WITH N.E.C. REQUIREMENTS IMSA 19-1 3 CONDUCTOR #14 AWG MINIMUM.
4. HAND HOLE IS NOT REQUIRED IN THE POLE IF A BREAKAWAY TRANSFORMER BASE IS USED.

CITY OF BOZEMAN
STANDARD DRAWING

Date: 2016-08-05

Scale: N.T.S.

TYPICAL FRANGIBLE TYPE
TRANSFORMER BASE DETAIL

FIGURE 16

City of Bozeman – Street Lighting Method of Measurement

Introduction

Street lighting luminance measurements are best taken on nights with clear skies, dry pavement and in areas with little to no light contribution from adjacent properties. Preliminary luminance measurements may be taken using OpticaLight, a luminance photo-mapping application on an iPad or iPhone. The recommended distance for taking luminance measurements with the OpticaLight App is 20-ft to 30-ft from the measurement point. The technician performing the luminance measurements shall complete the Street Lighting Measurement Form to record the measured street luminance values and the factors that may affect the lighting measurements. If the measurements from OpticaLight result in an average luminance that is below the acceptable tolerance from the luminance criteria, luminance measurements shall be re-taken using a calibrated luminance meter with a 1-degree or 1/3-degree measuring angle and +/- 2% accuracy.

Street Lighting Method of Measurement

1. **Intent:** There are many factors that can lead to differences between calculated street luminance and street luminance measured in the field. The intent of this report is to provide guidance for City of Bozeman field technicians to measure the luminance of street lighting installations to compare with luminance criteria. By first understanding the many factors that affect street luminance conditions and differences with calculated street luminance, technicians will be able to:
 - a. Determine which factors can be avoided by following these recommended methods;
 - b. Understand which factors can be accounted for and considered as reasonable variations; and
 - c. Identify which factors may need further investigation to troubleshoot any issues that need to be addressed in order to bring a non-compliant street lighting installation into compliance.
2. **Measured vs. Calculated Street Luminance:** The following factors affect the measurement of street luminance to some degree. Some factors can have a significant impact on the luminance and perceived brightness of the street surface, while other factors have a minimal effect.
 - a. **Pavement Conditions:** The street surface material, age and condition affects the reflectance, and therefore, the luminance and perceived brightness of the street surface.
 - i. **Type of Pavement:** The Illuminating Engineering Society's Recommended Practice for Roadway Lighting (RP-8-14) defines four pavement types (R1 – R4) that have different reflectance properties. The most common pavement types used within the United States are types R1 (typical concrete) and R3 (typical asphalt).
 1. R1: Mostly diffuse reflectance properties characteristic of Portland cement or asphalt surface with a minimum of 15% of the aggregates composed of artificial brightener aggregates.

2. R2: A combination of diffuse and specular reflectance characteristics of asphalt surfaces with aggregate composed of a minimum of 60% gravel of size greater than 10 mm. Also asphalt surfaces composed of 10% - 15% artificial brightener in aggregate mix.
 3. R3: Slightly specular reflectance typical of asphalt surfaces with dark aggregates, rough texture and some months of use. This surface is common in the United States.
 4. R4: Mostly specular surface typical of very smooth asphalt texture.
- ii. Age of Pavement: As pavement ages, the reflectance properties also change, particularly with asphalt pavement. Pavement reflectance can be measured using a standard 18% reflectance photo-gray card.
1. Concrete (type R1): The reflectance properties of concrete pavement are much more stable throughout the life of the pavement than asphalt.
 2. Asphalt (type R3): Fresh, newly laid asphalt is very dark. Over a period of 6 - 12 months from laying new asphalt, the pavement lightens and eventually stabilizes to be a more consistent reflectance. When measuring luminance of an asphalt street, the pavement reflectance should be measured by comparing the luminance of a standard 18% reflectance photo-gray card with the luminance of the pavement, using the following equation:

$$R_{pavement} = \frac{L_{pavement} \times R_{gray\ card}}{L_{gray\ card}}$$

$R_{pavement}$ = Reflectance of Pavement

$R_{gray\ card}$ = Reflectance of Gray Card = 0.18

$L_{pavement}$ = Luminance of Pavement

$L_{gray\ card}$ = Luminance of Gray Card

When measuring the pavement reflectance, the measurement of the pavement luminance and gray card luminance should be taken with the meter aimed at the same point, moving the photo-gray card instead of moving the meter. Moving the meter to aim at a different point may result in a different light level at the two points, introducing error into this measurement.

- iii. Wet Pavement: When pavement is wet, the street surface becomes more specular, affecting the reflectance and luminance of the street. Luminance measurements should not be taken when the pavement is wet.
- iv. Snow: When there is snow on the street, luminance and brightness of the street is significantly increased. Luminance measurements should not be taken when there is snow on the streets.

b. Atmospheric Conditions:

- i. Ambient Temperature: At higher ambient temperatures, electronic components operate at a lower efficiency, resulting in a reduction in lumen output from LEDs. At lower ambient temperatures, the electronic components operate at a higher efficiency, increasing the lumen output from LEDs. The effect of temperature will vary depending on the luminaire's thermal management design.
- ii. Cloudy Sky: Clouds increase the reflection of light pollution back to the ground. Particularly when the ground is covered with snow and the sky is overcast, there is more light contribution from sky glow than under clear sky conditions. Under cloudy sky conditions, luminance measurement shall be taken both with lights off and lights on to determine the contribution from reflected sky glow.
- iii. Humidity and Airborne Particulates: In high humidity or poor air quality conditions, more light is scattered in the air before reaching the roadway surface. If the effect of light scattering in the air is visible, luminance measurements should not be taken.

c. Ambient Lighting Conditions:

- i. Twilight: After sunset and before sunrise, is the period of twilight when the skylight fades into darkness. Twilight has three stages, civil twilight, nautical twilight and astronomic twilight. Street lighting measurements shall not be taken until Nautical Twilight to eliminate light contribution from the sky. Nautical Twilight can be determined using the Sunrise Sunset Calendar website: <http://www.sunrisesunset.com/USA/Montana.asp>

1. Civil Twilight: During civil twilight, electric lighting is not needed to clearly distinguish terrestrial objects. During clear evening's civil twilight, horizontal illuminance decreases from approximately 45 footcandles to 0.2 footcandles.
2. Nautical Twilight: During nautical twilight, the horizon is still clearly distinguishable. During a clear evening's nautical twilight, horizontal illuminance decreases from approximately 0.2 footcandles to 0.0008 footcandles.

3. Astronomical Twilight: By the end of astronomical twilight, the sky is dark enough for all astronomical observations.

- ii. Moonlight: On a clear night, full moonlight produces 0.01 footcandles, and a quarter moon produces 0.001 footcandles. The contribution, even from full

October 2016
Bozeman, Montana

Wednesday
5
Twi A: 5:49am Twi N: 6:24am Twi: 6:58am Sunrise: 7:28am Sunset: 6:58pm Twi: 7:27pm Twi N: 8:02pm Twi A: 8:36pm Moonrise: 11:49am Moonset: 9:47pm

Excerpt from the Sunrise
Sunset Calendar website

moonlight, is generally not enough to effect the lighting measurement. However, technicians should note the phase of the moon and moonrise in the luminance measurement report. If measurements are taken during a full moon, the technician may also take luminance measurements with the lights turned off to establish the contribution from moonlight.

- iii. Light Spill from Adjacent Properties: Light contribution from adjacent properties may be significant, and should be accounted for by technicians when measuring street luminance. At sites where light spill from adjacent properties may affect street luminance measurements, technicians should measure the street luminance both with the streetlights turned off, and again with streetlights turned on.
- d. Electrical / Utility Conditions: Voltage supplied can affect the lumen output of a luminaire. Lower voltage may result in reduced lumen output and higher voltage may result in increased lumen output. Some variation in voltage is expected, but should not exceed +/- 5% from the design voltage at the luminaire. The following factors may affect the voltage supplied to a luminaire:
 - i. Wire Sizing: Voltage drop occurs over distance of electrical wiring, and is a function of the wire type, wire size, length of wire, ampacity of the electrical load and the supply voltage. Larger gauge wire has less voltage drop per linear foot than smaller gauge wire. For LED street lighting retrofit projects, the electrical load is most often being reduced from the original load. Since the existing wire was engineered for a higher load, it is typically over-sized for the new lower LED loads and voltage drop is not usually a concern.
 - ii. Wire Type: Copper wire has the best conductivity and longevity, maintaining its conductivity over time. Aluminum wire is more susceptible to corrosion and thermal expansion and contraction, which can affect the wiring connections and conductivity over time. In older street lighting installations, the age of the wiring may contribute to inadequate operating conditions.
 - iii. Conduit Type: For in-grade electrical wiring installations, PVC and HDPE conduit provides the best long-term protection of the wiring. While most new street lighting installations use these conduit types, some older street lighting may have been installed with galvanized rigid conduit (GRC) or even with direct bury cable (DBC) with no conduit protection. GRC and DBC installations can corrode or degrade over time, reducing the functional life of the wiring, which may contribute to inadequate operating conditions.
 - iv. Utility Supply Voltage: Voltage supplied by the utility to the Lighting Control Center may vary from the design voltage. If the voltage at the Lighting Control Center is more than 2% below the design voltage, the City should contact the electrical utility to help determine the cause.

e. Luminaire Manufacturing

- i. Manufacturing Quality: Optics and light output may vary between the sample luminaire that was used to create the photometry used in the lighting calculations and the actual luminaires installed in the field. While normal tolerances in the manufacturing process should be expected, the quality of manufacturing process may result in unacceptable variation from the specifications.
- ii. Luminaire Specifications: Luminaires have multiple options for different optical distributions and lumen outputs. If the installed luminaires do not match the specified and calculated luminaires, the measured light levels may vary significantly from designed levels.
- iii. Thermal Management: Heat from LEDs is emitted back through the circuit board that the LED is mounted to. If this heat is not adequately dispersed away from the circuit board, and the LEDs overheat, the light output degrades much faster.
- iv. LED Driver: The LED driver regulates the electrical voltage and current that is delivered to the LEDs. The electrical current is typically expressed in milliamps (mA). LEDs can be driven at multiple drive currents, with lower drive currents emitting less light and higher drive currents emitting more light. If the light output is too low, a higher drive current will increase the light output of the luminaire. Some drivers are designed with field selectable drive current that may be set to a higher drive current without replacing the driver.

f. Measuring Equipment

- i. Calibrated Luminance Meter: Calibrated luminance meters like the Konica Minolta LS-110 or LS-160 provide high accuracy luminance measurements at low light levels that are typical in street lighting applications. Luminance values can be measured at any distance.
- ii. OpticaLight iPhone/iPad Application: The OpticaLight iPhone/iPad application provides a less expensive option for measuring luminance. Luminance measurement from this application tend to be lower than the LS-110 luminance meter by 15% - 20% on average. The accuracy improves when measurements are taken at a distance of 20-ft to 30-ft from the measurement point. When there is high contrast, measurements may need to be taken at a closer range to reduce the area within the view, thereby reducing the contrast within the view.

g. Construction

- i. Light Pole Locations: As-built light pole locations may vary from designed locations to avoid conflicts that were unforeseen during the design phases. Light pole locations that vary significantly from the design may adversely impact the measured light levels on the street.

- ii. Light Pole Geometry: The pole height and mast arm length should match the design specifications. Variations in height or location of the luminaire may affect the measured light levels on the street.
- iii. Luminaire Orientation & Positioning: Luminaires may be installed with a tilt or twist, resulting in the luminaire not being level, changing the light distribution from the intended design.

h. Light Loss Factors

Roadway lighting calculations are performed using light loss factors that reduce the lumen output of luminaires to ensure that adequate luminance is provided through the life of the lighting system as the light source ages and dirt accumulates on the luminaire. A lighting calculation using light loss factors results in the "maintained luminance" of the street. When a new lighting installation is being measured, these light loss factors should be close to 1.0, resulting in "initial luminance" of the street.

- i. Lamp Lumen Depreciation (LLD): For maintained lighting calculations, the Lamp Lumen Depreciation (LLD) factor for LED luminaires shall be 0.9.
- ii. Luminaire Dirt Depreciation (LDD): For maintained lighting calculations, the Luminaire Dirt Depreciation (LDD) factor for LED luminaires shall be 0.9.
- iii. Total Light Loss Factor (LLF): Multiplying the LLD(0.9) x LDD(0.9) results in a total Light Loss Factor (LLF) of 0.81.

References

European Road Lighting Technologies - Luminance Design and Pavement Reflection Factors

<http://international.fhwa.dot.gov/euroroadlighting/04.cfm>

"Furthermore, results of studies have shown that, in the case of porous asphalts, it typically takes between 6 months and a year for the pavement to stabilize in order to obtain reliable R-values."

"In an additional conversation with Werner Riemenschneider, however, he clarified that after the pavement had aged for 6 to 12 months, the Swiss typically found that the measured average values were within 15 percent of the average design value, usually on the high side."

"In the good cases the Belgians noted discrepancies of less than 10 percent, when comparing measured luminance levels against calculated levels for pavements, where the reflection characteristics have been determined."

"In Switzerland, experts emphasized the importance of dry roadways when conducting field measurements. There are, however, only a couple of summer months during which pavements are dry enough to be measured. In addition, the team heard warnings about dew points and pavement ages. It was noted that, during observations in cold weather (typically October through December), with a clear sky, when conditions were under the dew point, a water film could suddenly appear on the roadway. This film could provide a reflectance differential of 200 percent. Given these difficulties and variations in pavement reflection characteristics, the Swiss typically verify lighting installations with incident light measurements."

PNNL – Lumen Maintenance and Light Loss Factors

http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22727.pdf

Twilight Envelope (3.2 lux) as a Visibility Criterion

<http://www.visualexpert.com/Resources/twilightcriterion.html>

During civil twilight, approximately the first half hour after sunset, ground illuminance in good weather declines by a factor of about 100, from roughly 330 lux to 3.2 lux.

American Meteorological Society

Civil Twilight: http://glossary.ametsoc.org/wiki/Civil_twilight

During a clear evening's civil twilight, horizontal illuminance decreases from ~585–410 lux to ~3.5–2 lux.

Nautical Twilight: http://glossary.ametsoc.org/wiki/Nautical_twilight

During a clear evening's nautical twilight, horizontal illuminance decreases from ~3.5–2 lux to ~0.008 lux.

Astronomical Twilight: http://glossary.ametsoc.org/wiki/Astronomical_twilight

During a clear evening's astronomical twilight, horizontal illuminance due to scattered sunlight decreases from ~0.008 lux to $\sim 6 \times 10^{-4}$ lux.

Sunrise/Sunset Calendar

<http://www.sunrisesunset.com/USA/Montana.asp>

This website provides calendars with sunrise/sunset information for specific locations, with appropriate adjustments for latitude, longitude and time zone. Information display options include

sunrise, sunset, moon phase, moonrise, moonset, civil twilight, nautical twilight and astronomical twilight.

City of Bozeman – Street Lighting Luminance Method of Measurement

The City of Bozeman Street Lighting Standards are based on roadway luminance criteria. Luminance is the intensity of light per unit area that is emitted from a surface in a given direction, expressed as candela per square meter (cd/m^2). The luminance of the roadway surface is the light reflected off of the pavement toward a driver. Accurate luminance measurements require a calibrated luminance meter with a $1/3^\circ$ – degree measuring angle and $\pm 2\%$ accuracy. Konica Minolta produces very high quality luminance meters the LS-160 is the current model offered by Konica Minolta (<http://sensing.konicaminolta.us/products/ls-160-luminance-meter/>), and the Konica Minolta LS-110 can be rented from Advanced Test Equipment Rentals (<http://www.atecorp.com/products/minolta/ls-110.aspx>).



Konica Minolta LS-160
Luminance Meter

For preliminary testing, there is a photographic luminance mapping application from OpticaLight (website) for iPad and iPhone (<https://itunes.apple.com/us/app/opticalight-candela/id1086540410?mt=8>). The OpticaLight App was tested and compared to measurements from a calibrated Konica Minolta LS-110 luminance meter. The accuracy of the OpticaLight App was found to be more accurate for measurements that were taken at close range (20ft to 30ft), and less accurate for more distant measurements.

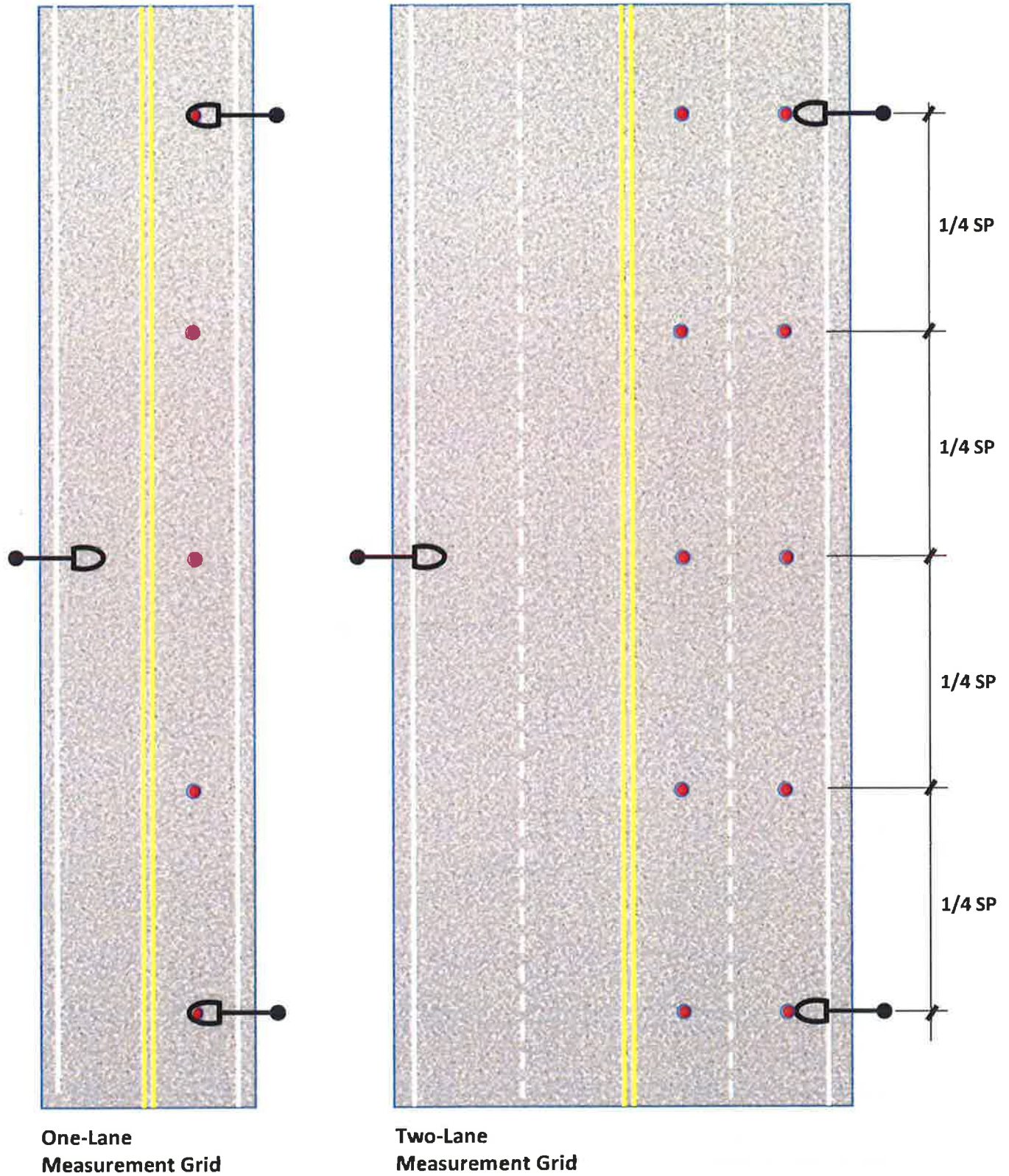


OpticaLight Photo Luminance Mapping App

Distant Measurements		
Optica Light App	Konica Minolta	% Difference
0.57	1.07	47%
0.31	0.44	30%
1.7	1.9	11%
1.8	1.97	9%
2.4	2.9	17%
0.65	0.86	24%
0.48	0.7	31%
Low	0.49	
1.13	1.29	24%
Near Measurements		
Optica Light App	Konica Minolta	% Difference
1.6	1.88	15%
6.1	6.9	12%
2.1	2.4	13%
0.33	0.44	25%
0.51	0.67	24%
0.32	0.39	18%
0.66	0.69	4%
0.41	0.43	5%
0.33	0.38	13%
1.5	1.55	3%
5.7	6	5%
0.13	0.2	35%
0.04	0.05	20%
1.52	1.69	15%

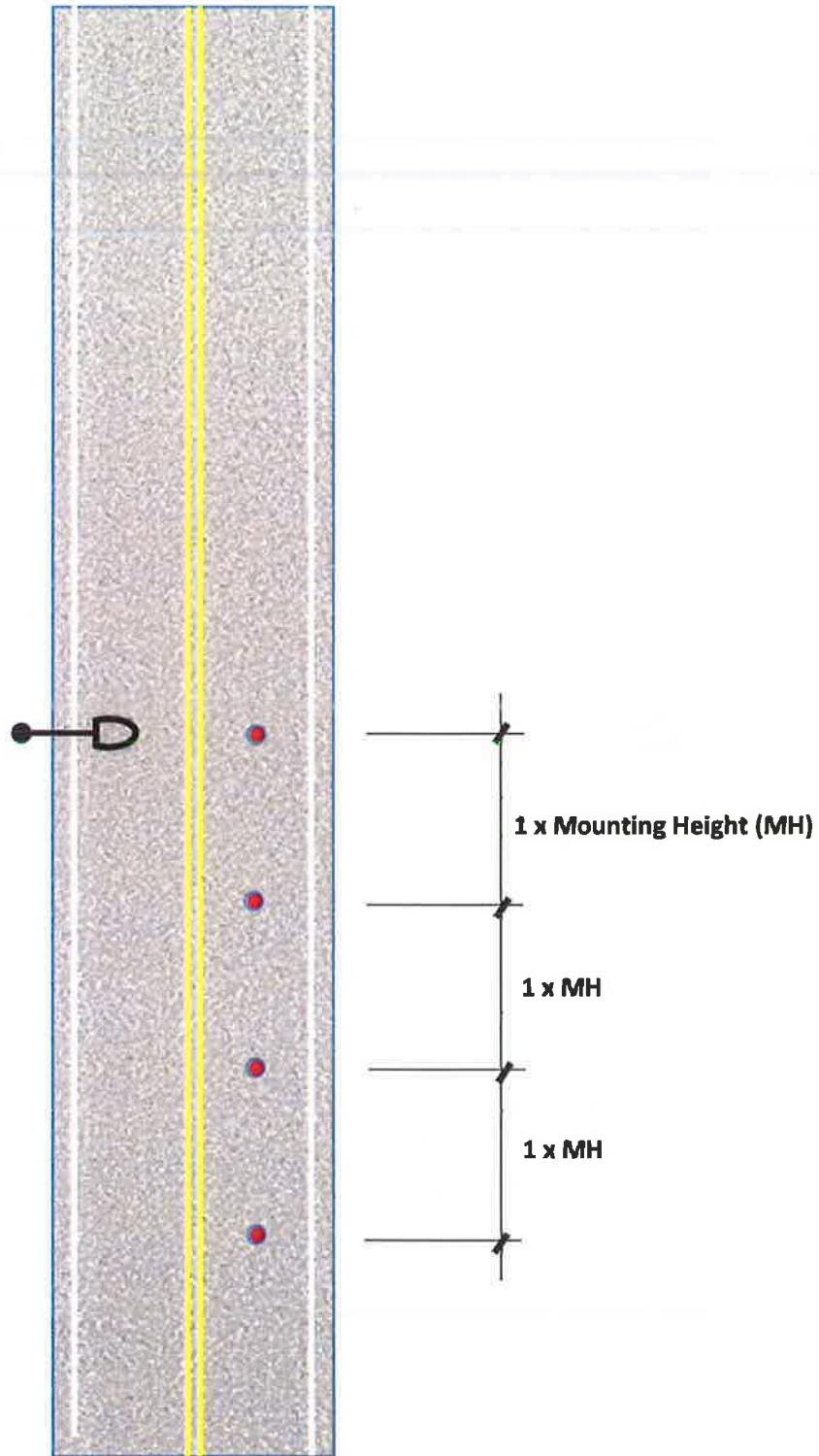
OpticaLight App vs. Konica Minolta
LS-110 Luminance Meter

Luminance Measurement Grid





Luminance Measurement Grid



**Single Luminaire
Measurement Grid**

City of Bozeman – Street Lighting Method of Measurement

Step-by-Step Street Luminance Measurement Method

1. Schedule and Prepare for Site Visit:

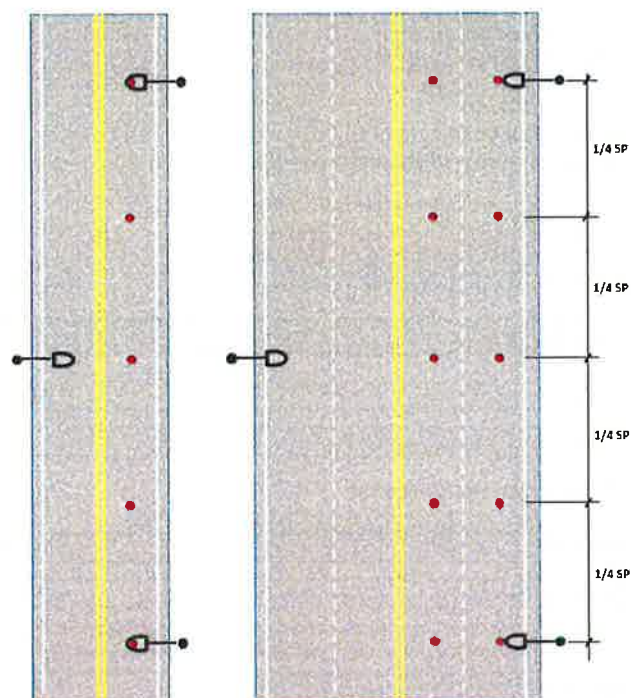
a. Determine Measurement Start Time:

Street lighting measurements shall not be taken until Nautical Twilight to eliminate light contribution from the sky. Nautical Twilight can be determined using the Sunrise Sunset Calendar website: <http://www.sunrisesunset.com/USA/Montana.asp>

b. Arrange Traffic Control (if necessary)

c. Resources & Equipment Needed

- i. Personal Protective Equipment (PPE)
 1. High Visibility Vest
 2. High Visibility Pants or Gators
 3. Hard Hat
- ii. Measuring Wheel or 200-ft Measuring Tape
- iii. Luminance Measurement Equipment
 1. iPad/iPhone with OpticaLight App, or
 2. Calibrated Luminance Meter
- iv. Photo-gray Card to measure pavement reflectance
- v. Camera
- vi. Street Lighting Measurement Form (Excel Spreadsheet) to record conditions taken in steps 2-4 below.



One Lane

Measurement Grid

Two Lane

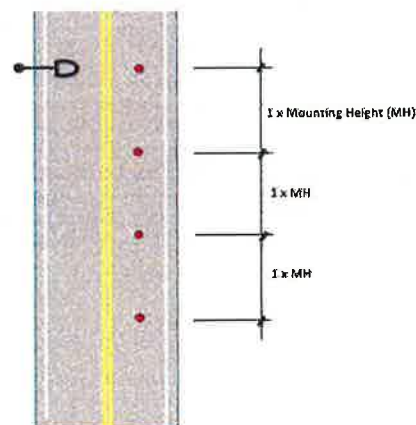
Measurement Grid

2. Record Field Conditions:

- a. Pavement Type (Concrete, Asphalt-New, or Asphalt-Aged)
- b. Pavement Conditions (dry, wet, or snow packed):
Only measure when pavement is dry
- c. Sky Conditions (clear, partly cloudy, overcast)
- d. Light spill from adjacent properties

3. Layout & Mark Measurement Points:

- a. Locate points in the center of each lane spaced at 1/4 of the street light pole spacing



Single Luminaire

Measurement Grid

4. Measured and Record Street Luminance:

- a. Select Luminance Measurement Equipment (OpticaLight or Calibrated Luminance Meter)
- b. Measure Pavement Reflectance
 - i. Measure Gray Card Luminance
 - ii. Measure Pavement Luminance at same location
- c. Measure Street Lighting Luminance
 - i. With OpticaLight, luminance measurements should be taken 20-ft to 30-ft away for most accurate readings.
- d. Measure Ambient Luminance (only required if there is significant contribution of light from adjacent sites)



**City of Bozeman
Street Lighting Measurement Form**

User Input
Pull Down Menu
Programmed Output

Date & Time	
Date	2/9/2017
Start Time (after Nautical Twilight)	7:00 PM
Sunrise/Sunset Calendar http://www.sunrisesunset.com/USA/Montana.asp	
Sunset	5:41 PM
Nautical Twilight	6:47 PM
Moon Phase	Full Moon
Moonrise	4:36 PM
Moonsset	6:33 AM

Insert Photo #1

Field Conditions	
Pavement Type	Asphalt - New (type R3 adjusted)
Pavement Conditions	Dry
Sky Conditions	Clear
Light Spill from Adjacent Properties Photograph measurement site and describe light contribution from adjacent properties	

Insert Photo #2



City of Bozeman
Street Lighting Measurement Form

Lighting Measurements

Luminance Measurement Equipment OpticalLight iPhone/iPad App

Pavement Reflectance	
Photo-Gray Card Luminance	0.39
Photo-Gray Card Reflectance	18%
Pavement Luminance	0.13
Measured Pavement Reflectance	0.06
Standard Pavement Reflectance	0.07
Pavement Reflectance Factor	1.17

18% is the standard photo-gray card reflectance

If Measured Reflectance > Standard, Factor = 1

Number of Lanes in Each Direction 1-Lane

Street Lighting Luminance Measurements (cd/m ²)			
Measurement Row #	Lane 1	Lane 2	Lane 3
1	0.3	0	0
2	0.2	0	0
3	0.16	0	0
4	0.2	0	0
5	0.3	0	0
Lane Averages	0.23	0.00	0.00
Street Average	0.23		

Ambient Lighting Luminance Measurements (cd/m ²) (only if needed, measure with street lights off)			
Measurement Row #	Lane 1	Lane 2	Lane 3
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
Lane Averages	0.00	0.00	0.00
Street Average	0.00		

Lighting Criteria & Measurement Comparison			
	Street Classification	Pedestrian Conflict	Avg Luminance
Luminance Criteria	<u>Local - Continuous</u>	<u>Low</u>	<u>0.3</u>
Luminance Measurement Summary [(Street Lighting - Ambient) x Refl Factor]			<u>0.27</u>
Variation from Criteria	-10%	Pass	
Allowable Variation	-20%		

If the Variation from Criteria Fails the Allowable Variation while using the OpticalLight iPad/iPhone App, the luminance measurements shall be retaken with a Calibrated Luminance Meter. If the Variation from Criteria still Fails using a Calibrated Luminance Meter, then the City of Bozeman shall contact the Design Engineer to trouble-shoot the installation to determine the cause of the inadequate luminance levels.



City of Bozeman
Street Lighting Measurement Form

Trouble-Shooting: Potential Sources of Discrepancy between Lighting Calculations & Measured Values

Electrical / Utility Conditions

Voltage to Luminaire
Wire Sizing
Wire Type
Utility Voltage at Lighting Control Center

Manufacturing Conditions

Manufacturing Tolerances
Luminaire Optics
Thermal Management
LED Driver

Measuring Equipment

Calibrated Luminance Meter
Opticalight iPhone/iPad App

Lighting Calculation Variables

Construction

Light Pole Location
Light Pole Geometry
Mounting Height
Mast Arm Length

Lighting Calculations

Pavement Type

R1 - Typical Concrete with Diffuse Reflectance
R2 - Asphalt with Fine Aggregate and Artificial Brightener
R3 - Asphalt with Course, Dark Aggregate (Most Common in USA)
R4 - Asphalt with Very Smooth Texture

Light Loss Factors

Lamp Lumen Depreciation
Luminaire Dirt Depreciation