An Investigation into

Stormwater Management, Pollution, and Monitoring in the Flathead Watershed, Montana: Phase I

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Flathead Basin Commission
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Acronyms & Abbreviations

ARM = Administrative Rules of Montana
COD = Chemical Oxygen Demand
Cu = Total Recoverable Copper
DO = Dissolved Oxygen
FBC = Flathead Basin Commission
FCPZO = Flathead County Planning and Zoning Office
FWPCA = Federal Water Pollution Control Act
KPWD = Kalispell Public Works Department
MCWAIC = Montana Clean Water Act Information Center
MDEQ = Montana Department of Environmental Quality
MDNRC = Montana Department of Natural Resources and Conservation
MDT = Montana Department of Transportation
ME Labs = Montana Environmental Laboratory
MEP = Maximum Extent Practicable
MFWP = Montana Fish, Wildlife, & Parks
MNHP = Montana Natural Heritage Program
MPDES = Montana Pollutant Discharge Elimination System
MS4 = Municipal Separate Storm Sewer System
NOAA = National Oceanic and Atmospheric Administration
NPDES = National Pollutant Discharge Elimination System
NPS = National Park Service
NRCS = Natural Resource Conservation Service
Pb = Total Recoverable Lead
SWMP = Stormwater Management Program
TKN = Total Kjeldahl Nitrogen
TMDL = Total Maximum Daily Load
TN = Total Nitrites and Nitrates
TP = Total Phosphorus
TSS = Total Suspended Solids
USDA = United States Department of Agriculture
USEPA = United States Environmental Protection Agency
USGS = United States Geological Survey
WPWD = Whitefish Public Works Department
Zn = Total Recoverable Zinc

Preface & Abstract

Preface

The following report is intended for use by the Flathead Basin Commission and the cities and towns within the Flathead Basin, MT that have contributed data to this project. The purpose of this project is to provide these entities with (1) an understanding of where stormwater infrastructure data exists in the basin and where this data may be lacking, (2) where potential water quality degradation may be occurring as a result of stormwater pollution, (3) the results of nonpoint source pollution monitoring efforts employed in the basin, and (4) recommendations for ways to expand this project in the future.

Before reading, it should be noted that the author is not responsible for any spatial inaccuracy or misrepresentation of the stormwater infrastructure data. The integrity of this spatial data was not thoroughly investigated in the field by the author prior to the publication of this report, except in locations where such is explicitly stated. Additionally, the outfall priority rankings presented in this report are the opinion of the author and are based on a limited number of sub-basin characteristics. These priority rankings should not be accepted as (a) the definitively highest polluting areas within the basin or (b) the only areas in the basin responsible for contributing to water quality degradation through stormwater pollution. These priority areas are merely suggestions for locations on which to focus water quality monitoring efforts in the future.

Abstract

Located in northwest Montana, the Flathead Watershed is an ecologically, socially, economically, and culturally vital resource that is anticipated to experience increasing threats to water quality in the future.

The purpose of this project is to understand how stormwater—one of the many potentially significant causes of water quality degradation—is currently being managed within the Flathead Watershed to identify locations to prioritize future water quality monitoring efforts. Specifically, this goal was accomplished through (1) the creation of an inventory of current stormwater infrastructure within urban areas of the Flathead Basin, (2) the construction of a model for prioritizing sub-basins within the watershed that have the highest potential for water quality degradation, and (3) the testing of two techniques for monitoring nonpoint source pollution in the basin—stormwater sampling and dry-weather outfall inspections for illicit discharge detection. Stormwater infrastructure for Kalispell, Whitefish, Polson, Bigfork, Lakeside, Evergreen, Ronan, and Columbia Falls is included in the inventory. Each of these areas has unique stormwater management strategies, and the ownership, maintenance, and documentation of each area's stormwater system varies. Based on sub-basin area, the land use characteristics of each sub-basin, and the impairment status of the receiving waterbody, all 177 known sub-basins within the Flathead Watershed were ranked according to their water pollution potential. The model identified 12 outfalls to be the highest priority for future water quality monitoring, eight of which are in Kalispell, three of which are in Whitefish, and one of which is in Polson. One set of stormwater samples was collected at outfalls in Kalispell, Evergreen, Whitefish, and Columbia Falls, and dry-weather outfall inspections were performed in Kalispell. Both techniques have potential for basin-wide implementation. There is great potential for this project to be expanded in the future as more data is uncovered regarding stormwater management throughout the basin.

Introduction

Flathead Lake, the largest natural freshwater lake west of the Mississippi River, and its surrounding drainage basin are essential resources in the region of northwestern Montana. The Flathead Watershed is nested within the larger Columbia River Basin and serves as an ecologically, socially, economically, and culturally vital resource for residents in the neighboring Flathead and Lake counties (See Fig. 1). Bounded by the rugged Mission Mountains to the east and Salish Mountains to the west, the Flathead Watershed is a patchwork of valleys, wetlands, cities, rivers, wilderness, floodplains, farmland, and lakes, all of which are hydrologically interconnected and eventually drain into Flathead Lake.

In terms of water quality, the Flathead Watershed is a unique watershed in that it has some of the cleanest waters in the country owing to its relatively undeveloped status. Although there are areas of urbanization, the Flathead Watershed is different from similarly sized watersheds on the east coast of the country in that it contains vast stretches of natural wilderness that have yet to be developed, and the watershed remains far less densely populated than some of its eastern counterparts. However, as populations in the area continue to grow and increased urbanization and industrialization are expected, water quality will be an issue on the forefront of decision-makers' and residents' minds in years to come. In order to predict and preemptively address these future water quality concerns, it is important to first understand the current state of water quality and water management strategies across the watershed. This project focuses on stormwater, one of the many potentially significant causes of water quality degradation in the Flathead Watershed, and aims to better understand what systems are currently in place for stormwater management. Gaining this understanding is the first step in ensuring that stormwater pollution in the Flathead Basin can be attenuated in the future.

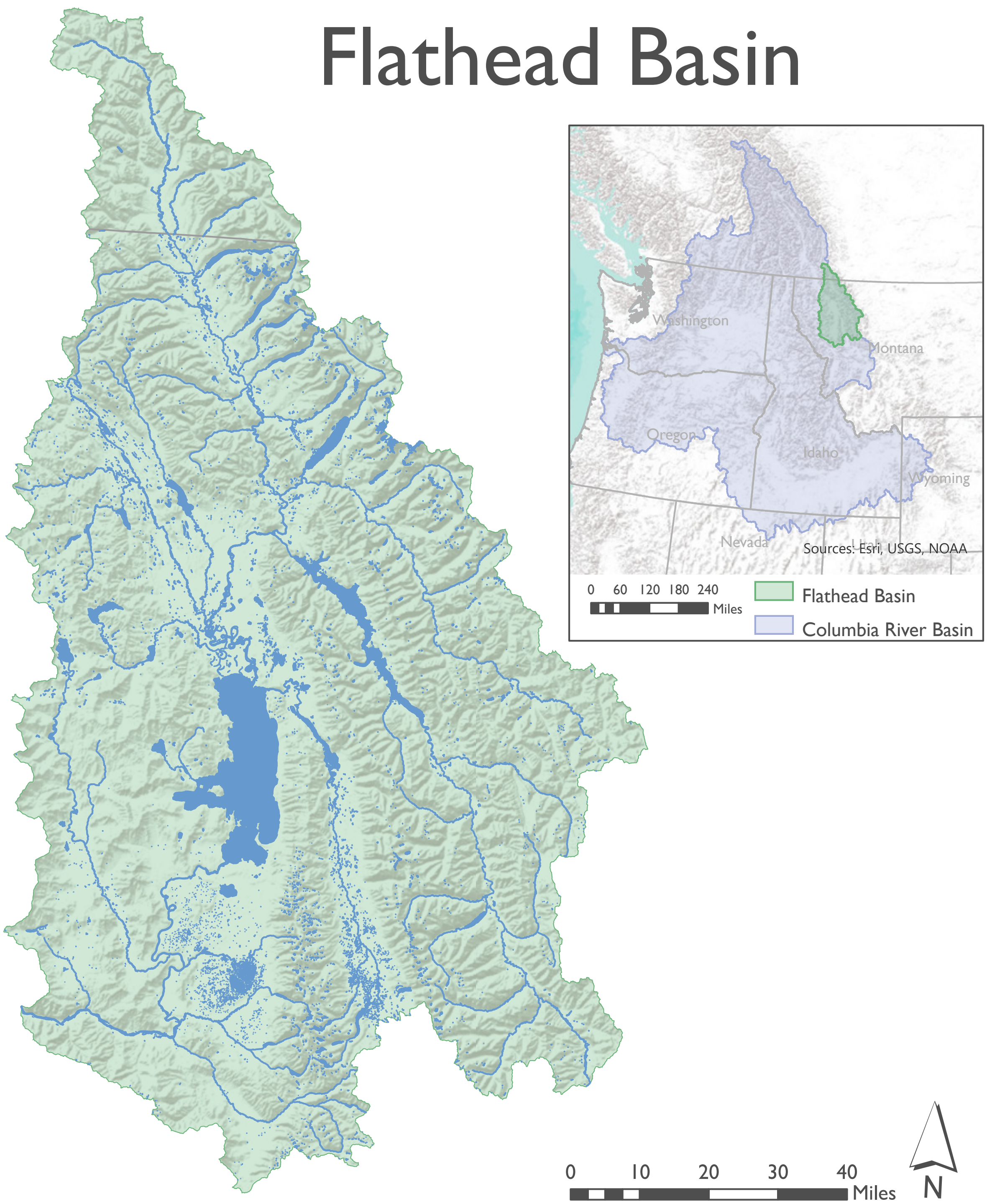


Figure 1. Map of Flathead Basin in the context of the Columbia River Basin. Data from Pacific States Marine Fisheries Commission (2017), National Weather Service (1999), USDA NRCS (2013), USGS (2019), Montana State Library (1993), and Statistics Canada (2016). Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Basemap from Esri, USGS, NOAA, Garmin, and NPS. Inset basemap from Esri, USGS, and NOAA. Created by Emilie Henry (2020).

What is Stormwater and Why Does it Matter?

Stormwater is defined as runoff generated from precipitation events that does not soak into the ground and flows over impervious surfaces in a landscape. These impervious or impermeable surfaces can include building structures, paved roads and parking lots, and unvegetated or devegetated landscapes. There are two primary ways in which urban areas manage their stormwater: (1) combined sewer systems or (2) municipal separate storm sewer systems (MS4s). In combined systems, stormwater and sanitary sewer systems utilize the same underground pipes. Stormwater combines with raw sewage coming from homes and businesses, and the combination of stormwater and sewage is treated at a wastewater treatment plant before being discharged into a waterbody. During large precipitation events, the wastewater treatment plant can be overwhelmed, and the combination of raw sewage and stormwater can be discharged into waterbodies directly without treatment. In MS4s, stormwater and sanitary sewers utilize different systems of pipes, meaning that stormwater in these systems is not treated at a wastewater treatment plant and there's no potential for combined sewer overflow.

The distinction between these two systems becomes important in the context of stormwater pollution. Stormwater not only flows across the impermeable surfaces of a landscape but also picks up and transports pollutants from the landscape. These pollutants can include but are not limited to oil and grease, agricultural chemicals, plastic and other litter, grass clippings, and large influxes of sediment. If these pollutants enter a waterway in large enough quantities, they all have the potential to negatively affect water quality, watershed hydrology, and/or aquatic ecology in different ways.

Within the context of the Flathead Watershed, many of the urban areas within the basin have stormwater systems, all of which are MS4s. Thus, although combined sewer overflows do not occur here, almost all stormwater in the basin does not get treated before it is discharged into local waterbodies. As a result, any pollutants this stormwater picks up from the landscape can enter local waterbodies directly, which has negative implications for the basin's water quality.

How is Stormwater Regulated in the Flathead Basin?

The history of governmental involvement in water pollution control dates back to 1948 with the Federal Water Pollution Control Act (FWPCA). Initially, FWPCA emphasized the state's role in protecting water resources with few federal regulations (USEPA, 2010b, 1-1). However, the FWPCA Amendments of 1972 drastically altered this framework by granting the federal government a major role in pollution control programs and led to the establishment of the National Pollutant Discharge Elimination System (NPDES) (USEPA, 2010b, 1-2). Further developed by the Clean Water Act of 1977, the NPDES permit program requires that "any point source that discharges or plans to discharge pollutants into waters of the United States is required to obtain an NPDES permit," with different activities being subject to different regulations and requiring different management strategies (USEPA, 2010b, 1-5). Regulated activities include industrial activities, construction activities, and MS4s (USEPA, 2010a, 3). In terms of MS4s specifically, Phase I of NPDES only addressed large and medium MS4s—that is, municipalities that serve a population of 100,000 or more. The second phase of NPDES expanded the stormwater program to include small MS4s with populations less than 100,000 (USEPA, 2010b, 2-9).

Within the context of Montana, the state has regulatory authority over stormwater permits, specifically the Montana Department of Environmental Quality (MDEQ) Permitting and Compliance Division (USEPA, 2010a, 3). The NPDES on the national level was translated to the Montana Pollutant Discharge Elimination System (MPDES) at the state level, and it is through MPDES permits that MDEQ can regulate stormwater discharges within the state. Similar to the NPDES standards, stormwater discharge associated with construction activities, industrial activities, and MS4s are permitted through an MPDES permit, each of which requires different actions for different types of activities. The MS4 permit in particular requires the permittee to (1) develop a Stormwater Management Program (SWMP) that is designed to reduce pollutant discharges from the MS4 to the maximum extent practicable (MEP); (2) protect water quality; and (3) satisfy the appropriate water quality requirements of the Montana Water Quality Act (USEPA, 2010a, 5).

As of the time of this report, the only city or town within the Flathead Basin that classifies under the Administrative Rules of Montana (ARM) 17.30.1102 as a small MS4 is Kalispell based on its population, population density, potential for growth, and potential for discharge to result in exceedances of water quality standards (USEPA, 2010a, 3; MDEQ, 2003). Therefore, with the exception of Kalispell and infrastructure owned by the Montana Department of Transportation (MDT) within Kalispell city limits, none of the other cities and towns within the Flathead Watershed are legally required under these federal and state mandates to manage and monitor their stormwater discharges. Because of this, any of the work cities and towns outside of Kalispell do to manage, regulate, or treat their stormwater is voluntary. Additionally, there are industrial facilities and construction-related activities within the basin that are permitted by the state under the Multi-Sector General Permit for Industrial Stormwater Discharges and General Permit for Stormwater Discharges Associated with Construction Activity, respectively (MDEQ, 2020). While these activities do exist, the bulk of this project focuses on stormwater infrastructure in urban cities and towns across the basin rather than specific industrial or construction projects.

Purpose

This project was created through a partnership with the City of Kalispell (kalispell.com) and the Flathead Basin Commission (FBC) (flatheadbasincommission.org) in an effort to increase understanding and awareness of stormwater in the Flathead Watershed. Created by the Montana Legislature nearly 40 years ago, the FBC seeks to protect and monitor water quality and natural resources in the Flathead Watershed through community involvement and consensus-building. The City of Kalispell, a major urban area within the Flathead Basin, sought to partner with the FBC with the intent to ensure compliance with their MS4 permit, to increase capacity, and to foster collaboration on issues related to water quality. Together, the city and the FBC supported a Big Sky Watershed Corps Member who was responsible for executing the beginning phases of the project. An AmeriCorps program, Big Sky Watershed Corps allows young professionals to assist with local conservation efforts in Montana's watershed communities. All three organizations pooled resources and efforts to implement Phase I of this project.

That said, the purpose of Phase I of this project is to understand how stormwater is currently being managed within the Flathead Watershed in order to identify specific locations on which to prioritize future water quality monitoring efforts that would have the greatest impact on pollution reduction. More specifically, the goal was four-fold: (1) to determine the current state of stormwater in the Flathead Watershed by creating a comprehensive inventory of existing stormwater infrastructure; (2) to identify locations within the Flathead Watershed that may be at the highest risk for polluting waterbodies in order to inform future water quality monitoring efforts; (3) to test different methods for detecting and monitoring nonpoint source pollution within the Flathead Basin; and (4) to offer recommendations about how to monitor and mitigate stormwater pollution in the Flathead Basin in the future.

Primarily, this report documents existing stormwater infrastructure in incorporated cities and unincorporated urban and semi-urban towns throughout the basin in order to gain a more thorough understanding of how stormwater is managed across the watershed. Based on this inventory, an outfall prioritization model was developed in which outfalls across the Flathead Watershed were ranked based on their hypothesized pollution potential. Both the inventory of stormwater infrastructure and outfall prioritization model are intended to assist the FBC in prioritizing water quality monitoring efforts in the future. Additionally, this report presents two methods by which stormwater pollution can be detected and monitored—stormwater sampling and dry-weather outfall inspections for illicit discharge detection. The effectiveness of these methods is assessed, and recommendations for altering the methodology in order to achieve the best results are presented. In short, this report identifies where stormwater monitoring should occur and with what methods to ultimately determine where stormwater treatment would have the largest impact on the basin's water quality.

Setting and Characteristics of the Flathead Basin

In order to better understand the relevance of this project, it is important to elaborate on the geologic, biologic, and anthropogenic settings of the Flathead Basin. Each of the following sections will discuss these aspects in more depth and highlight them within the context of local water quality.

Geologic Setting

Geologically, the unique landscapes of the Flathead Watershed are hundreds of millions of years in the making. Between 1.4 and 1.0 billion years ago, the Rodinia Mountains—a result of the creation of the Rodinia Supercontinent millions of years prior—eroded to near sea-level, depositing shallow marine, eolian, and fluvial sediments into the adjacent valleys. These sediments would later be consolidated and become the ~45,000-foot-thick Belt Supergoup, which is considered the bedrock of the Flathead region (Blakey & Ranney, 2018; Blood, 2017, 19). In the approximately 900 million years following, a series of small mountain-building events called orogenies occurred as subduction along the western coast of North America continued and island arcs crashed into the continent, culminating with the Sevier Orogeny between 140 and 55 million years ago (Blakey & Ranney, 2018). Then, between 65 and 50 million years ago, came the Laramide Orogeny, a thick-skinned deformational event with basement-cored uplifts. This event resulted in the uplift of the Rocky Mountains and the thrusting of the Belt Supergroup eastward to create the well-known Lewis Overthrust (Blakey & Ranney, 2018; Blood, 2017, 21).

The transition from compressive stresses to extensional forces came between 50 and 35 million years ago when the East Pacific Rise collided with the western edge of North America, causing a shift from a convergent tectonic boundary to a transform one (Blakey & Ranney, 2018). These extensional stresses led to the creation of the NW-SE trending valleys of the Flathead region, including the North Fork of the Flathead River and the Stillwater River Valley (LaFave et al., 2004). The direction of extension changed between 20 and 15 million years ago to create the N-S trending Kalispell and Mission Valleys after the East Pacific Rise subducted underneath the North American craton (Blakey & Ranney, 2018; LaFave et al., 2004). In all of these valleys, Tertiary sediments were deposited on top of Belt Supergroup bedrock and are found to have extremely variable thickness, with deposits being generally thicker north of Flathead Lake (LaFave et al., 2004). By 3 million years ago, the Flathead and Mission Valleys were bordered by towering mountains, including the Whitefish, Salish, Mission, and Swan ranges (Blood, 2017, 22).

These mountain ranges were then carved and shaped during the Last Glacial Maximum that began about 20,000 years ago. During this time, northwestern Montana was fully glaciated with the exception of pluvial Lake Missoula, which was formed as northern ice sheets spread south, blocked drainages like the Clark Fork of the Columbia River, and created an ice dam (Blakey & Ranney, 2018). Glacial Lake Missoula persisted until approximately 15,000 years ago when this ice dam broke, releasing torrents of water that would eventually create the Channeled Scablands of eastern Washington (Blakey & Ranney, 2018). Other evidence for this period of glaciation can be seen in the U-shaped valleys, craggy peaks, and knife-edge ridges of Glacier National Park and the meters thick deposits of glacial till in the Kalispell and Mission Valleys (Blood, 2017, 22).

As a result of all of these geologic processes, the hydrologic regime of the Flathead Watershed is unique. The glacial alluvium lining the Kalispell and Mission valleys serves as an aquifer for groundwater, a key source of drinking water for residents in the basin

(See Fig. 2). Because of the hydrologic connection between surface water and groundwater in these areas, stormwater has the ability to quickly enter the groundwater system, bringing any pollutants it may have picked up along with it. Therefore, stormwater pollution in the Flathead has the potential to not only pollute surface waterbodies but also contaminate local groundwater resources.

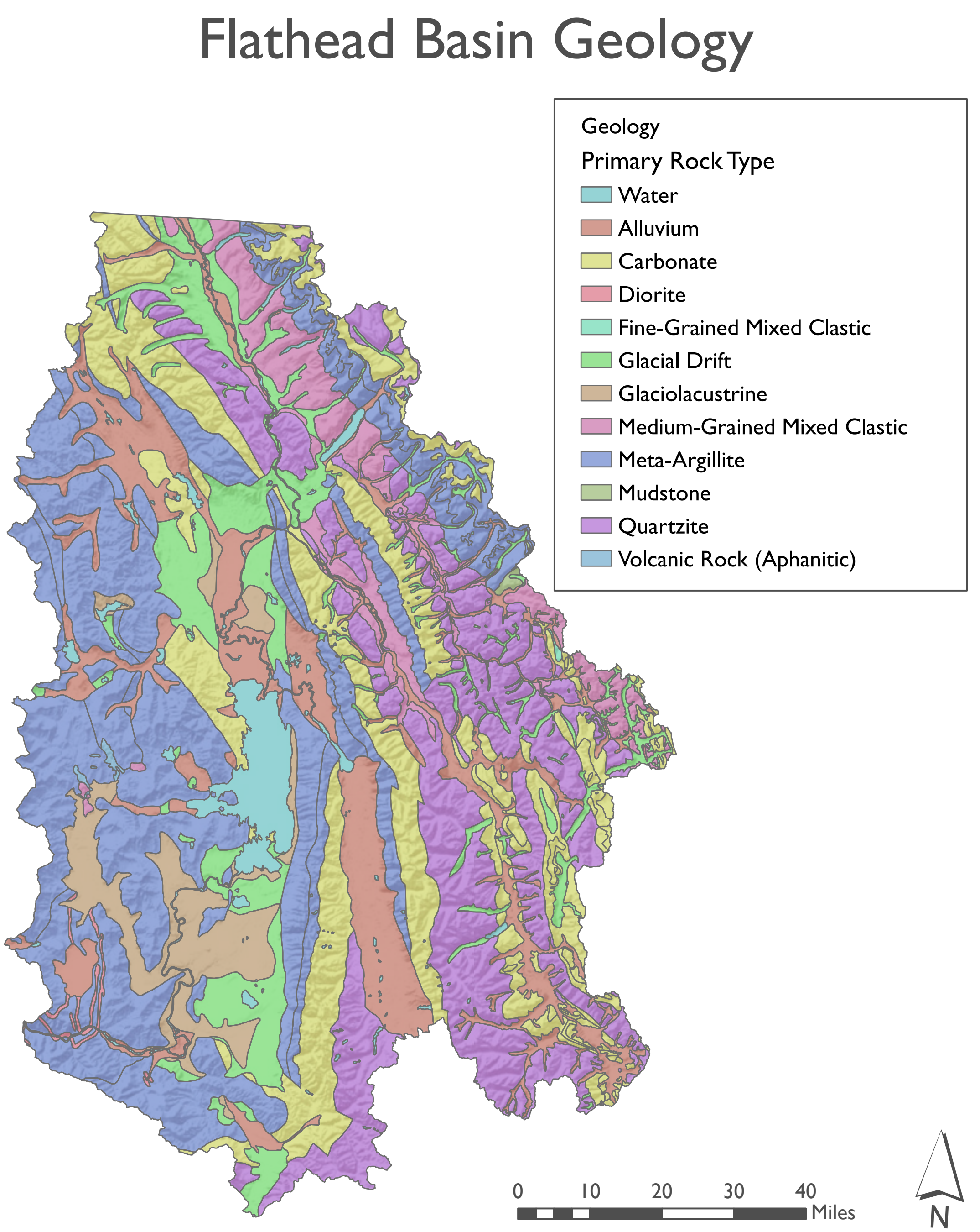


Figure 2. Geologic map of Flathead Basin, MT. Geologic data from Stoeser et al. (2005) and clipped to the extent of Flathead Basin from MFWP (2018). Basemap from Esri, USGS, and NOAA. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020). Geologic data only accounts for the portion of Flathead Watershed that is in Montana.

Biologic Setting

The Flathead Watershed is one of the largest, most biologically intact ecosystems in North America and supports thousands of different species of plants and both terrestrial and aquatic animals (Curtis, 2017, 42). With over 400 terrestrial animal species, the Flathead Watershed supports over 300 species of birds—including blue herons, bald eagles, ospreys, peregrine falcons, and long-billed-curlews—and over 70 species of mammals—including black bears, grizzlies, mountain lions, elk, moose, mountain goats, bighorn sheep, and white-tailed deer (Curtis, 2017, 42; MDNRC, 1977). All of these terrestrial animals depend on healthy aquatic ecosystems for survival, either as sources of food and water, avenues for reproductive processes, or means of shelter.

In terms of aquatic species, the waters of the Flathead Basin are home to 46 species of fish, many species of aquatic insects, and over 600 species of phytoplankton and zooplankton (Curtis, 2017, 42; MDNRC, 1977, 16-17). The headwaters of tributaries serve as the spawning areas for many fish species, while Flathead Lake provides a critical food source for their adult development (MDNRC, 1977, 16-17). Because of this, both tributaries to the lake and the lake itself must have adequate water quality to support these organisms, or else these animals will die in infancy or starve as adults. Additionally, these aquatic organisms rely on cold, clear, and low-productivity waterbodies, meaning that inputs of temperature, sediment, and nutrient pollution could be detrimental to their survival.

Anthropogenic Setting

The land of the Flathead Watershed was grouped into the following simplified land use categories based on more complex categories presented in landcover data from the Montana Natural Heritage Program (MNHP) (2013): Agriculture; Alpine Sparse and Barren; Cliff, Canyon, and Talus; Commercial/Industrial; Coniferous and Deciduous Woodland; Developed (Open Space); Grassland and Steppe; Harvested Forest; High Intensity Residential; Insect-Killed Forest; Introduced Vegetation; Low Intensity Residential; Mining and Resource Extraction; Open Water; Railroad; Recently Burned; Roads; Shrubland; and Wetland/Marsh/Bog, Floodplain, and Riparian. See Appendix A for more information about how these categories were grouped.

As previously stated, the land use composition of the Flathead Watershed differs significantly from many other watersheds across the country in that it is primarily made up of natural landscapes (See Fig. 3 & Table 1). Of the portion of the Flathead Watershed that is in Montana, which is over 5,400,000 acres, humanmade landscapes make up only approximately 550,000 acres or ~10% of the basin area, while woodland, shrubland, and grassland combined compose about 3,600,000 acres or ~67% of the basin area (See Fig. 3 & Table 1). Although these are the current statistics, the natural beauty of the Flathead continues to attract more and more residents. In 1970, population estimates for the Flathead Basin were around 54,000 people according to the US Census Bureau (2004). Since then, the number of people that call the Flathead Watershed home has increased steadily from approximately 101,000 in 2000 to approximately 134,000 in 2019 (US Census Bureau, 2011 and 2020). With increased population arises a need for further development and industrialization of the landscape, which inevitably converts natural areas into humanmade ones. This development has the potential to cause problems for water quality in that (1) more humans and human activities tend to correlate with an increased pollutant load on the

Flathead Basin Land Use

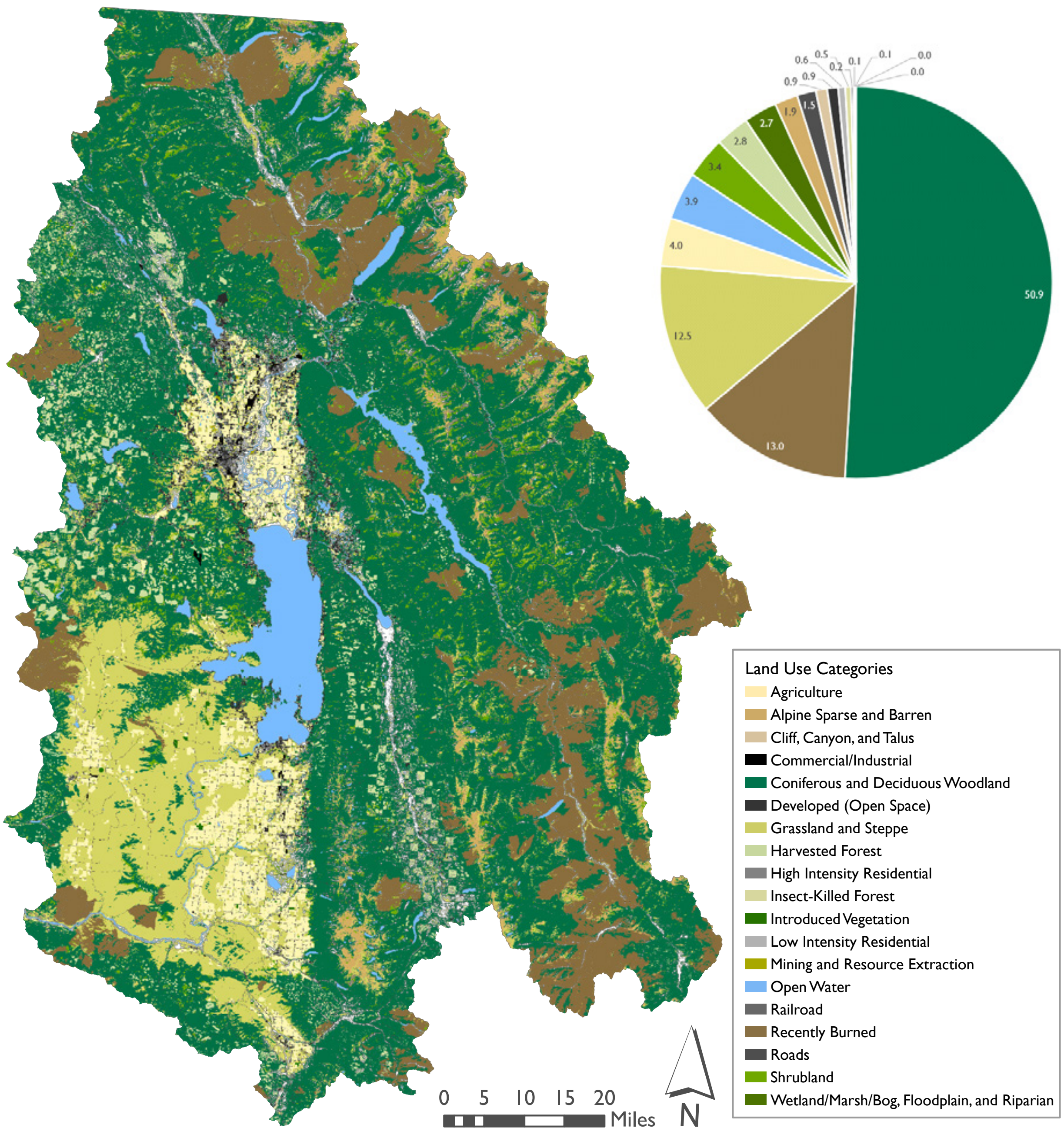


Figure 3. Map of Flathead Watershed land use categories. Land use categories used in this report were adapted from land use categories presented in Montana Landcover Framework and clipped to the outline of Flathead Basin (MNHP, 2013; MFWP, 2018). See Appendix A for more information about adaptations made to categories in the MNHP (2013) dataset. Land use data only accounts for the portion of Flathead Watershed that is in Montana. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

landscape and (2) the increase in impervious surfaces that results from urbanization often correlates with an increased volume of stormwater runoff, meaning that those pollutants on the landscape are being mobilized and dumped into waterbodies. As a result, conversations about stormwater management and an increased attention to water quality and pollution mitigation are necessary to ensure that the waters of the Flathead Basin remain as pristine as possible.

	Land Use Category	Area (acres)
	Coniferous and Deciduous Woodland	2,759,777
	Recently Burned	702,175
	Grassland and Steppe	677,278
	Agriculture	214,643
	Open Water	213,589
	Shrubland	186,096
	Harvested Forest	151,725
	Wetland/Marsh/Bog, Floodplain, and Riparian	147,551
	Alpine Sparse and Barren	103,708
	Roads	83,954
	Cliff, Canyon, and Talus	50,676
	Developed (Open Space)	48,573
	Low Intensity Residential	31,823
	Insect-Killed Forest	25,631
	Commercial/Industrial	10,096
	Introduced Vegetation	10,096
	Railroad	2,970
	High Intensity Residential	2,436
	Mining and Resource Extraction	990

Table 1. Land use categories and their corresponding areas in Flathead Basin, MT. Land use categories used in this report were adapted from land use categories presented in Montana Landcover Framework and clipped to the outline of Flathead Basin (Montana Natural Heritage Program, 2013; Montana Fish, Wildlife, & Parks, 2018). See Appendix A for more information about adaptations made to categories in the Montana Natural Heritage Program (2013) dataset. Land use data only accounts for the portion of Flathead Watershed that is in Montana.

Data Included in Inventory

In order to predict and preempt water quality concerns related to stormwater, it's important to first understand how stormwater is currently being managed within the Flathead Watershed. The following sub-sections present the inventory of existing stormwater infrastructure in urban areas across the basin. Urban areas included in this inventory include the following: Kalispell, Whitefish, Polson, Bigfork, Lakeside, Evergreen, Ronan, and Columbia Falls (See Fig. 4). Generally, the elements of stormwater systems that are included in this inventory include catch basins, otherwise known as storm drains, which serve as inlets for stormwater to run off impervious surfaces and into the stormwater system; storm lines, either pressurized, gravity-driven, open channel, or culverts, which transport stormwater from the urban area toward a discharge location; storm manholes, which are points of access to the underground system and often serve as locations where multiple storm lines converge; outfalls, which are locations at which stormwater exits the stormwater system and is often discharged into a waterbody; and drainage basins, which are boundaries that group areas of the landscape that drain to a single outfall. Some locations have additional infrastructure elements in their inventories, such as treatment units, sump pumps, infiltration features like detention basins, and dry wells, which look similar to catch basins but allow stormwater to infiltrate into groundwater locally. Because stormwater is managed and infrastructure is documented differently in each location, the data contained in each city's/town's inventory is slightly different, the specifics of which will be discussed at greater length in the following sub-sections.

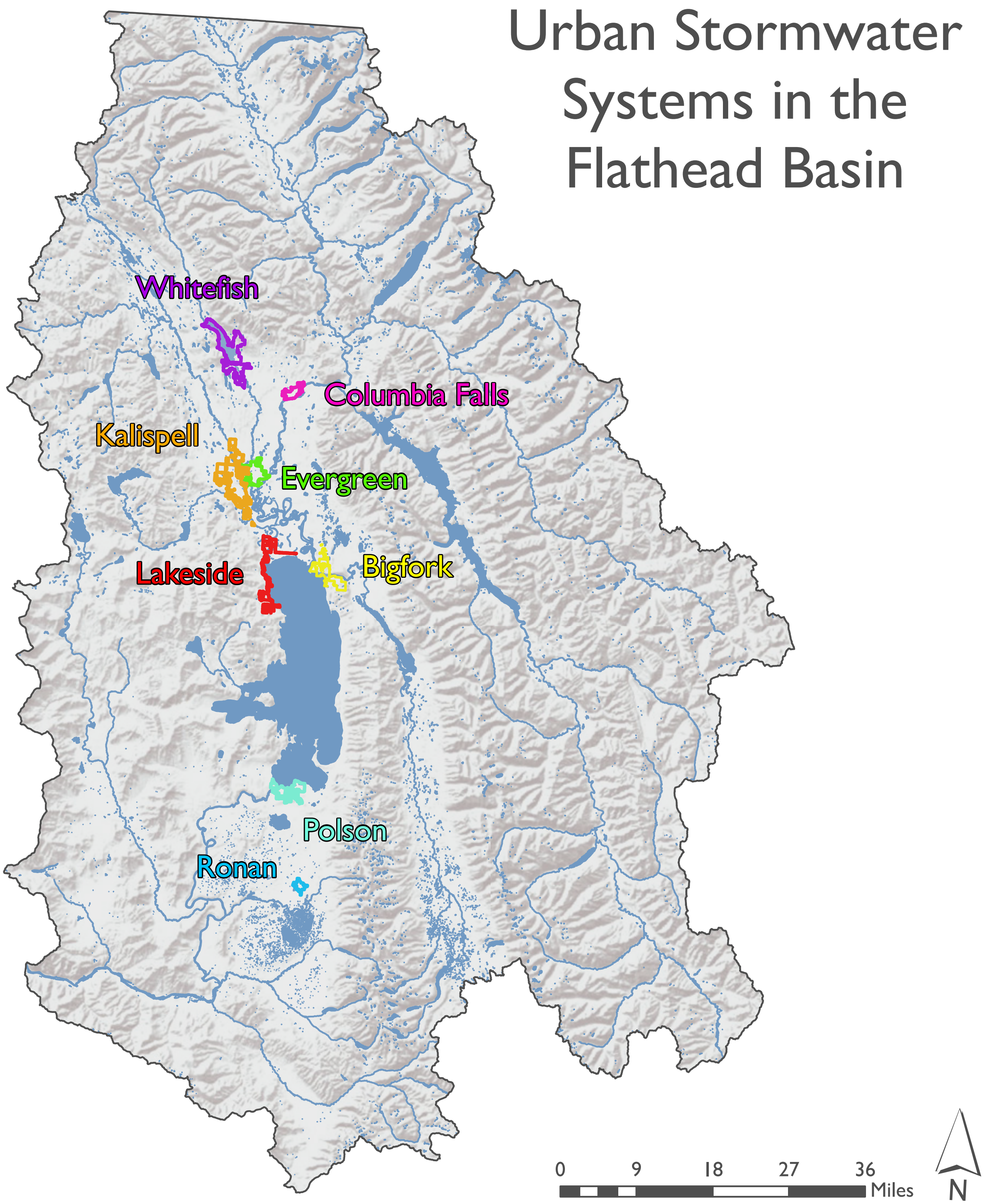


Figure 4. Locations of urban areas within the Flathead Basin. Data from Montana State Library (2019), Flathead County GIS (2016), and USDA NRCS (2013). Basemap from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The City of Kalispell has a centralized stormwater system, parts of which are owned by the city, MDT, and private businesses and residents. As previously mentioned, the city and MDT meet the requirements for a small MS4 under ARM 17.30.1102 and are permitted separately by MDEQ, meaning that all stormwater conveyances that are owned or operated by either the city or MDT within Kalispell city limits are subject to the terms of their respective permits. These two entities are the only permitted MS4s within the Flathead Basin.

Stormwater infrastructure within Kalispell city limits was documented and shared by the Kalispell Public Works Department (KPWD). Infrastructure elements included in the dataset provided by KPWD include catch basins, storm manholes, outfalls, cleanouts, lift stations, treatment units, storm gravity lines, storm pressure lines, lateral lines, culverts, stormwater features that include underground detention facilities and infiltration basins, and drainage basins (See Fig. 5). The inventory is divided by ownership—either city-owned, privately-owned, or abandoned. MDT-owned infrastructure is present within Kalispell city limits and is classified in the inventory as privately-owned. Specifically, 47% of documented catch basins are city-owned and the remaining 53% are privately-owned, while 56% of documented storm manholes are owned by the city, 44% are privately-owned, and less than 1% are abandoned. Outfalls are not yet categorized according to ownership. The majority of infrastructure within Kalispell city limits is also categorized according to year of installation. The ages of 84% of catch basins, 88% of manholes, and 91% of fragments of storm gravity lines are known, with years of installation ranging from 1960 to 2020. In terms of maintenance, the City of Kalispell cleans out city-owned treatment units every 6 months or every year depending on sediment loads at particular locations. Catch basins are vacuumed out every five years, and storm mains and lateral lines are cleaned out as needed (J. Schrader, personal communication, October 12, 2020).

Because of its status as a permitted MS4, the City of Kalispell is unique in the Flathead Basin in that there is a specific position within the city government titled Environmental Specialist that is dedicated to ensuring permit compliance and general stormwater management. Kalispell's stormwater permit has program requirements for public outreach and education, public involvement and participation, illicit discharge detection and elimination, construction site stormwater management, post-construction site stormwater management, and pollution prevention and good housekeeping for municipal operations. The Environmental Specialist develops and implements programs within these categories in addition to collecting and analyzing stormwater samples to determine effectiveness of best management practices. In short, Kalispell's Environmental Specialist is responsible for all activities relating to stormwater within the city, a position that no other location within the Flathead Basin has.

FIELD OBSERVATIONS

Aside from dry-weather outfall inspections conducted in Kalispell, Kalispell's stormwater infrastructure was not thoroughly investigated in the field for this project. Observations made during the dry-weather outfall inspection process will be discussed in a later section.

The MS4 permit requires the city to regulate development projects to consider potential water quality impacts including appropriate post-construction stormwater management controls. Specifically, all new development and redevelopment projects greater than 10,000 square feet are required to implement post-construction stormwater management controls that are designed to infiltrate, evapotranspire, and/or capture for reuse the post-construction runoff generated from the first 0.5 inches of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. For projects that cannot meet 100% of the runoff reduction requirement, the remainder of the runoff from the first 0.5 inches of rainfall must be treated onsite using post-construction stormwater management control(s) expected to remove 80% total suspended solids (TSS). These requirements are outlined in the City of Kalispell's Standards for Design and Construction and the Montana Post-Construction Storm Water BMP Design Guidance Manual (City of Kalispell, 2020; HDR, 2017).

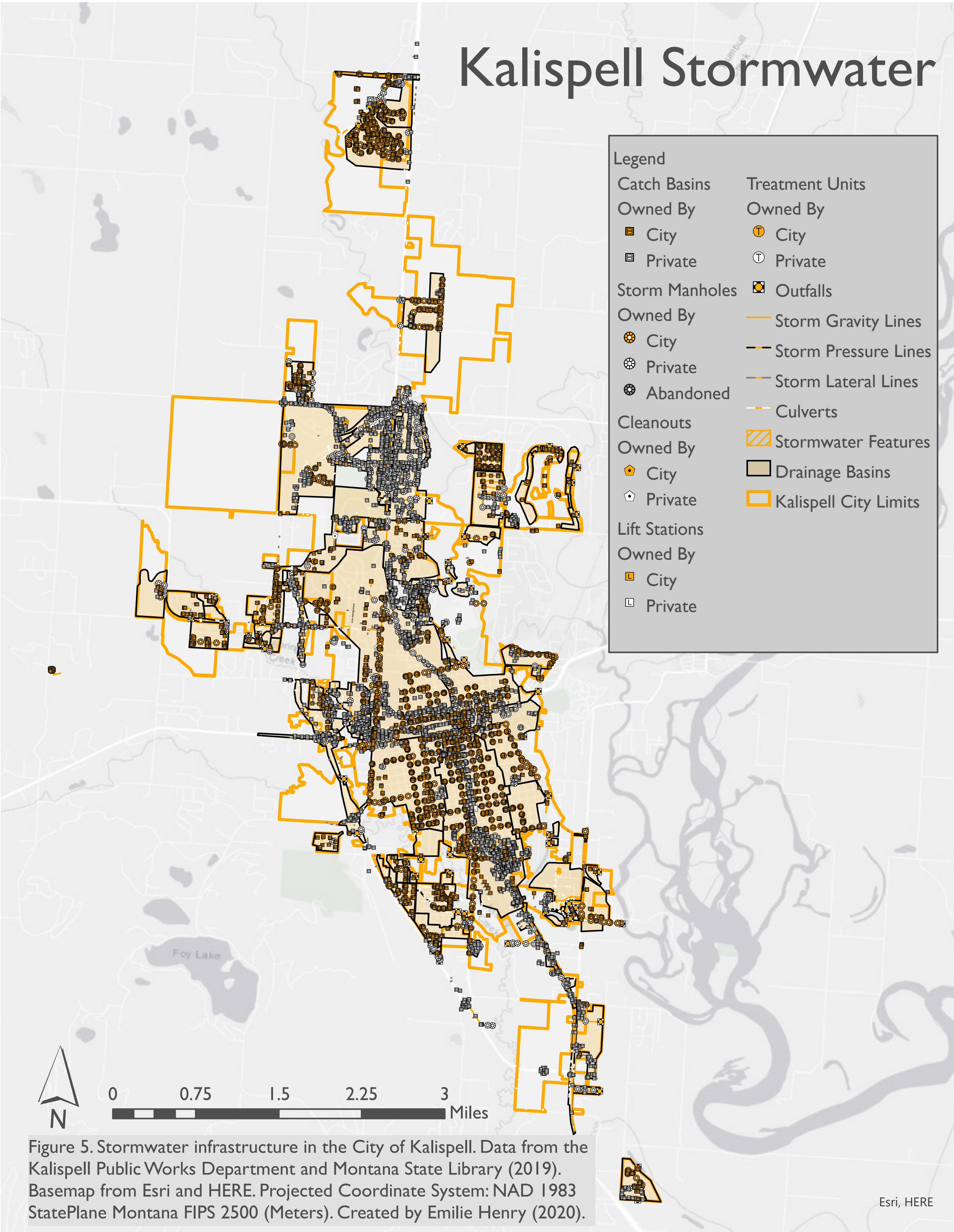


Figure 5. Stormwater infrastructure in the City of Kalispell. Data from the Kalispell Public Works Department and Montana State Library (2019). Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The City of Whitefish has a centralized stormwater system, data for which has been documented and shared by the Whitefish Public Works Department (WPWD). Infrastructure elements included in the dataset provided by the WPWD include catch basins, storm manholes, outfalls, weirs, cleanouts, network structures, system valves, sump pumps, storm gravity lines, storm pressure lines, open drains, culverts, and detention basins. From this data and maps presented in Stanford et al. (1997), the author was able to interpolate the boundaries of drainage basins (See Fig. 6). According to the WPWD, parts of Whitefish's stormwater system are owned by the city, MDT, and private businesses and residents. In particular, 88% of catch basins, 89% of storm manholes, and 51% of outfalls are presently categorized as city-owned, while the rest are labeled as "Private" or "Other." Although it is known that MDT-owned infrastructure is present within Whitefish city limits, specifically along US Highway 93, the inventory does not yet differentiate between city- and MDT-owned infrastructure, meaning that some of the city-owned infrastructure is erroneously categorized in the inventory. According to Matt Trebesch, GIS/IT-Coordinator for the City of Whitefish, it is largely unknown who maintains stormwater infrastructure along Highway 93, and often, both agencies employ a reactive maintenance strategy, working together to fix drainage problems in this area when they arise (Personal communication, September 11, 2020). Additionally, age of infrastructure is only partially known. More specifically, approximately only 5% of catch basins, 4% of manholes, and 8% of outfalls within the City of Whitefish have known installation dates, which range between the years 2000 and 2020. This infrastructure of known age is located along East 2nd Street and in developments off of East 2nd Street between Spokane Avenue and Hugh Rogers Wag Park. It is believed that all other infrastructure was installed before 2000.

FIELD OBSERVATIONS

Whitefish's stormwater system was not thoroughly investigated in the field for this project.

Although Whitefish is not currently permitted as an MS4, the city does impose stormwater-specific regulations for development and redevelopment projects and adheres to the guidelines found within the Montana Post-Construction Storm Water BMP Design Guidance Manual (HDR, 2017). These post-construction regulations are virtually the same as those utilized by the City of Kalispell, the specifics of which are outlined in the previous section.

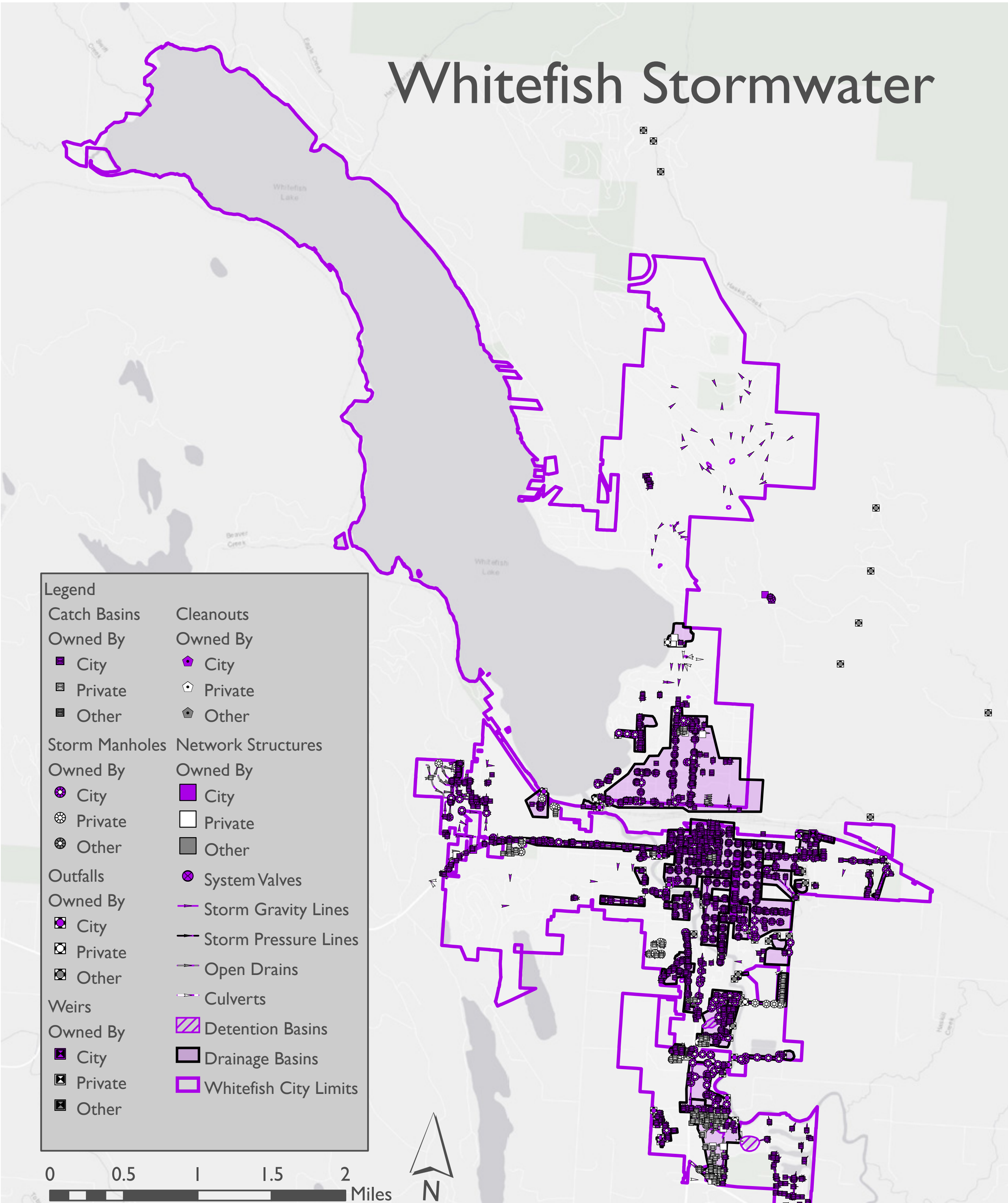


Figure 6. Stormwater infrastructure in the City of Whitefish. Data from the Whitefish Public Works Department and Montana State Library (2019). Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The City of Polson has a city-owned stormwater system whose management has been passed between city departments. According to Ashley Walker, Polson's Water and Sewer Superintendent, the Water and Sewer Department had managed the stormwater system in the past before its management was passed to the Streets Department and then back to the Water and Sewer Department in the beginning months of 2020 (Personal communication, February 7, 2020 and June 19, 2020). Little can be said with certainty regarding the origins of the system. However, it is said that a 40-inch main and a series of lateral lines were installed as part of a federal irrigation project in the early 1900s that discharge to a separator/vault treatment system before ultimately flowing into the Flathead River (USEPA, 2010a, 32). It is the author's perception that the main referenced here runs along 9th Avenue West and discharges to an outfall located near the intersection of 6th Street West and 6th Avenue West, although that has not been confirmed (See Fig. 7). Considerable additions and upgrades to the system were done in 1953 by Morrison-Maierle, Inc. (1953), and according to data provided by Walker, another wave of renovations and upgrades occurred in the 1960s and 70s (Personal communication, June 19, 2020). It is unclear whether the 1953 Morrison-Maierle installation is the same as the "early 1900s" federal irrigation project referenced in the USEPA report (2010a).

Most infrastructure depicted in Fig. 7 was collected by the author and a number of volunteers during the summer of 2020. Because little up-to-date information was available for Polson's stormwater system, a citizen science volunteer data collection event was organized to collect stormwater infrastructure data in downtown Polson. See Appendix B for more details about how and when this data was collected. The elements of Polson's stormwater system that were documented during this event include catch basins, stormwater manholes, and outfalls; from this data, storm gravity lines and drainage basins were able to be interpolated (See Fig. 7). The infrastructure data collected during this event was corroborated and supplemented with data presented in a preliminary engineering report (PER) by Thomas, Dean, & Hoskins (2010b).

FIELD OBSERVATIONS

While collecting data, much of Polson's stormwater system was thoroughly investigated in the field by volunteers. It became clear through this exercise that the system is irregularly or rarely maintained at least in some areas of the city. Many catch basins, especially those closer to the river's or lake's shore, were entirely filled with debris and sediment, sometimes to the extent that plants were beginning to grow through the grates. It is possible that the shuffle of management of the stormwater system between city departments may be responsible for this perceived lack of maintenance. Additionally, two other observations sounded alarms for potential water quality degradation in the area. During the August 20th data collection day, a group of volunteers noted that a couple of catch basins within Polson's largest sub-basin emanated a sewage smell, which raises concerns about potential sewer leaks into the stormwater system. During a period of dry weather on August 5th, it was also observed by the author that one of the main storm lines within the largest sub-basin was experiencing flow. It was impossible to backtrack the flow given the size of the drainage area, so the source of this flow is unknown, raising concerns for potential illicit discharges in the area as well. Both illicit discharges and sewer leaks could have detrimental impacts on water quality.

Inventory of Stormwater Infrastructure
Polson

Although the City of Polson is not permitted by MDEQ as an MS4, the city does enforce stormwater-specific requirements for new development and redevelopment projects that are 5,000 square feet in size or larger (City of Polson, n.d., 28). These core requirements include a drainage submittal, geotechnical site investigation, stormwater control facilities to manage rate of runoff, natural and constructed conveyance systems, and operation and maintenance (City of Polson, n.d.). The City of Polson currently has no requirements regarding water quality at post-construction sites.

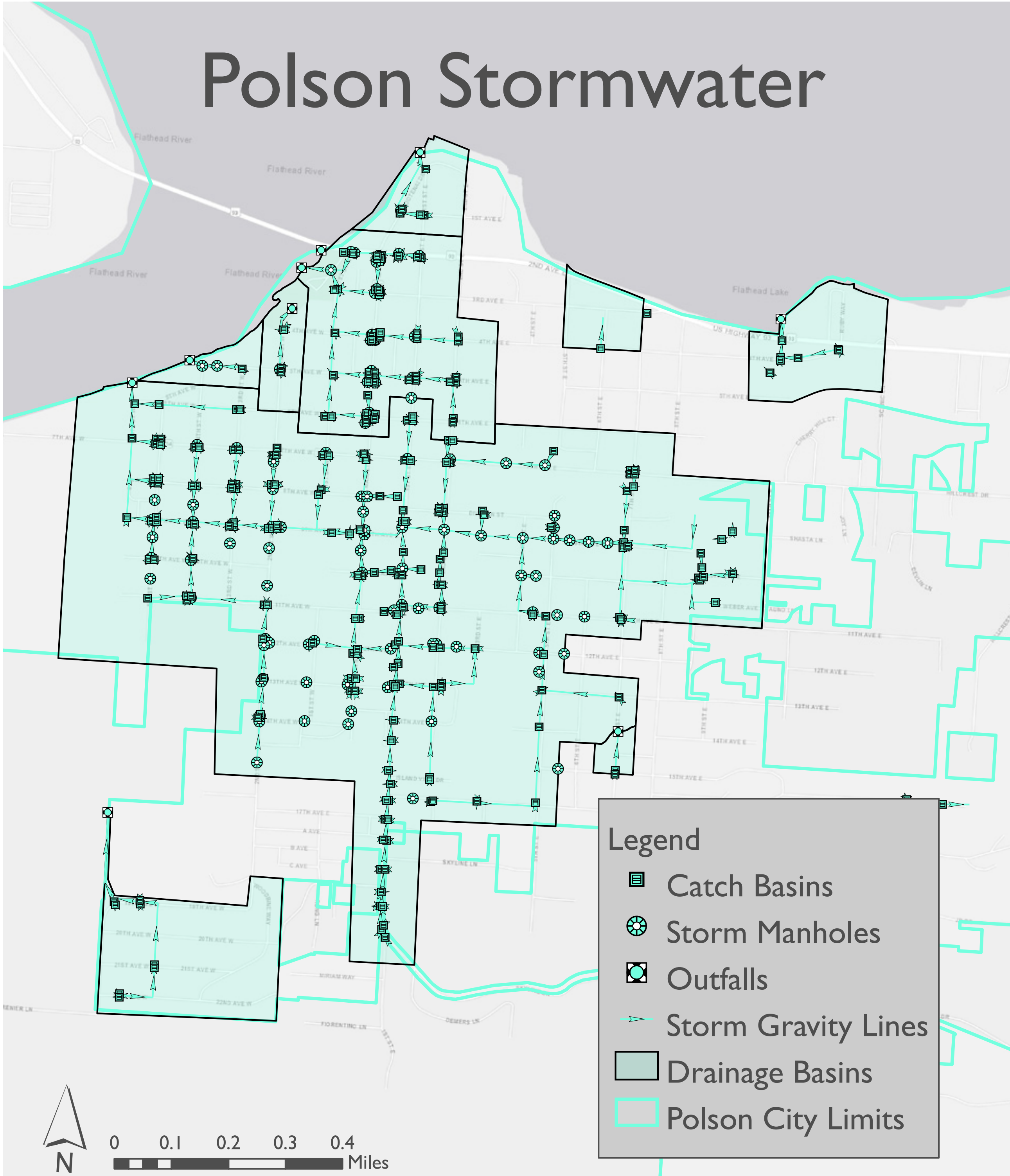


Figure 7. Stormwater infrastructure in the City of Polson. Data from Montana State Library (2019) and Thomas, Dean, & Hoskins, Inc (2010b). Most data collected by volunteers during summer 2020. See Appendix A for more details. Basemap from Esri, HERE, Garmin, OpenStreetMap, and the GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The Town of Bigfork has a county-owned, centralized stormwater system that is believed to have been installed in the 1950s. In 2007, at the request of local residents, the Bigfork Stormwater Project was initiated to investigate conveyance problems that were thought to be responsible for road and residential flooding during and after storm events (Koopal, 2014). Following this investigation, a series of engineering reports were completed, providing Flathead County with information and recommendations about potential future improvements to its stormwater facilities in the area (Koopal, 2014). In 2009, Flathead County created the Bigfork Stormwater Advisory Committee whose primary purposes were to oversee a Sampling and Analysis Plan, educate residents, and recommend improvements or additions to existing stormwater infrastructure, specifically ways to reduce flooding and treat stormwater prior to discharge (Koopal, 2014).

Stormwater infrastructure data for Bigfork includes catch basins, storm lines, outfalls, filtration units, and drainage basins (See Fig. 8), all of which was provided electronically by WGM Group or digitized from previous maps and studies, including those by Whitefish Lake Institute (Koopal, 2014), 48 North (2009), and WGM Group (n.d.a, n.d.b, and n.d.c). The exact boundaries of drainage basins within the area are inconsistent among these studies, with 48 North (2009) depicting 28 sub-basins, some of which drain into a neighboring basin before ultimately discharging into a waterbody, and Koopal (2014) grouping those 28 sub-basins together into the four larger basins depicted in Figure 8. Because outfalls were not included in the GIS data received from WGM Group, it is unclear which of these basin classifications is most accurate, but for simplicity, the groupings used by Koopal (2014) were used in this project.

The stormwater systems of each of these four drainage basins contain a different series of stormwater treatment devices installed during recent renovations. The first drainage area at Grand Drive was renovated such that stormwater passes through multiple biofiltration facilities, a hydrodynamic separator, and a cartridge filtration system prior to discharge at the outfall (WGM Group, n.d.c). Much of the stormwater from the second drainage area at Electric Avenue and River Street was rerouted during renovations to discharge at the Grand Drive outfall in order to mitigate flooding in the area, and a hydrodynamic separator was installed prior to discharge at the River Street outfall (Koopal, 2014; WGM Group, n.d.c). Finally, a combination of a hydrodynamic separator and cartridge filtration system was installed prior to discharge at both the Bridge Street North and Bridge Street South outfalls (WGM Group, n.d.a and n.d.b; 48 North, 2012). All stormwater infrastructure in the town is maintained by the Flathead County Public Works Department according to the Operation and Maintenance Manual (Koopal, 2014, 10; 48 North, 2011). In this way, the vast majority of Bigfork's stormwater is receiving some form of treatment prior to discharge at these four outfalls, which has positive implications for water quality.

FIELD OBSERVATIONS

Bigfork's stormwater system was not thoroughly investigated in the field for this project.

Any new subdivision developments in the Town of Bigfork are subject to the drainage facilities design requirements outlined in the Subdivision Regulations of the Flathead County Development

Code (FCPZO, 2014). These specific regulations require the subdividers (1) to install temporary and/or permanent erosion and sedimentation control facilities and (2) to develop a SWMP, which "identifies measures and locations to minimize the potential for surface water pollution" as part of the preliminary application submittal (FCPZO, 2014, 42). All drainage structures must meet MDEQ requirements, and all runoff from the subdivision that discharges into a waterbody must meet the Flathead County Lake and Lakeshore Protection Regulations and comply with MDEQ standards (FCPZO, 2014, 42; FCPZO, 2002).

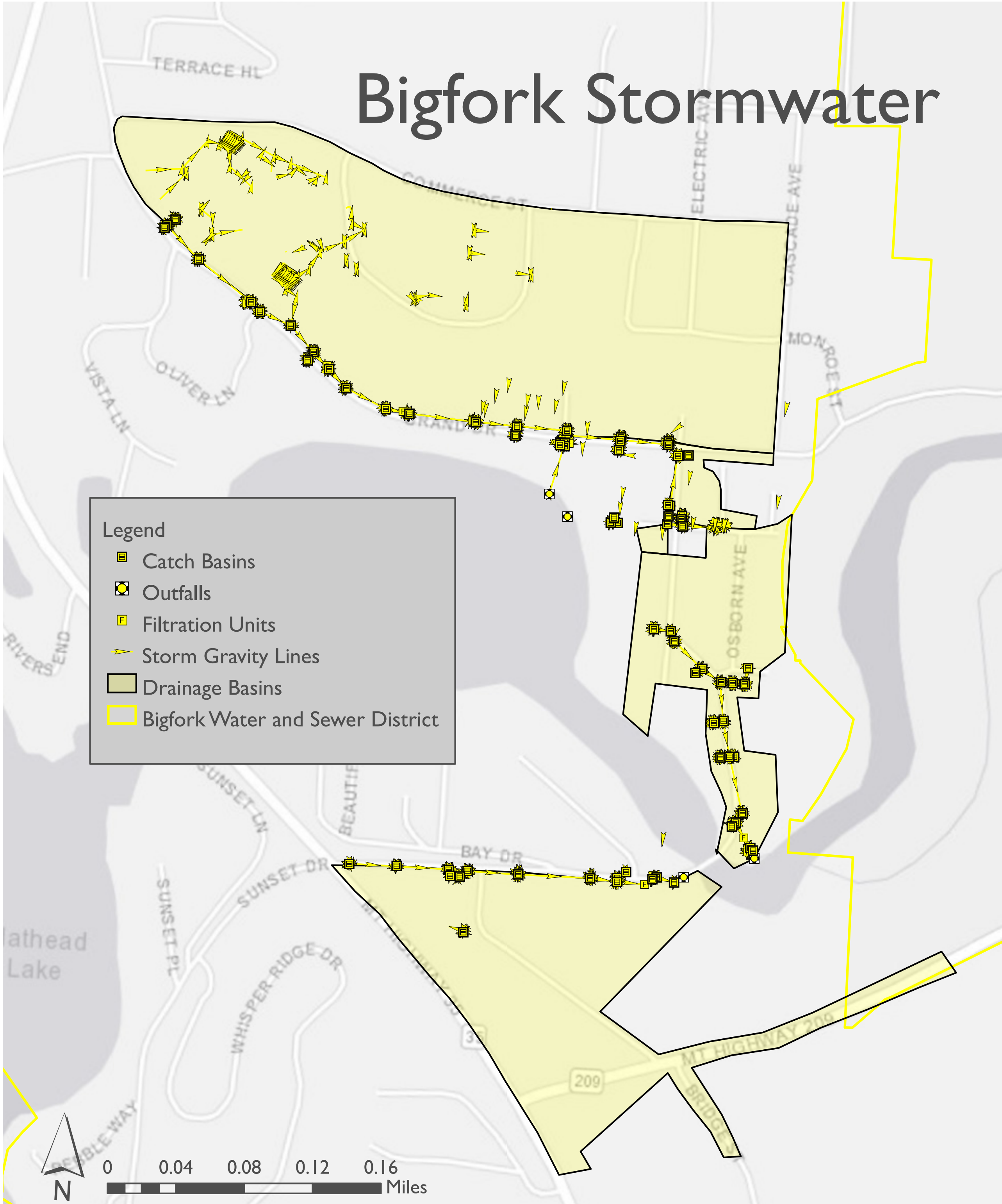


Figure 8. Stormwater infrastructure in the Town of Bigfork. Data from WGM Group, Flathead County GIS (2016), and Koopal (2014). Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The Town of Lakeside does not have a centralized stormwater system according to representatives from the Lakeside Water and Sewer District. MDT is responsible for all stormwater infrastructure along US Highway 93, which mostly consists of culverts directing drainage from one side of the highway to the other. Additionally, Flathead County maintains some of the ditch lines, and MDEQ requires a stormwater review on any new development (R. Olson, personal communication, January 22, 2020; FCPZO, 2014). According to a resident, some of the infrastructure along Waterside Way was paid for by another resident who was tired of seeing the parking lot of his building flood and freeze over in the winter, suggesting that most infrastructure in Lakeside is likely privately-owned and was likely installed at different times in a piecemeal fashion (Personal communication, July 31, 2020).

Most infrastructure data depicted in Fig. 9 within the limits of Lakeside's water and sewer district was collected by the author and Mikaela Richardson, the 2020 Big Sky Watershed Corps Member with the Flathead Conservation District. Stormwater infrastructure data collected in Lakeside includes catch basins, stormwater manholes, outfalls, and infiltration basins. Based on this data, storm gravity lines and drainage basins were able to be interpolated (See Fig. 9). For specific details about when and how this data was collected, see Appendix B. Most residential areas within the Lakeside Water and Sewer District do not have any stormwater infrastructure, and there are water-carved channels alongside many residential roadways, indicating that these areas serve as channels for runoff during storm events.

Aside from a few infiltration structures and culverts, all stormwater infrastructure in the town is located on privately-owned property in and around the intersections of Bierney Creek Road, Waterside Way, Adams Street, and Stoner Loop with US Highway 93. Due to a lack of accessibility, most MDT-owned infrastructure along US 93 was not documented.

FIELD OBSERVATIONS

While collecting data, much of Lakeside's stormwater infrastructure was investigated in the field. From the infrastructure investigated, it was very apparent that both privately and MDT-owned infrastructure is not regularly maintained in this area. Many catch basins in the parking lots of businesses were filled to the brim with sediment and debris, as was an MDT-owned catch basin just north of Waterside Way. For many of these catch basins, it was impossible to see beneath the grate, and when possible, it was clear that sediment and debris were partially or completely blocking either the inflow pipe, outflow pipe, or both. Additionally, some catch basins along Stoner Loop smelled like sewage, raising concerns of potential sewer leaks into the stormwater system. The status of maintenance and potential sewer contamination raise concerns about water quality in the Town of Lakeside.

Any new subdivisions in Lakeside are subject to the drainage facilities design requirements outlined in the Subdivision Regulations of the Flathead County Development Code, the specifics of which are addressed in the previous section (FCPZO, 2014).

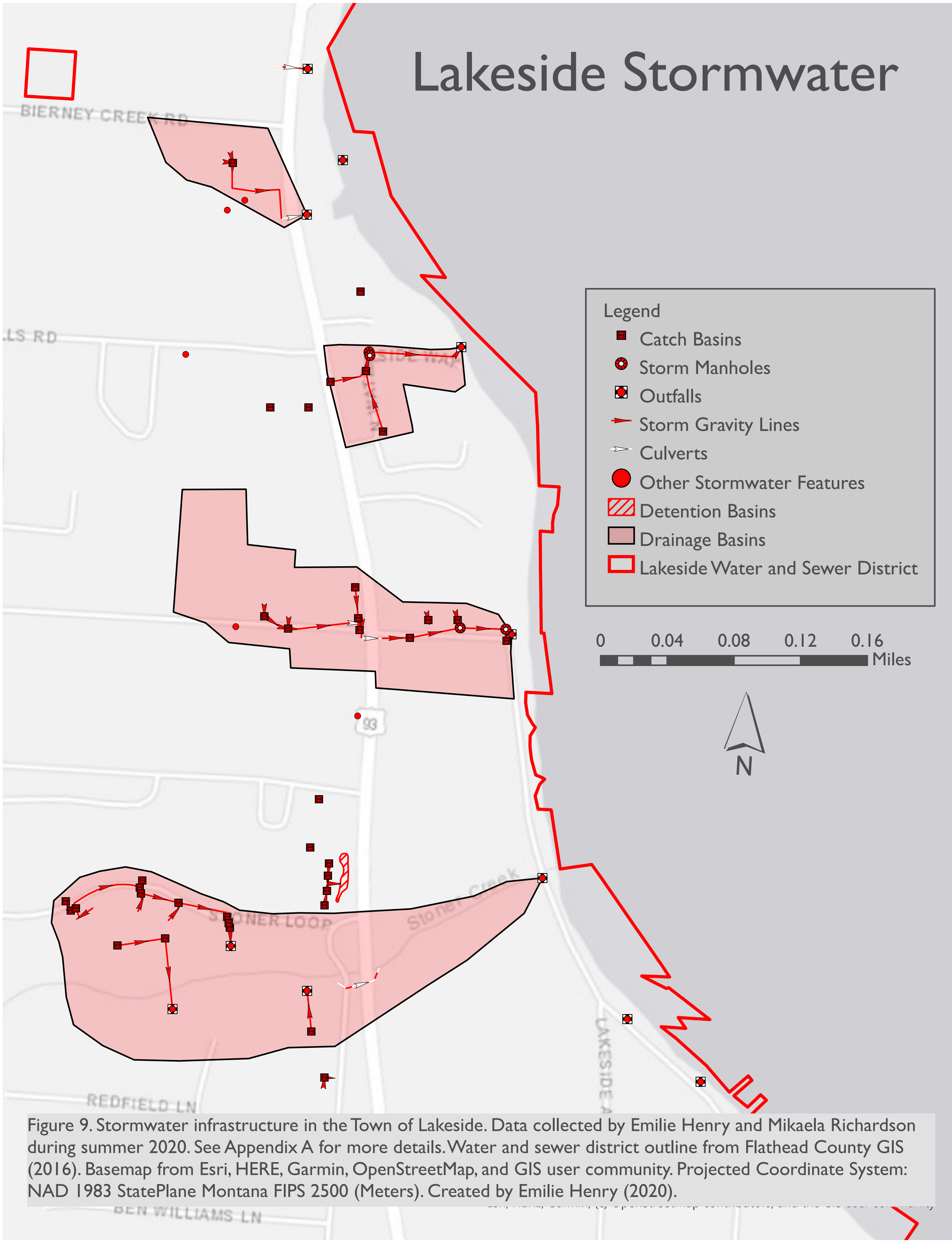


Figure 9. Stormwater infrastructure in the Town of Lakeside. Data collected by Emilie Henry and Mikaela Richardson during summer 2020. See Appendix A for more details. Water and sewer district outline from Flathead County GIS (2016). Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

According to representatives of Evergreen's Water and Sewer District, the Town of Evergreen does not have a centralized stormwater system. The private businesses within the town have constructed dry wells and/or catch basins to manage drainage on their individual properties, but the town is not responsible for the maintenance of this infrastructure. Similarly, in 2014, MDT constructed a stormwater system along US Highway 2 within the town's limits, which MDT is responsible for maintaining. Because the water table is so high in this area, any catch basins that MDT or private businesses have installed are nestled in between water mains and sewer lines, which are not far beneath the paved surfaces (M. James & C. Murray, personal communication, January 29, 2020).

Most of the infrastructure depicted on the map within the limits of Evergreen's Water and Sewer District was collected by the author. Elements of the stormwater system that were collected in the field include catch basins, stormwater manholes, and outfalls; and based on this data, storm gravity lines and drainage basins were able to be interpolated (See Fig. 10). For specific details about when and how this data was collected, see Appendix B. Because of the size of the town and placement of infrastructure along busy highways, much of Evergreen's infrastructure was not able to be documented, including most privately-owned dry wells and small systems within parking lots of businesses and MDT-owned infrastructure along US Highway 2, MT 35, and Reserve Drive. Therefore, only accessible infrastructure was documented, primarily privately-owned residential systems within the town.

Any new subdivisions in the Town of Evergreen are subject to the drainage facilities design requirements outlined in the Subdivision Regulations of the Flathead County Development Code, the specifics of which are addressed in previous sections (FCPZO, 2014).

FIELD OBSERVATIONS

While collecting data, many portions of Evergreen's stormwater systems were thoroughly inspected in the field. In contrast to Polson and Lakeside, what little stormwater infrastructure there is in Evergreen appeared to be well-maintained. While there was some debris present in almost all of the catch basins examined, only a couple were very full of sediment and debris, indicating that this privately-owned infrastructure receives at least somewhat regular maintenance, although the specifics of those maintenance plans are unknown and are almost certainly not consistent across all privately-owned infrastructure in the town. Additionally, it should be noted that very little to no MDT-owned infrastructure was examined in Evergreen, so nothing can be said about MDT's maintenance protocols in the area.

In addition to decently maintained infrastructure, the stormwater systems in Evergreen stood out in that there were some forms of treatment being utilized within a privately-owned residential system in the Trumbull Creek Crossing development off of East Reserve Drive. Within the neighborhood are at least six outfalls that discharge into detention basins, and prior to discharge at each outfall is a SNOUT® Oil and Debris Separator. After stormwater has settled in the catch basin, this device skims oil and grease off the top and traps it along with larger debris in the basin, preventing them from being discharged at an outfall. Although it is believed that this stormwater system was installed in accordance with the Flathead County Development Code for subdivisions, it is noteworthy to see treatment devices in a privately-owned, nonpermitted stormwater system (FCPZO, 2014).

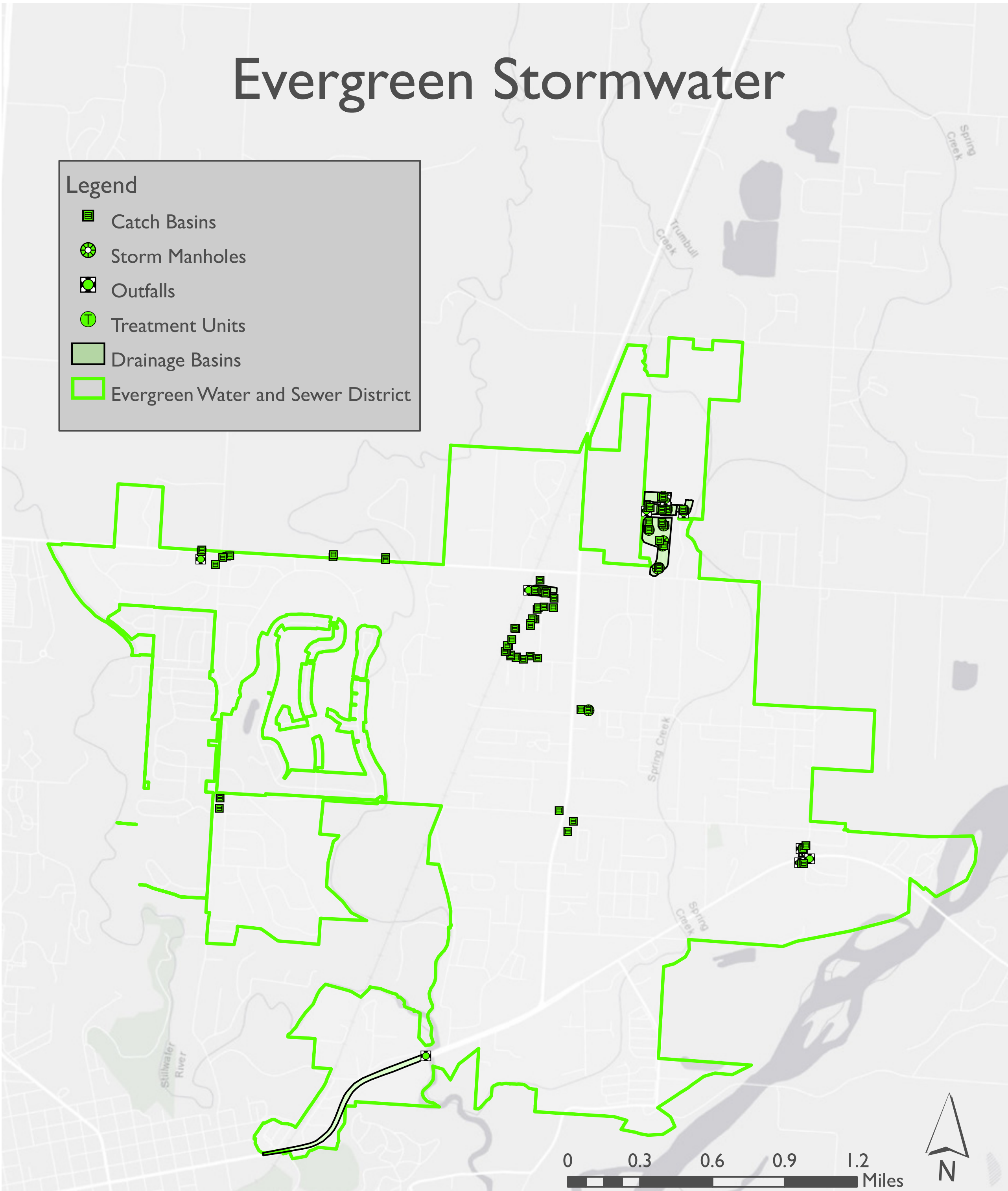


Figure 10. Stormwater infrastructure in the Town of Evergreen. Data collected by Emilie Henry during summer 2020. See Appendix A for more details. Water and sewer district outline from Flathead County GIS (2016). Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

According to Ronan's Public Works Director Dan Miller, the City of Ronan has a limited and incomplete stormwater system (Personal communication, July 2, 2020). A PER was completed for the city's stormwater system by Thomas, Dean, & Hoskins, Inc. (2010a). Within the PER is a map of stormwater infrastructure in the city, the source of the infrastructure data shown in Figure 11. The only elements of Ronan's stormwater system that were included in the PER include storm lines, and from these lines, outfalls and drainage basins were able to be interpolated by the author. Very little seems to be known about Ronan's stormwater system outside of what is documented in the PER.

The city is not currently permitted by the state as an MS4, and no information could be found regarding stormwater-specific regulations that the city itself imposes on new and redevelopment projects.

FIELD OBSERVATIONS

Ronan's stormwater system was not thoroughly investigated in the field for this project.

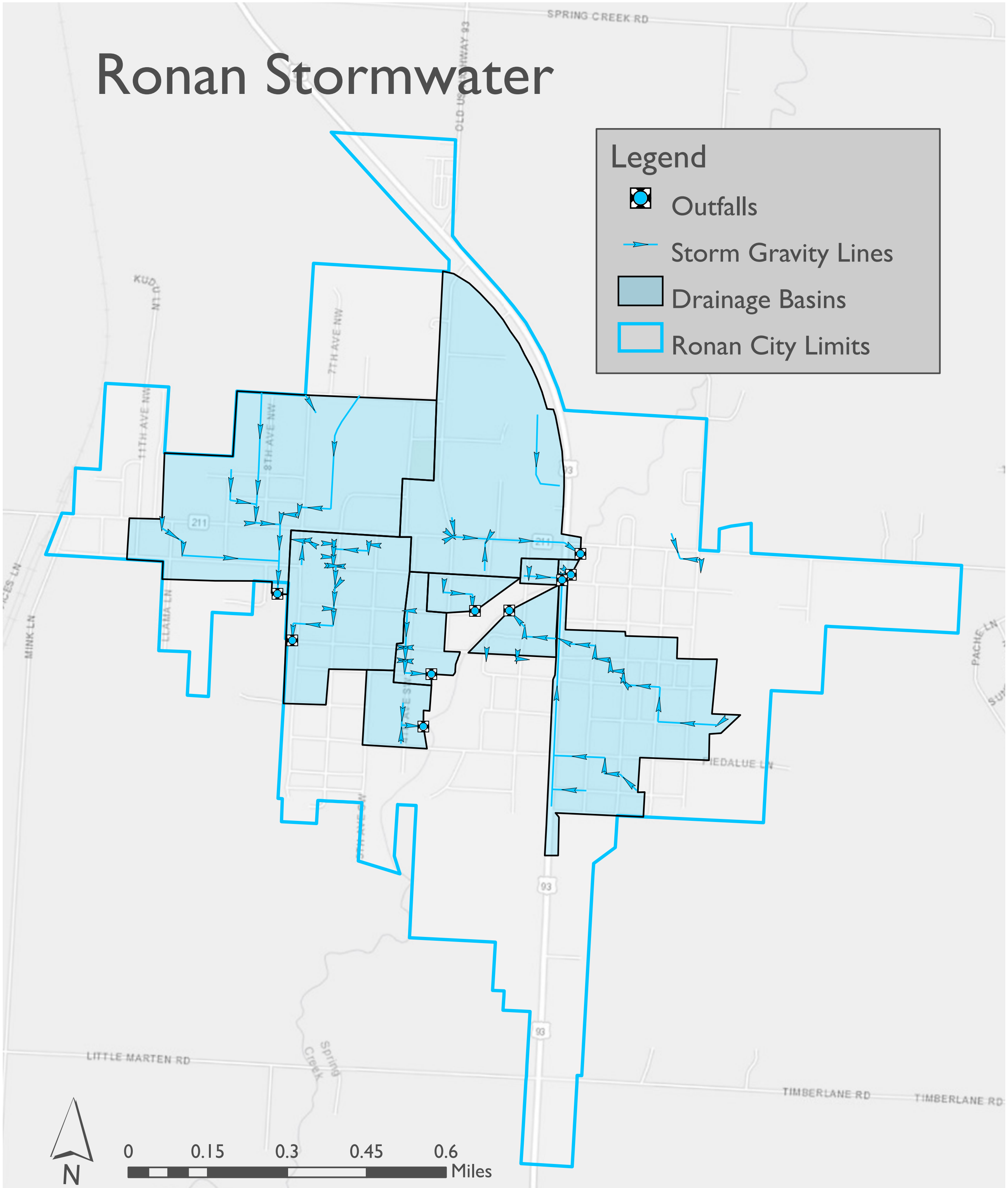


Figure 11. Stormwater infrastructure in the City of Ronan. Data from Montana State Library (2019) and Thomas, Dean, & Hoskins, Inc (2010a). Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Extent of Inventory

The City of Columbia Falls does not have a traditional stormwater system because the soils underlying the city tend to have a higher infiltration capacity than other soils in the area (T. Bradshaw, personal communication, January 22, 2020). However, Columbia Falls does own several dry wells and infiltration basins within city limits, none of which discharge to surface waters. As of the summer of 2020, the city is in the process of updating and digitizing their data to improve its accuracy (T. Bradshaw, personal communication, February 26, 2020). All stormwater infrastructure depicted in Figure 12 within Columbia Falls' city limits was digitized by the author from data provided by MDT or from a previous study by Tappenbeck & Ellis (2011). Although Columbia Falls is not currently permitted by MDEQ as an MS4, the city does regulate stormwater management in new developments to some extent, requiring the use of drainage easements and reserves, subsurface storm drains, open channels, culverts, temporary storage areas, dry wells, and/or metering basins to address drainage concerns (City of Columbia Falls, 2005, 12). However, the city's Standards for Public Works Improvements only provides generalized guidelines for implementation of these BMPs, and the city currently has no requirements regarding water quality at post-construction sites.

FIELD OBSERVATIONS

Ronan's stormwater system was not thoroughly investigated in the field for this project.

Industrial and Construction Activities

In addition to these urban areas, there are various industrial and construction sites throughout the Flathead Basin whose stormwater discharges are permitted through MDEQ. As of 2009, six facilities within the Flathead Basin were permitted under MDEQ's Multi-Sector General Permit for Industrial Stormwater Discharges (USEPA, 2010a, 13-25), but little information was found about the current status of those permits or if any new industrial areas have been permitted since. Additionally, 71 construction sites in Flathead County and one in Lake County are currently being regulated under the General Permit for Stormwater Discharges Associated with Construction Activity according to MDEQ's website (2020). For simplicity and because these activities are already being overseen by the state, little investigation was done into these activities.

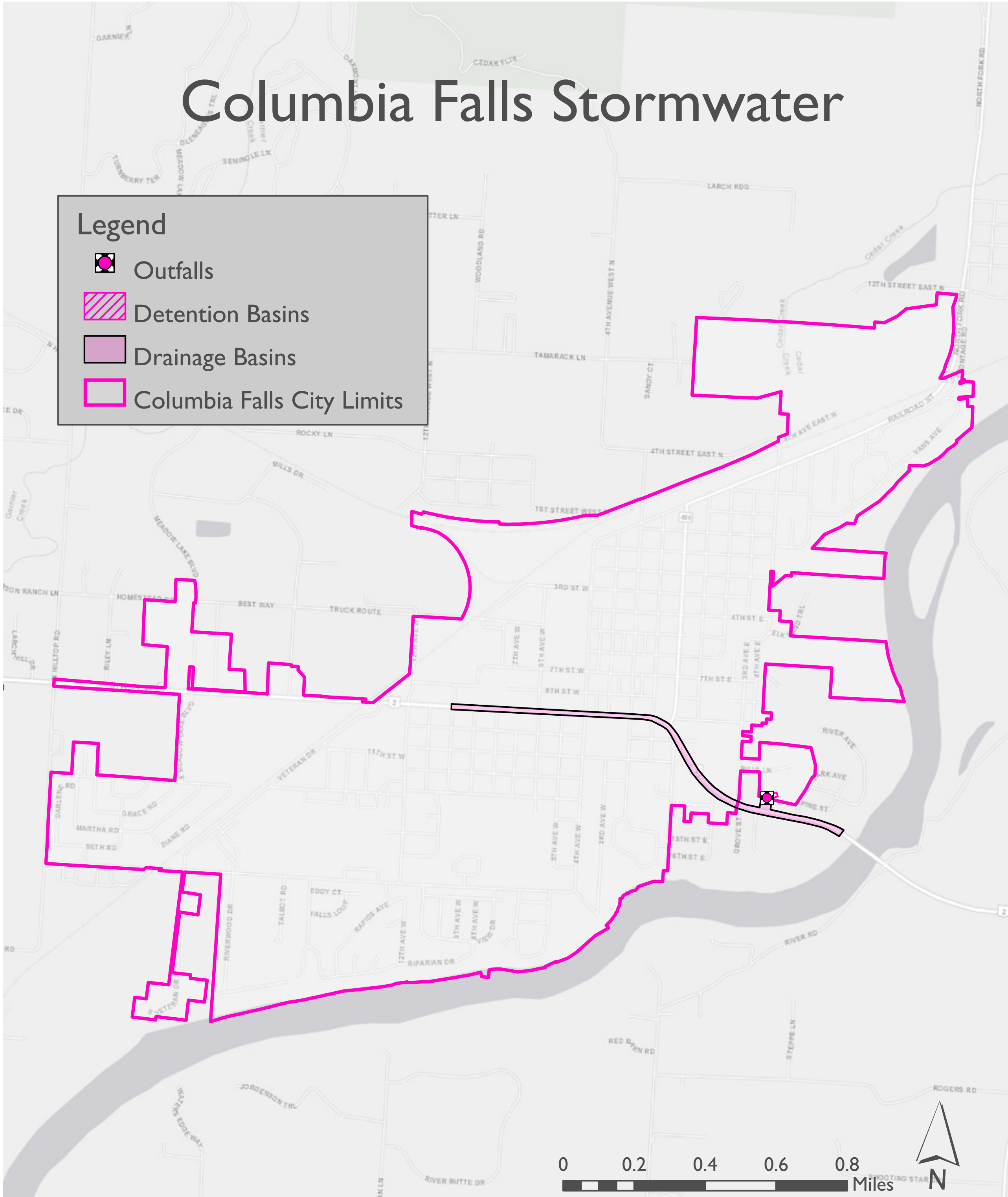


Figure 12. Stormwater infrastructure in the City of Columbia Falls. Data from Montana Department of Transportation, Montana State Library (2019), and Stanford et al. (1997). Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

After the inventory of stormwater infrastructure in the basin was completed, a model for ranking outfalls within the Flathead Watershed was created. The purpose of this model is to rank the basin's 177 outfalls and their corresponding drainage areas according to their potential to contribute to water quality degradation. See Appendix F for maps of all known sub-basins and outfalls within the Flathead Watershed. Since stormwater contributes a variety of pollutants to waterbodies within the basin, this model is designed to account for general polluting potential and is not specialized to focus on a single pollutant or group of pollutants. Discussed more in depth in the subsequent sections, the following parameters were used to rank outfalls and their corresponding sub-basins: (1) Sub-basin area, (2) predominant land use characteristics in the sub-basin, and (3) the impairment status of the receiving waterbody.

Parameters

Sub-Basin Area

The drainage area contributing runoff to a particular outfall is the first parameter used in the model. Higher priority was given to outfalls that drain a larger area of the landscape because larger areas are more likely to contain larger pollutant loads. Within the Flathead Watershed, sub-basin areas vary in range from 0.09 acres at the smallest to 701.64 acres at the largest. Several grouping methods were assessed including separating sub-basins into groups of equal acreage (small <234 acres, medium 234 – 468 acres, large >468 acres), groups with equal numbers of observations (small <3.5 acres, medium 3.5 – 13.75 acres, large >13.75 acres), and predetermined groups (small <50 acres, medium 50 – 100 acres, and large >100 acres). Since the data is strongly right skewed with 84% of sub-basins in the Flathead Watershed less than 50 acres in size, utilizing predetermined categories produced the most logical data distribution. Small basins (<50 acres) were given a size ranking of zero, medium basins (50 – 100 acres) were given a size ranking of one, and large basins (>100 acres) were given a ranking of two. See Appendix G for the sizes and area rankings of every known sub-basin within the Flathead Watershed.

Sub-Basin Area Land Use Characteristics

Additionally, land use characteristics of each sub-basin were considered in the model. The land use categories used in the model were adapted from categories presented by the MNHP (2013). See Appendix A for more details about how these adaptations were made. Higher priority was given to sub-basins that drain mostly industrial and/or commercial lands because these land use classifications are characterized by mostly impervious surfaces. Higher priority was also given to sub-basins that drain mostly agricultural lands because these land use classifications are generally associated with large nutrient loads. Medium priority was given to sub-basins that drain mostly residential lands because these land use classifications are characterized by a mixture of permeable and impermeable surfaces, and lower priority was given to sub-basins that drain mostly natural areas because these land use classifications are characterized by mostly permeable surfaces. The area of each land use classification within the individual sub-basins was calculated (See Fig. 3), and the overall classification of the sub-basin was determined by the land use classification making up the largest percent of the sub-basin.

Sub-basins were considered natural and given a land use ranking of zero if their largest percent land use classification was one of the following: Alpine Sparse and Barren; Cliff, Canyon, and Talus; Coniferous and Deciduous Woodland; Grassland and Steppe; Harvested Forest; Insect-Killed Forest;

Introduced Vegetation; Open Water; Recently Burned; Shrubland; and Wetland/Marsh/Bog, Floodplain; and Riparian. Sub-basins were considered residential and given a land use ranking of one if their largest percent land use classification was High Intensity Residential or Low Intensity Residential. Sub-basins were considered commercial/industrial or agricultural and given a land use ranking of two if their largest percent land use classification was one of the following: Agriculture; Commercial/Industrial; Developed (Open Space); Mining and Resource Extraction; Railroad; and Roads. Of the known sub-basins within the Flathead Watershed, 76% are majority commercial/industrial, 20% are majority residential, 3% are majority agricultural, and less than 1% are majority natural. See Appendix G for the percentage of each sub-basin covered by each land use category, the majority land use classification for each sub-basin, and the land use ranking for each known sub-basin with the Flathead Watershed.

Status of Receiving Waterbody

The final parameter considered in the model is the impairment status of the waterbody into which the outfall is draining. Under the Clean Water Act, states are required to identify impaired waterbodies, that is waterbodies that do not meet water quality standards (USEPA, 2010b, 6-13). These water quality standards vary for each waterbody. The total maximum daily load (TMDL) for each waterbody calculates the maximum amount of a pollutant or group of pollutants allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for those particular pollutants.

An impairment ranking of two was given to sub-basins whose outfalls are discharging into waterbodies that are impaired with more than one pollutant. Those waterbodies within the Flathead Watershed that are impaired with more than one pollutant include Ashley Creek, Flathead Lake, Spring Creek in Flathead County, Whitefish River, and Whitefish Lake (MCWAIC, 2020). An impairment ranking of one was given to sub-basins whose outfalls are discharging into a waterbody that is impaired with only one pollutant or a waterbody that has not been tested for impairment. Waterbodies within the Flathead Basin that are impaired with

RESULTS

After determining the rankings for each of these three parameters, they were then totaled for each sub-basin, giving sub-basins an overall priority ranking between zero and six (See Appendix G). In Figure 13, all sub-basins within the Flathead Watershed are shown according to their ranking. The model identified 12 high priority sub-basins within the Flathead Watershed, that is sub-basins with overall rankings of five or six. Eight of these twelve high priority sub-basins are in Kalispell—KAL_SC1, KAL_AC6, KAL_AC11, KAL_SC16, KAL_SWR15, KAL_SWR4, KAL_SWR16, and KAL_SC14 (See Fig. 14). Three high priority sub-basins are in Whitefish—WHI_WR5, WHI_WR11, and WHI_WR30 (See Fig. 15)—and one is in Polson, POL_FR1 (See Fig. 16). All but two of the sub-basins determined to be high priority have a majority of their area covered by roadways. Given their impermeable nature, sub-basins with a large percentage of roads were given a land use ranking of two, but after visual inspection of the aerial imagery, some of these sub-basins appear to be more residential than commercial/ industrial. Sub-basins KAL_SWR16 and KAL_SWR14 are examples (See Fig. 14). Currently, the City of Kalispell collects samples four times a year from KAL_AC11 and KAL_SWR4 in order to remain in compliance with their permit, and samples at KAL_AC6 and WHI_WR5 were analyzed in Stanford et al. (1997), Tappenbeck & Ellis (2011), and this report, which will be discussed in the subsequent section. None of the other sub-basins determined to be high priority from this model have been monitored for water quality in the past.

one pollutant include the Stillwater River. Numerous waterbodies within the basin have not yet been tested for pollutants and therefore cannot be labeled as impaired or not. An impairment ranking of zero was given to sub-basins whose outfalls are discharging into a waterbody that has been tested and determined to be not impaired or outfalls that are not discharging directly into a surface waterbody, which are considered closed basins. While there are numerous closed basins within the Flathead Watershed, there are no waterbodies that have been tested and determined to be not impaired. See Appendix G for the name of the receiving waterbody, the impairment status of the receiving waterbody, the pollutants of impairment if applicable, and the impairment ranking for each known sub-basin within the Flathead Watershed.

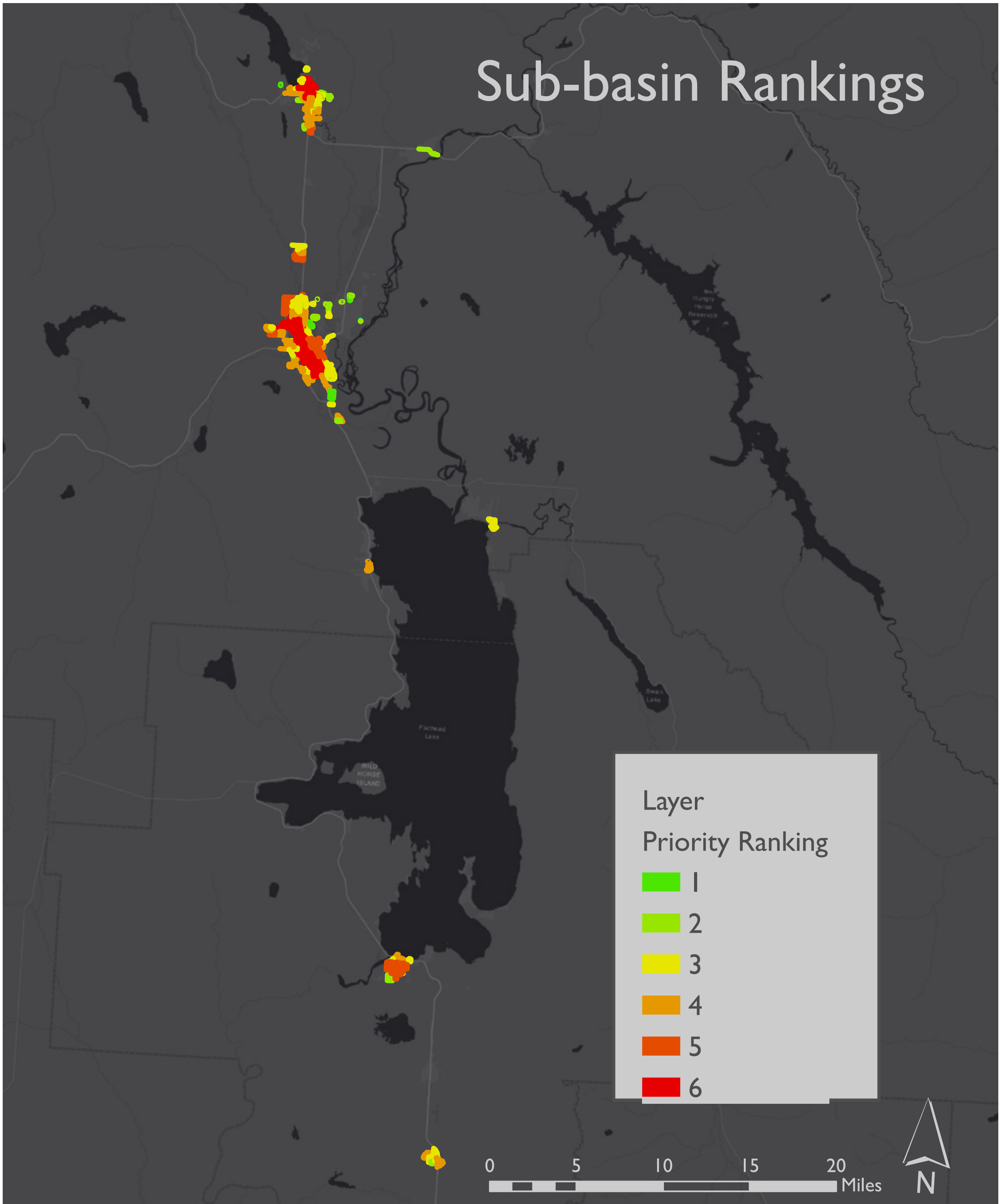


Figure 13. Sub-basins according to prioritization ranking. Basemap data from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

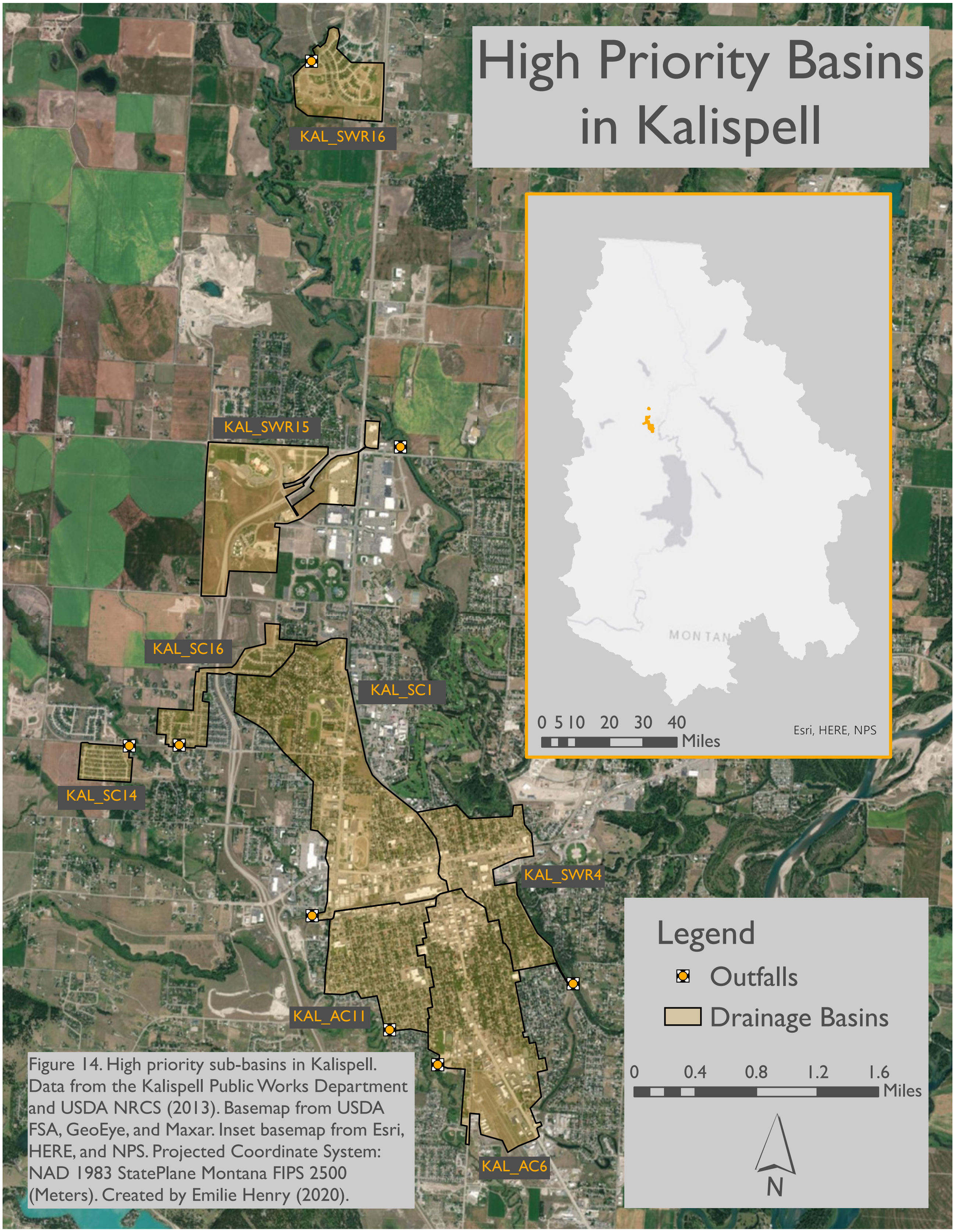


Figure 14. High priority sub-basins in Kalispell. Data from the Kalispell Public Works Department and USDA NRCS (2013). Basemap from USDA FSA, GeoEye, and Maxar. Inset basemap from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

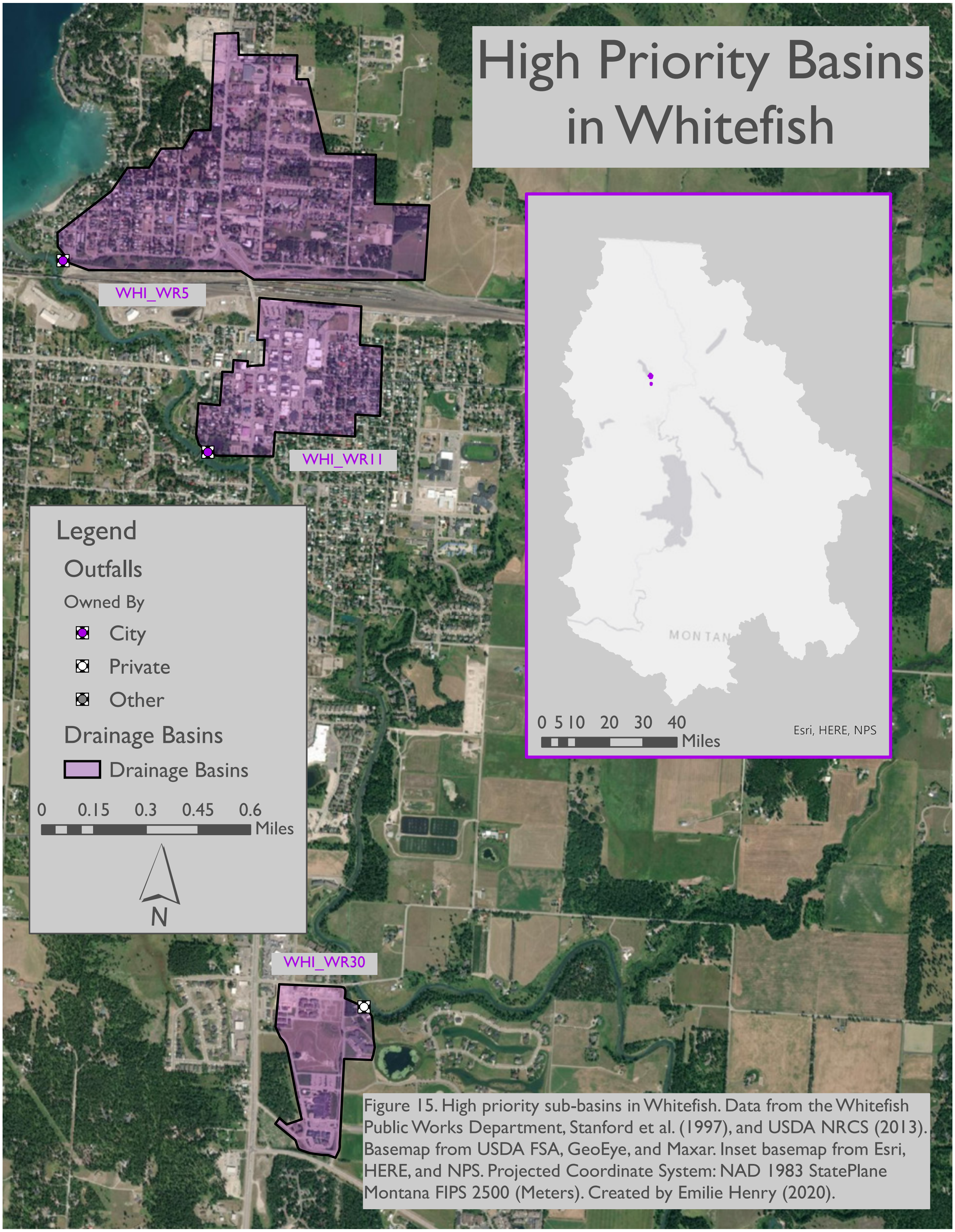


Figure 15. High priority sub-basins in Whitefish. Data from the Whitefish Public Works Department, Stanford et al. (1997), and USDA NRCS (2013). Basemap from USDA FSA, GeoEye, and Maxar. Inset basemap from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

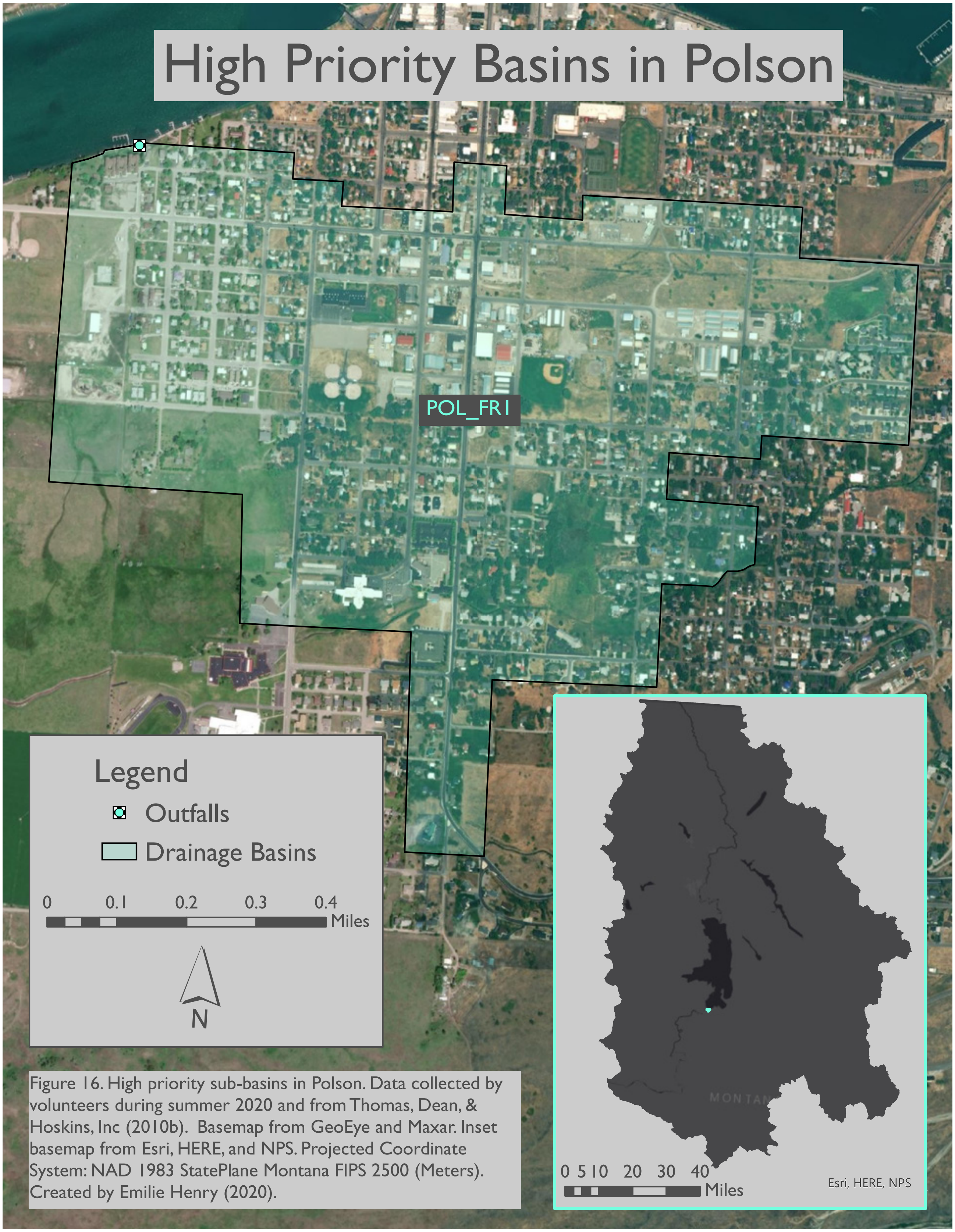


Figure 16. High priority sub-basins in Polson. Data collected by volunteers during summer 2020 and from Thomas, Dean, & Hoskins, Inc (2010b). Basemap from GeoEye and Maxar. Inset basemap from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Sampling Locations

One method for detecting nonpoint source pollution that was tested in the Flathead Basin is stormwater sampling. Four stormwater sampling sites across the northern part of the Flathead Basin were chosen for sampling between January and November of 2020. These locations were chosen because they had previously been sampled by Stanford et al. (1997) and/or Tappenbeck & Ellis (2011), meaning they all have previous water quality datasets on which to expand. These four outfalls are located in Kalispell, Evergreen, Whitefish, and Columbia Falls (See Fig. 17).

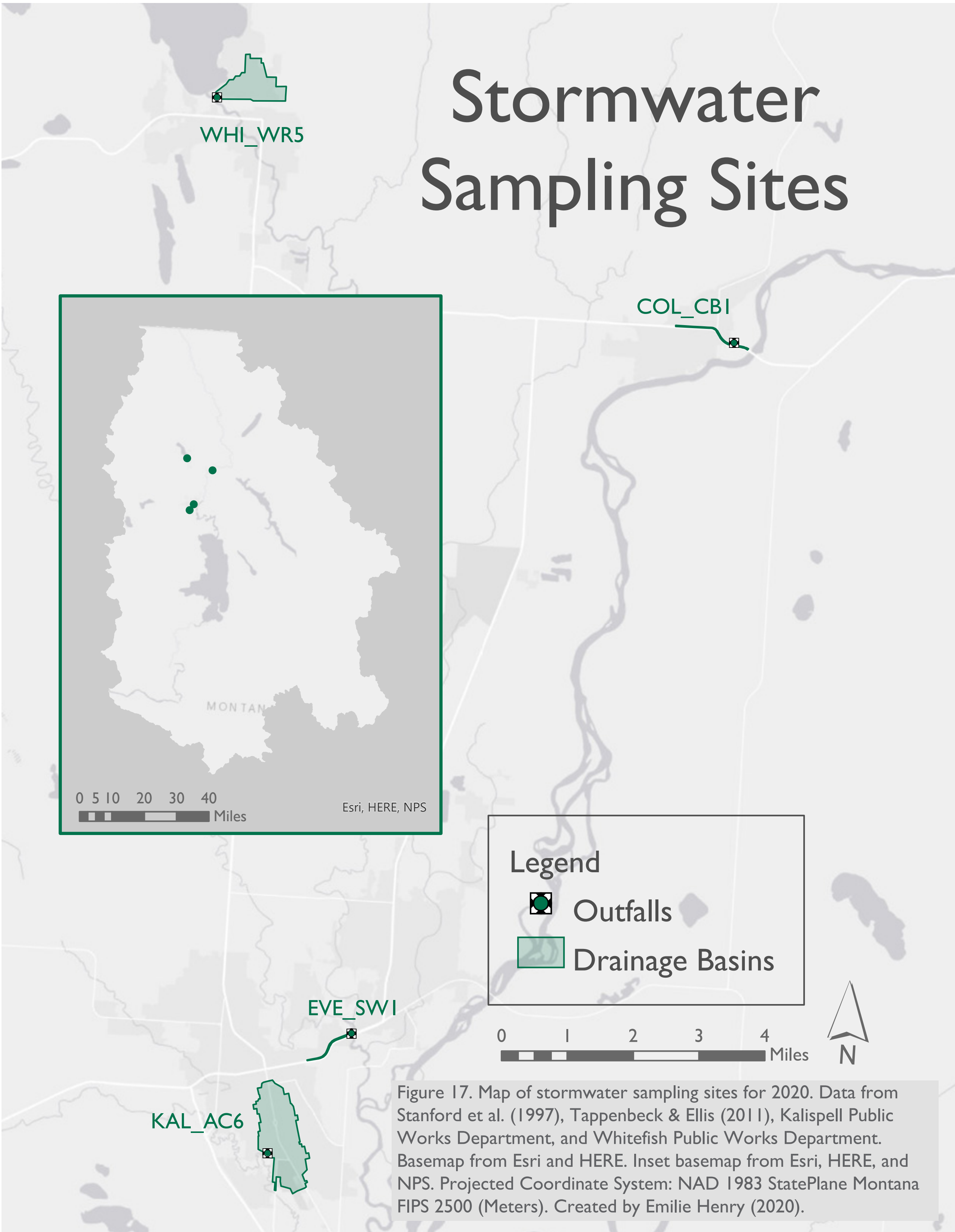


Figure 17. Map of stormwater sampling sites for 2020. Data from Stanford et al. (1997), Tappenbeck & Ellis (2011), Kalispell Public Works Department, and Whitefish Public Works Department. Basemap from Esri and HERE. Inset basemap from Esri, HERE, and NPS. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Kalispell

The first sampling site is located within the City of Kalispell (48°11'0.31"N, 114°18'45.06"W) and is known as "Kalispell – City Shop" or KAL_AC6 (See Fig. 18). The sub-basin drains a predominantly commercial and residential area, and the sampling site itself is at the end of the pipe. KAL_AC6 discharges into Ashley Creek, which is impaired with total nitrogen, total phosphorus, sediment, dissolved oxygen, and temperature (MCWAIC, 2020). The sub-basin itself is approximately 545 acres in size, and roadways make up the largest land use classification in the sub-basin according to MNHP (2013). According to the prioritization model discussed in the previous section, this outfall was determined to be one of the twelve high priority sub-basins within the Flathead Watershed with an overall ranking of six (See Fig. 14 and Appendix G).

Figure 18. Kalispell – City Shop (KAL_AC6) sampling location. Photo taken on 05/12/2020 during Sampling Event 1.

Evergreen

Known as "Evergreen – Hwy 2" or EVE_SW1, the second sampling site is located off of US Highway 2 in the Evergreen Water and Sewer District (48°12'39" N, 114°17'14" W) (See Fig. 19). The sub-basin drains a commercial area, primarily runoff from the Highway, and the sampling site is located at the end of the pipe (Tappenbeck & Ellis, 2011). EWE_SW1 discharges into the Stillwater River, which is impaired with sediment at this location (MCWAIC, 2020). The sub-basin is approximately 10 acres in size, and roadways make up the largest land use classification in the sub-basin (MNHP, 2013). The outfall was ranked as medium priority with an overall ranking of three by the model discussed in the previous section (See Appendix G).

Figure 19. Evergreen – Hwy 2 (EVE_SW1) sampling location. Photo taken on 03/11/2020.

Whitefish

The third sub-basin is located in the City of Whitefish (48°24'53" N, 114°21'3" W) and is known as "Whitefish – City Beach" or WHI_WR5 (See Fig. 20). The sub-basin

Figure 20. Whitefish – City Beach (WHI_WR5) sampling location. Photo taken on 05/13/2020 during Sampling Event 1.

Figure 21. Columbia Falls – Hwy 2 (COL_CB1) sampling location. Photo taken on 05/13/2020 during Sampling Event 1.

drains a predominantly industrial and residential area, and the sampling site itself is located at the end of the pipe (Stanford et al., 1997). WHI_WR5 discharges into Whitefish River, which is impaired with oil and grease, polychlorinated biphenyls (PCBs), and temperature (MCWAIC, 2020). The basin is approximately 260 acres in size, and roadways make up the largest land use classification in the sub-basin (MNHP, 2013). According to the prioritization model discussed in the previous section, this outfall was determined to be one of the twelve high priority sub-basins within Flathead Watershed with an overall ranking of six (See Fig. 15 and Appendix G).

Columbia Falls

Known as "Columbia Falls – Hwy 2" or COL_CB1, the fourth and final sampling site is located off of US Highway 2 within the City of Columbia Falls (48°22'3.81"N, 114°10'30.32"W) (See Fig. 21). The sub-basin drains a primarily commercial area, and the sampling site itself is located at the end of the pipe (Tappenbeck & Ellis, 2011). Considered a closed basin, COL_CB1 drains into a detention basin that does not have any surface water discharges. The sub-basin is approximately 13 acres in size, and roadways make up the largest land use classification in the sub-basin (MNHP, 2013). The outfall was ranked as low priority with an overall ranking of two by the model discussed in the previous section (See Appendix G).

Procedure

The following general procedures were used in the stormwater sample collection process. Weather was continuously monitored at all locations using data from local weather stations in Kalispell, Whitefish, and Columbia Falls from Weather Underground. See Table 2 for more details about specific weather stations used to track weather. Ideal conditions for sampling include the following stipulations: (1) Samples are collected within the first hour of a rain event in order to capture the first flush of pollutants; (2) a period of at least two weeks has passed since the previous rain event to allow pollutants to accumulate on the landscape; and (3) each location has received at least 0.1 inches of total accumulated precipitation at the time of sampling. These conditions are ideal, and it was rare that all three of these conditions were met during a single precipitation event. As a result, a Stormwater Sampling Weather Tracker (See Appendix I) was created using data from local weather stations in Table 2 in order to record weather conditions before, during, and after samples were collected and contextualize the results.

In the days leading up to a predicted rain event, equipment was gathered and calibrated in preparation. Specifically, a Hach® HQ30d Portable Dissolved Oxygen Meter was calibrated using a water-saturated air technique, and an Oakton® pHTestr 30 Pocket Tester was calibrated using a three-point calibration technique using 4.00, 7.00, and 10.01 standards. On the day of sample collection, a Stormwater Sampling Data Sheet was filled out in the field (See Appendix H), and collection bottles were filled with stormwater from each location. For each sampling site, two one-liter glass bottles and one one-liter plastic bottle were filled with stormwater in accordance with Montana Environmental Laboratory (ME Labs) requirements. Following collection, all bottles were delivered to ME Labs in Kalispell for analysis. ME Labs analyzed each sample for the following parameters:

- Total suspended solids (TSS),
- chemical oxygen demand (COD),
- total phosphorus (TP),
- total nitrates and nitrites (TN),
- total Kjeldahl nitrogen (TKN),
- total recoverable copper (Cu),
- total recoverable lead (Pb),
- total recoverable zinc (Zn),
- and oil and grease.

Dissolved oxygen (DO) and pH measurements were taken in the field using the Hach® HQ30d Portable Dissolved Oxygen Meter and Oakton® pHTestr 30 Pocket Tester, respectively. These parameters were chosen in accordance with those outlined in the City of Kalispell's Stormwater Management Program (2019).

	Kalispell	Whitefish	Columbia Falls	Columbia Falls
Weather Station ID	KMTKALIS52	KMTWHITE58	KMTCOLUM55	KMTCOLUM1
Station Name	River Place	Whitefish Golf Club	2020 Weather Station	Tamarack Lane
Lat/Long	48.22°N, 114.285°W	48.415°N, 114.361°W	48.355°N, 114.142°W	48.385°N, 114.189°W
Elevation (ft)	3071	3054	3054	3133
Hardware	Ambient Weather WS-1200-IP (Wireless)	AcuRite 5-in-1 Weather Station with AcuRite Access	AcuRite Pro Weather Center	La Crosse
Software	Weather Logger V3.0.7	myAcuRite	myAcuRite	N/A
Retrieved from	https://www.wunder ground.com/dashboard/ pws/KMTKALIS52	https://www.wunder ground.com/dashboard/ pws/KMTWHITE58	https://www.wunder ground.com/dashboard/ pws/KMTCOLUM55	https://www.wunder-ground.com/weather/us/ mt/columbia-falls/KMT-COLUM1
Dates Used	05/01/2020 – 9/30/2020	05/01/2020 – 9/30/2020	05/01/2020 – 07/06/2020	07/06/2020 – 09/30/2020

Table 2. Weather station data used to monitor stormwater sampling conditions in Kalispell, Whitefish, and Columbia Falls, MT. Data from these weather stations were used to create the Stormwater Sampling Weather Tracker (See Appendix I). All weather station data from Weather Underground (2020).

One set of samples from each of these four locations was collected during the spring of 2020. The samples were collected during the afternoon and early morning of May 12th and 13th, respectively. On May 12th around 8:00 AM, it began raining in the Kalispell and Evergreen areas, reaching accumulations of approximately 0.3 inches by 12:30 PM (See Fig. 22). Samples at KAL_AC6 and EVE_SWR1 were collected on 05/12/2020 at 12:39 PM and 1:10 PM, respectively (See Table 3). On May 13th, rain began falling around 2:00 AM in Whitefish and 4:00 AM in Columbia Falls reaching accumulations of 0.3 inches by around 7:00 AM (See Fig. 23). Samples at WHI_WR5 and COL_CB1 were collected on 05/13/2020 at 7:07 AM and 7:51 AM, respectively (See Table 3). Samples from KAL_AC6 and EVE_SW1 were delivered to ME Labs on 05/12/2020 at 2:40 PM, and samples from WHI_WR5 and COL_CB1 were delivered to ME Labs on 05/13/2020 at 8:30 AM.

Stormwater Sampling Data Sheet: Event 1, Parts A & B

Date: 5/12/2020 (KAL_AC6 and EVE_SW1) and 5/13/2020 (WHI_WR5 and CF_CB1)

Sampler Name: Emilie Henry

	Kalispell & Evergreen	Whitefish	Columbia Falls
Total Accumulated Precipitation at Time of Sampling (in):	0.32	0.3	0.32
Storm Duration from Beginning to Time of Sampling (hrs):	4	5	4

Site Name	Location	Type	Sample Spot	Time	DO Meter: DO (mg/L)	DO Meter: Sample Temp (°C)	DO Meter: Pressure (hPa)	DO Meter: % of Air Sat	pH Meter: pH	pH Meter: Sample Temp (°C)	Air Temp (°F)	Precip	Weather
Evergreen - HWY 2 (EVE_SW1)	Under bridge over Stillwater River on HWY 2 - 48°12'39" N, 114°17'14" W	Com	1	1:10 PM	8.90	11.6	907	91.5	8.50	11.1	41	2	5
Kalispell - City Shop (KAL_AC6)	Near City Shops off of 1st Ave W - 48°11'0.31"N, 114°18'45.06"W	Com/Res	1	12:39 PM	8.29	13.2	906	88.5	8.35	11.6	40	3	5
Whitefish - City Beach (WHI_WR5)	Near City Beach just north of railroad - 48°24'53" N, 114°21'3" W	Ind/Res	1	7:07 AM	8.23	13.0	901	88.1	8.05	11.1	41	3	5
Columbia Falls - HWY 2 (CF_CB1)	Off of HWY 2 near C. Falls Marine Services - 48°22'3.81"N, 114°10'30.32"W	Com	1	7:51 AM	9.51	9.8	903	94.1	8.68	9.7	40	2	5

Date Equipment Last Calibrated: 5/4/2020

Delivered to ME Lab on: 5/12/2020 at 2:40 PM (KAL_AC6 and EVE_SW1) and 5/13/2020 at 8:30 AM (WHI_WR5 and CF_CB1)

Delivered by: Emilie Henry

Key

Precipitation: **1**-No Rain, **2**- Lt. Rain, **3**-Rain, **4**- Heavy Rain/Storm Event, **5**-Snow

Weather: **1** - 0 to 5% (Clear), **2** - 5 to 25%, **3** - 25 to 75%, **4** - 75 to 99%, **5** - 100% (Rain)

Sample Spot: **1** - end of pipe, **2** - inside CB, **3** - In stream, **4** - In manhole

Type: Residential (Res), Industrial (Ind), Commercial (Com)

Table 3. Stormwater sampling data sheet from Sampling Event 1. Record of measurements taken in the field.

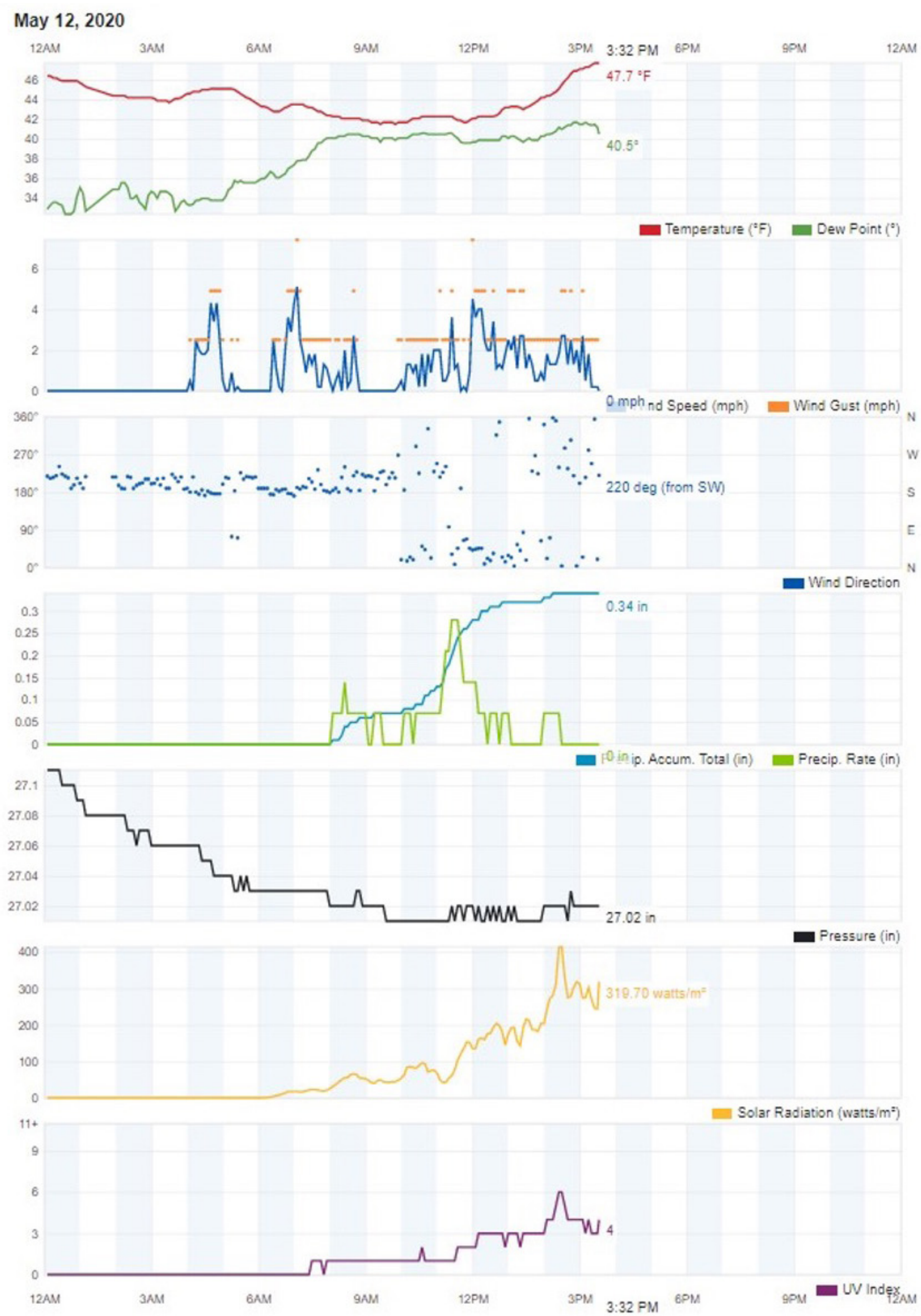
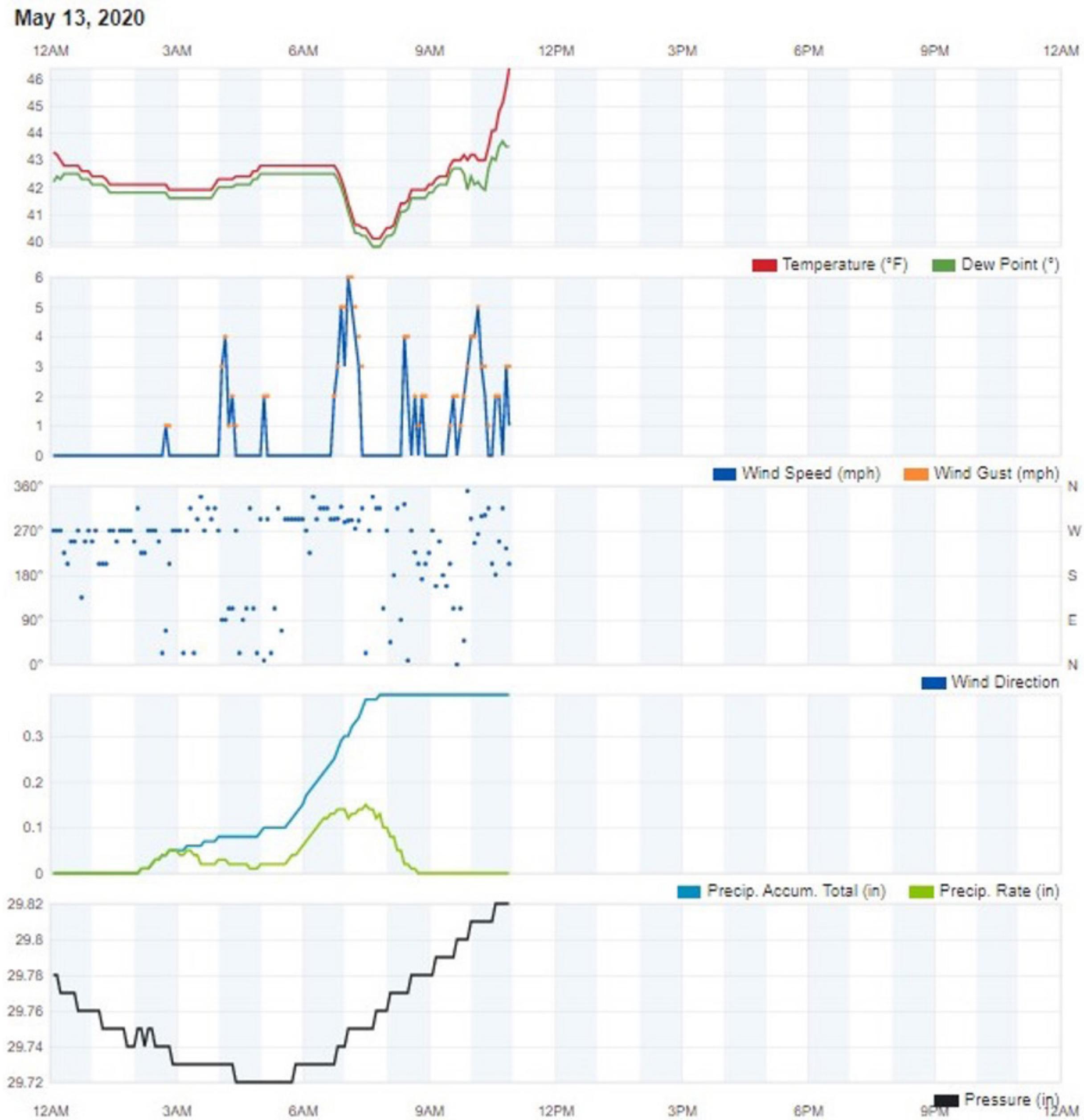


Figure 22. Graphs from local weather station in Kalispell from 05/12/2020 (Weather Underground, 2020b).


May 13, 2020
12AM
3AM
6AM
9AM
12PM
3PM
6PM
9PM
12AM
Temperature (°F)
Dew Point (°)
Wind Speed (mph)
Wind Gust (mph)
Wind Direction
Precip. Accum. Total (in)
Precip. Rate (in)
Pressure (in)
N
W
S
E
N

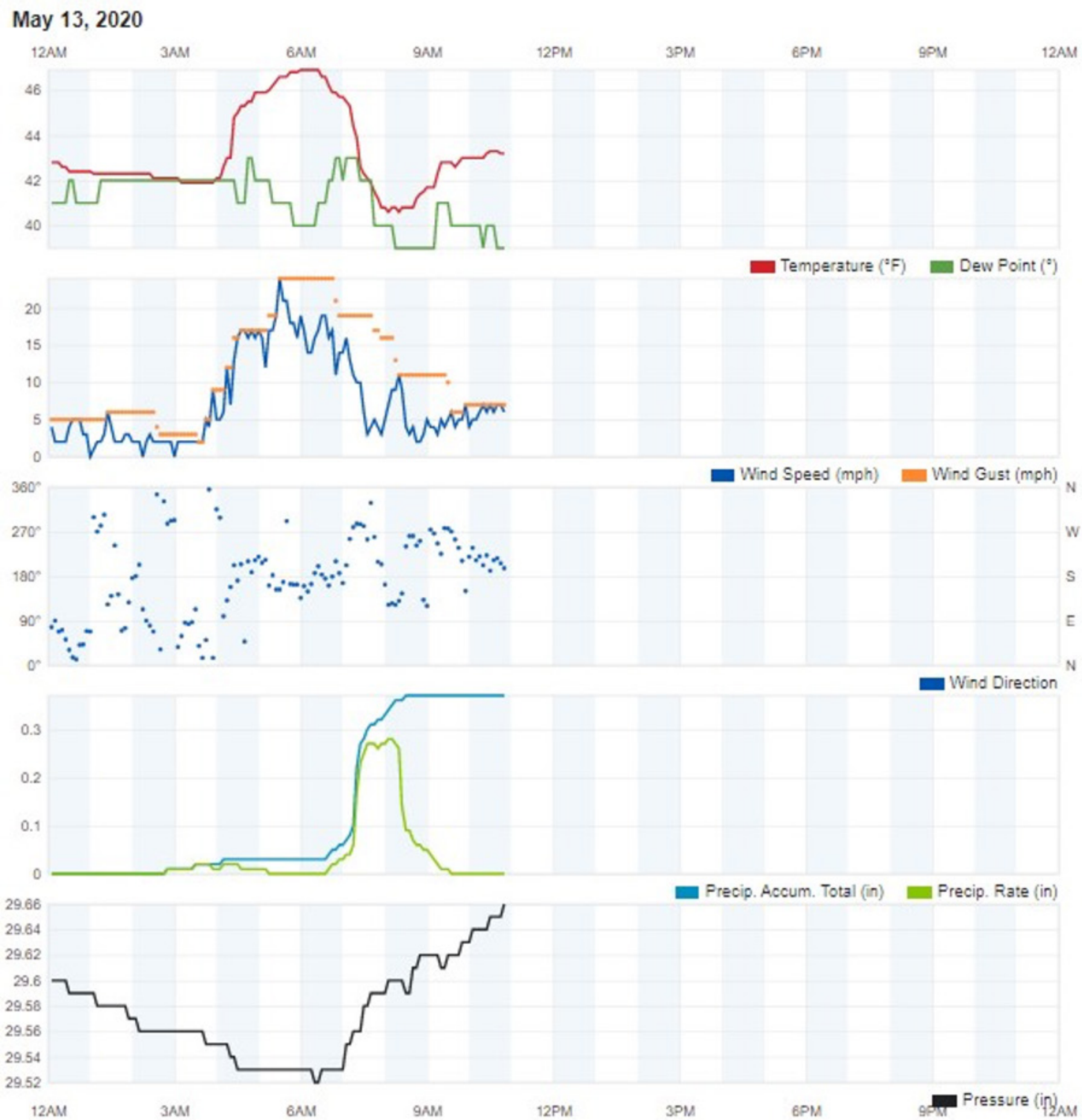


Figure 23. Graphs from local weather stations in Whitefish (a) and Columbia Falls (b) from 05/13/2020 (Weather Underground 2020a & 2020c).

Results

The results from stormwater sampling Event 1 are shown numerically in Table 4 and represented visually in Figure 24. Since only one sample was able to be collected due to the infrequency with which the ideal sample conditions were met, no statistical analysis was able to be performed on the results.

Stormwater Sampling Results: Event 1												
	DO (mg/L)	Sample Temp (°C)	pH	COD (mg/L)	Cu (mg/L)	Pb (mg/L)	Oil & Grease (mg/L)	TN (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Zn (mg/L)
EVE_SW1	8.90	11.6	8.50	184	0.030	0.0203	2	0.09	0.32	1.63	357	0.288
KAL_AC6	8.29	13.2	8.35	177	0.012	0.0060	1	0.09	0.24	1.57	138	0.106
WHI_WR5	8.23	13.0	8.05	128	0.014	0.0125	ND	ND	0.26	1.54	324	0.110
COL_CB1	9.51	9.8	8.68	132	0.015	0.0088	ND	ND	0.33	1.92	287	0.152

Table 4. Results for Sampling Event 1

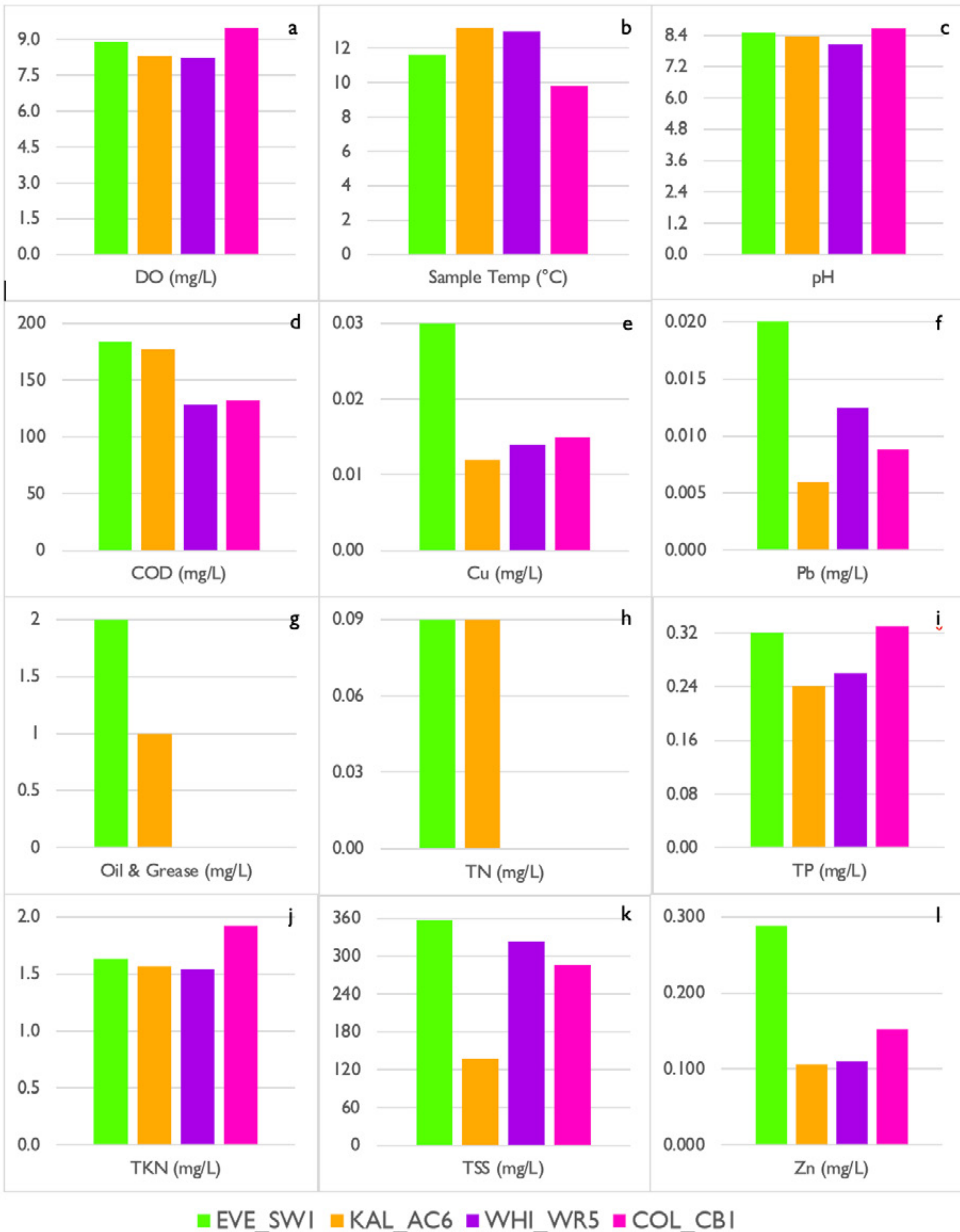


Figure 24. Graphs of results from stormwater samples from Kalispell (KAL_AC6), Evergreen (EVE_SW1), Whitefish (WHI_WR5), and Columbia Falls (COL_CB1) from Sampling Event 1.

Dry-Weather Outfall Inspections

Another potential method for detecting nonpoint source pollution in the Flathead Basin is dry-weather outfall inspections for illicit discharge detection. This methodology is currently only being implemented within the City of Kalispell. In order to be in compliance with its NPDES stormwater permit as a small MS4, Kalispell must conduct these dry-weather inspections of all of its approximately 80 outfalls at least once over the course of each permit cycle. The purpose of these dry-weather inspections is to detect illicit discharges, which are discharges into stormwater systems that are not composed entirely of stormwater and if present, determine their sources.

Procedure

Kalispell follows the outfall field screening protocol developed by the Center for Watershed Protection. For each outfall, Kalispell collects logistical information, including the inspection date and time, the name of person conducting the inspection, air temperature, and the amount of rainfall in last 24 hours; information about the outfall itself, including whether the outfall is submerged in water or sediment, pipe size, pipe shape, pipe material, and configuration; and information about any dry-weather flows that might be occurring, including a description of the flow and flow severity, a description of any odors and their severity, a description of any colors and their severity, and a description of any floatables and their severity. At the end of each inspection is an overall outfall characterization where the outfall is classified as one of the following: (1) "Unlikely," meaning it is not believed to be experiencing an illicit discharge; (2) "Potential," meaning is has up to two indicators of an illicit discharge; (3) "Suspect," meaning it has three severe indicators of an illicit discharge; or (4) "Obvious," meaning this outfall is clearly experiencing an illicit discharge. All of this information is recorded digitally in the field using an iPad and the Cityworks application. The digital inspection form in the Cityworks application was based on and contains the same information as Kalispell's Outfall Reconnaissance Inventory Data Sheet, which is included in Appendix J.

Results

Of the 21 outfalls inspected, only two had any measurable flow at the time of inspection and of those, none were believed to be experiencing an illicit discharge based on the characteristics of the discharge. Both are believed to be the result of over-irrigation in residential or commercial areas. Aside from locating the outfalls, which was very difficult in some instances, the procedure is straightforward and useful for both detecting illicit discharges and for examining the integrity of the outfall infrastructure.

As previously mentioned, the primary goal of this project is to understand more about how stormwater is currently being managed in the Flathead Watershed in order to prioritize future water quality monitoring efforts and ultimately reduce stormwater pollution entering waterbodies in the basin. Although this basic goal was accomplished, there is potential for significant expansion within each of the four primary facets of the project.

Inventory of Stormwater Infrastructure

Although the current inventory captures most major urban areas across the basin, there is potential to expand the extent of the inventory to further increase collective understanding of stormwater in the Flathead Basin. Particularly, a complete inventory of stormwater infrastructure within the City of Columbia Falls would be beneficial. As previously mentioned, the city is currently in the process of documenting its stormwater system, so it will likely be possible to add this infrastructure to the inventory in the near future. MDT-owned stormwater infrastructure along major highways in the area would also be useful to include in the inventory. Some MDT-owned infrastructure is included in the current inventory but only in certain locations and only for certain stormwater elements, so creating a comprehensive, basin-wide record of MDT-owned stormwater infrastructure would increase understanding of how runoff from impervious roadways is being managed. Additionally, construction and industrial activities in the basin whose stormwater discharges are currently permitted by MDEQ might be another useful addition to the inventory to increase its scope. In this way, the current inventory is in no way comprehensive and inclusive of all stormwater infrastructure in the basin but merely a starting point for understanding the Flathead Watershed's stormwater with potential for expansion. Finally, it is strongly recommended that this inventory be treated as a collaborative, dynamic tool that all relevant entities within the basin can reference, edit, and update over time. Treating this inventory as a living document rather than a snapshot in time will allow for more effective management of the Flathead Watershed's stormwater and nonpoint source pollution mitigation moving forward.

Outfall Prioritization Model

As previously discussed, stormwater is currently being managed in a diversity of ways across the Flathead Watershed. There are cities in the basin that own stormwater systems but know little about them and evidently do not maintain them. There are other towns in the basin that have stormwater infrastructure, but it is privately-owned and therefore unknown whether it is maintained according to a regular, documented schedule. There are other cities that own stormwater systems and have kept updated records but do not adhere to a proactive maintenance schedule. As a result of these differences in ownership, maintenance, and documentation of stormwater infrastructure across the basin, comparing sub-basins across the Flathead Watershed in a model is extremely difficult. It is because of these differences and lack of consistent data that the model used in this project only considered three parameters. While it does provide a good starting point for addressing potential stormwater pollution, the current model does not address all sub-basin characteristics that may influence water quality. Some additional parameters that would be beneficial to address in future sub-basin models include the following:

- Age of stormwater infrastructure;
- soil infiltration capacity;
- density of septic systems;
- regularity and/or consistency of maintenance;
- whether stormwater within a particular sub-basin is being treated prior to discharge and in what way;
- and the potential for stormwater to contribute to groundwater contamination.

All of these parameters have the potential to influence a particular sub-basin's water quality degradation potential, but more data—whether interview data or from scientific studies—is needed in order for these parameters to be accurately addressed in all locations. For example, some cities and towns have precise dates on which different pieces of infrastructure were installed, while others have general age ranges, such as post-1953, and others have no age estimates whatsoever. In this way, uncovering more data would allow these parameters to be applied consistently across the basin and subsequently create a more comprehensive sub-basin prioritization model. It is strongly recommended that the Flathead Basin Commission consider creating a technical sub-committee to assist in acquiring this data.

Stormwater Sampling

Stormwater sampling is one important method for detecting stormwater pollution, and it should continue to be implemented at high priority outfalls across the Flathead Basin. However, as mentioned in previous sections, the guidelines for collecting ideal samples are quite strict, and the surrounding mountains create weather patterns in the Flathead Basin that are generally unpredictable and extremely variable between locations, making stormwater sampling challenging. For example, on September 25th, 2020, Kalispell had a total precipitation accumulation of 0.19 inches, Whitefish had an accumulation of 0.50 inches, and Columbia Falls had no precipitation at all (See Appendix I). In this way, instances in which all sample locations have sufficient accumulation, all samples are able to be collected within the first hour of the storm event, the storm event itself is taking place at least two weeks after the preceding storm event, and the storm event is occurring during sampleable daylight hours are extremely rare and will only become rarer as locations for sample collection are expanded.

Therefore, if it is the FBC's priority to acquire the greatest number of stormwater samples, it is recommended that the guidelines for sample collection be modified. Additionally, it is the opinion of the author that a more collaborative approach be used for stormwater sample collection if possible. Depending on the locations of future sampling efforts and distance between these locations, it may be easier to ensure sufficient accumulation and capture an event's first flush if people who live and work in an area collect samples in that location rather than having one person collect samples at all locations. This methodology would introduce a new suite of challenges, including a lack of equipment for in-field measurements, but it might be the most effective methodology if it is the priority of the FBC to collect the greatest number of stormwater samples. Thus, before Phase II implementation, it is recommended that the FBC clarify its priorities for stormwater sample collection, discuss the pros and cons of different sampling methodologies, and determine what methodology would be most effective for achieving its goals.

Dry-Weather Inspections of Outfalls

Dry-weather outfall inspections are another important method for detecting and eliminating nonpoint source pollution and should be implemented in other high priority areas across the basin. As discussed previously, the City of Kalispell is the only city within the basin that is required to conduct these inspections, so it is not believed that any other cities or towns within the Flathead Watershed currently perform similar inspections. The procedure utilized by the City of Kalispell would be widely applicable to other cities and towns throughout the basin with little modification needed. Thus, it is recommended that this practice be implemented in other locations, particularly those with high densities of high and medium priority outfalls.

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City of Whitefish Public Works Department

City of Columbia Falls

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City of Polson

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Thomas, Dean, & Hoskins Engineering, Inc

City of Ronan

Dan Miller, Public Works Director for the City of Ronan
Shari Johnson, Founder of Shari A. Johnson & Associates Engineering, PLLC
Thomas, Dean, & Hoskins Engineering, Inc

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WGM Group Inc

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Appendix A: Land Use Categories

Data for the land use categories used in analyses in this report come from the Montana Landcover Framework by the Montana Natural Heritage Program (2013). Land use categories used in this report were created by the author by logically grouping existing "GNAME" categories within the MT Landcover Framework in order to simplify the number and complexity of categories (MNHP, 2013). The exact "GNAME" categories combined to create the categories used in this report are listed in the table below.

Land Use Category	Combined GNAME from MNHP 2013
Agriculture	Pasture/Hay Cultivated Crops
Alpine Sparse and Barren	North American Alpine Ice Field Rocky Mountain Alpine Bedrock and Scree Rocky Mountain Alpine Fell-Field
Cliff, Canyon, and Talus	Rocky Mountain Cliff Canyon and Massive Bedrock
Commercial/Industrial	Commercial/Industrial
Coniferous and Deciduous Woodland	Rocky Mountain Aspen Forest and Woodland Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest Northern Rocky Mountain Subalpine Woodland and Parkland Northern Rocky Mountain Mesic Montane Mixed Conifer Forest Rocky Mountain Foothill Limber Pine - Juniper Woodland Rocky Mountain Lodgepole Pine Forest Northern Rocky Mountain Ponderosa Pine Woodland and Savanna Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland Middle Rocky Mountain Montane Douglas-Fir Forest and Woodland Rocky Mountain Poor Site Lodgepole Pine Forest Inter-Mountain Basins Aspen Mixed Conifer Forest-Woodland Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
Developed (Open Space)	Developed, Open Space
Grassland and Steppe	Inter-Mountain Basins Big Sagebrush Steppe Inter-Mountain Basins Montane Sagebrush Steppe Northern Rocky Mountain Lower Montane Foothill and Valley Grassland Northern Rocky Mountain Subalpine-Upper Montane Grassland Northwestern Great Plains Mixedgrass Prairie Rocky Mountain Alpine Turf Rocky Mountain Subalpine-Montane Mesic Meadow
Harvested Forest	Harvested Forest-Tree Regeneration Harvested Forest-Shrub Regeneration Harvested Forest-Grass Regeneration
High Intensity Residential	High Intensity Residential
Insect-Killed Forest	Insect-Killed Forest
Introduced Vegetation	Introduced Upland Vegetation-Shrub Introduced Upland Vegetation-Annual and Biennial Forbland Introduced Upland Vegetation-Annual Grassland Introduced Upland Vegetation-Perennial Grassland and Forbland
Low Intensity Residential	Low Intensity Residential
Mining and Resource Extraction	Quarries, Strip Mines and Gravel Pits
Open Water	Open Water

Railroad	Railroad
Recently Burned	Recently Burned Forest Recently Burned Grassland Recently Burned Shrubland Burned Sagebrush Post-Fire Recovery
Roads	Major Roads Other Roads
Shrubland	Rocky Mountain Alpine Dwarf-Shrubland Wyoming Basins Dwarf Sagebrush Shrubland and Steppe Inter-Mountain Basins Big Sagebrush Shrubland Rocky Mountain Lower Montane-Foothill Shrubland Northern Rocky Mountain Montane-Foothill Deciduous Shrubland Northern Rocky Mountain Subalpine Deciduous Shrubland
Wetland/Marsh/Bog, Floodplain, and Riparian	Northern Rocky Mountain Conifer Swamp Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland Northern Rocky Mountain Wooded Vernal Pool Rocky Mountain Subalpine-Montane Riparian Woodland Rocky Mountain Subalpine-Montane Riparian Shrubland Rocky Mountain Alpine-Montane Wet Meadow North American Arid West Emergent Marsh Rocky Mountain Subalpine-Montane Fen Western Great Plains Saline Depression Wetland

Appendix B: Stormwater Infrastructure Data Collection Methodology

Description of Methodology

The following data collection methodology was used to locate and characterize key pieces of stormwater infrastructure in cities and towns in which little information about the stormwater system was previously known. These cities and towns include the City of Polson, the Town of Lakeside, and the Town of Evergreen. The methodology employed was based off that presented by Joshua Rotbert and Camryn McGrath in an ArcGIS StoryMap entitled "Mapping a Stormwater Drainage System." This methodology details the process by which catch basins can be located and characterized using simple, everyday technology including retractable tape measures, flashlights, and hand-held compasses (Rotbert and McGrath, n.d.). The Rotbert-McGrath methodology was expanded to include locating stormwater manholes and outfalls in order to better understand the connectivity of the system.

Data collectors walked the streets of their predetermined data collection section (See Appendix C), stopping and characterizing any catch basins, stormwater manholes, and outfalls they passed along the way. To characterize catch basins, Rotbert and McGrath (n.d.) detail the collection of the following catch basin elements: (1) Catch basin depth, which is defined as the distance from the surface of the grate to the bottom of the basin; (2) grate size, which is either a length-by-width measurement of rectangular grates or a diameter measurement of circular ones; (3) depth to the pipes, which is defined as the distance from the surface of the grate to the bottom of any pipes leading into or out of a catch basin; (4) the direction of flow, which is determined using the orientation of the outflow and/or inflow pipes in space; (5) pipe size, which is the diameter of the outflow and/or inflow pipes; and (6) pipe material, which is either high-density polyethylene (HDPE), polyvinyl chloride (PVC), corrugated metal pipe (CMP), or reinforced concrete pipe (RCP). To characterize manholes, data collectors noted the words written on the manhole's cover, either "Storm," "Storm Sewer," or blank. Any manholes that had covers indicating they were part of the sanitary sewer system were ignored. To characterize outfalls, data collectors noted the diameter of the pipe, the direction in which the outfall was pointed, and the pipe material.

The recording of this data occurred in two different ways, either using hard copies of data sheets and maps or digitally using an iPad. In the analog method, a hard copy of the catch basin data sheet (See Appendix D) was filled out for every catch basin encountered and a row in the manhole or outfall data table (See Appendix E) was filled out for every storm manhole and outfall encountered, respectively. The locations of catch basins were marked on a map in red and numbered according to the number assigned by the data collectors on the catch basin data sheet. Outfalls were marked on the map in black and manholes in blue and numbered according to the row number on the outfall or manhole data table. In the digital method, data was instead recorded on an iPad through a location-specific survey developed in Esri's Survey123 application. A new entry was created for each piece of infrastructure the data collectors encountered, and the same data included in the data collection sheets and tables were recorded digitally through survey questions. Within the survey was also a map with a custom basemap of the specific area's data collection sections (See Appendix C), and the location of each piece of infrastructure was saved along with all the characteristic information in the survey entry. The analog methodology was used in Polson, while the digital methodology was used in both Lakeside and Evergreen.

Once all of the data for a location had been collected using the analog method, the digitizer was able to take this location data from the map and the characteristic data from the sheets/tables and manually map each piece of infrastructure in ArcGIS Pro. All characteristic information was recorded in each shapefile's attribute table. On the other hand, using the digital method, once all of the data had been collected and all the survey entries submitted, the digitizer was able to download the entries directly as one shapefile and upload it into ArcGIS Pro, where all of the characteristic information for each piece of infrastructure was automatically stored within the shapefile's attribute table. In this regard, the digital method of recording was much quicker and simpler.

However, regardless of the recording method used, storm lines needed to be drawn between pieces of infrastructure, and the digitizer did this by interpolating between catch basins. Operating under the assumption that all examined systems are gravity-driven, inflow and outflow pipes were differentiated primarily by depth to pipe, with outflow pipes being generally deeper in the catch basin than inflow pipes; and thus, the direction of flow was able to be determined. The relative confidence of each fragment of pipe was then recorded on a spectrum from "High" to "Low." Fragments of pipe marked as "High" confidence are (1) pieces of pipe whose start and end points were both examined in the field and are consistent with one another or (2) verified by a published source. Fragments of pipe marked as "Low" confidence are pieces of pipe that were included under the digitizer's best judgment but were not field verified or verified by a published source. The catch basins were connected to each other and/or manholes by these storm gravity lines and eventually connected to an outfall. The digitizer was then able to draw in the approximate boundaries of drainage basins, which indicate the portion of a landscape that contributes runoff to a single outfall. A drainage basin was digitized for every outfall seen in the field or verified in a published source. Emilie Henry was the digitizer for all data collected in Polson, Lakeside, and Evergreen.

Polson

The stormwater data for the City of Polson was collected by different people on different dates according to the data collection section (See Appendix C.1). Those responsible for collecting the data and the dates on which data was collected for each section are as follows:

- Section 1: Emilie Henry and Mikaela Richardson, 06/19/2020
- Section 2: Emilie Henry and Lauren Hadley, 08/20/2020
- Section 3: Emilie Henry and Jeff Tuttle, 08/20/2020
- Section 4: Not collected in the field, digitized according to data in Thomas, Dean, & Hoskins (2010b)
- Section 5: Sarah Klaus and Heidi Fleury, 08/20/2020
- Section 6: Not collected in the field, digitized according to data in Thomas, Dean, & Hoskins (2010b)
- Section 7: Emilie Henry, 08/05/2020
- Section 8: Sarah Klaus and Heidi Fleury, 08/20/2020
- Section 9: Mikaela Richardson, David Sturman, and Lina Sturman, 08/20/2020
- Section 10: Mikaela Richardson and Monica Elser, 08/20/2020

- Section 11: Emilie Henry, 08/05/2020
- Section 12: Abigail Schmeichel, Carolyn Pardini, and Madalena Clough, 08/20/2020
- Section 13: Abigail Schmeichel, 08/20/2020

All of the data collected on 08/20/2020 was collected by volunteers as part of a larger citizen science data collection event in Polson. The day was split into a morning shift from 8:30 AM to 12:00 PM and an afternoon shift from 1:00 PM to 4:30 PM. A total of twelve (12) volunteers assisted in data collection over the course of the day, five (5) of which were part of the morning shift, two (2) of which were part of the afternoon shift, and five (5) of which participated in both. This event was supported by the Lake County Conservation District, the Flathead Lakers, and the Flathead Biological Station along with members of the community dedicated to conservation.

Lakeside

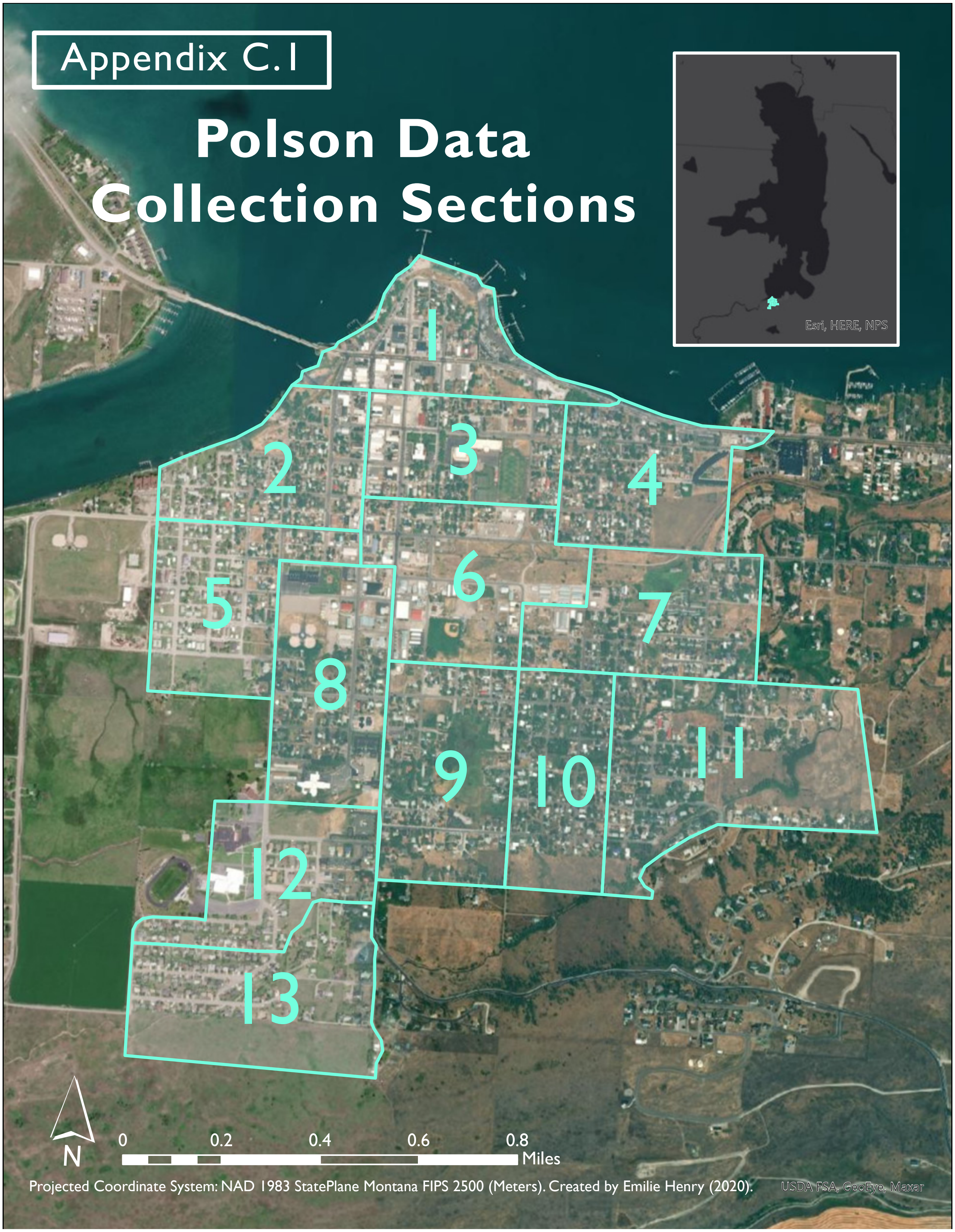
The stormwater data for the Town of Lakeside was collected by different people on different dates according to the data collection section (See Appendix C.2). Those responsible for collecting the data and the dates on which data was collected for each section are as follows:

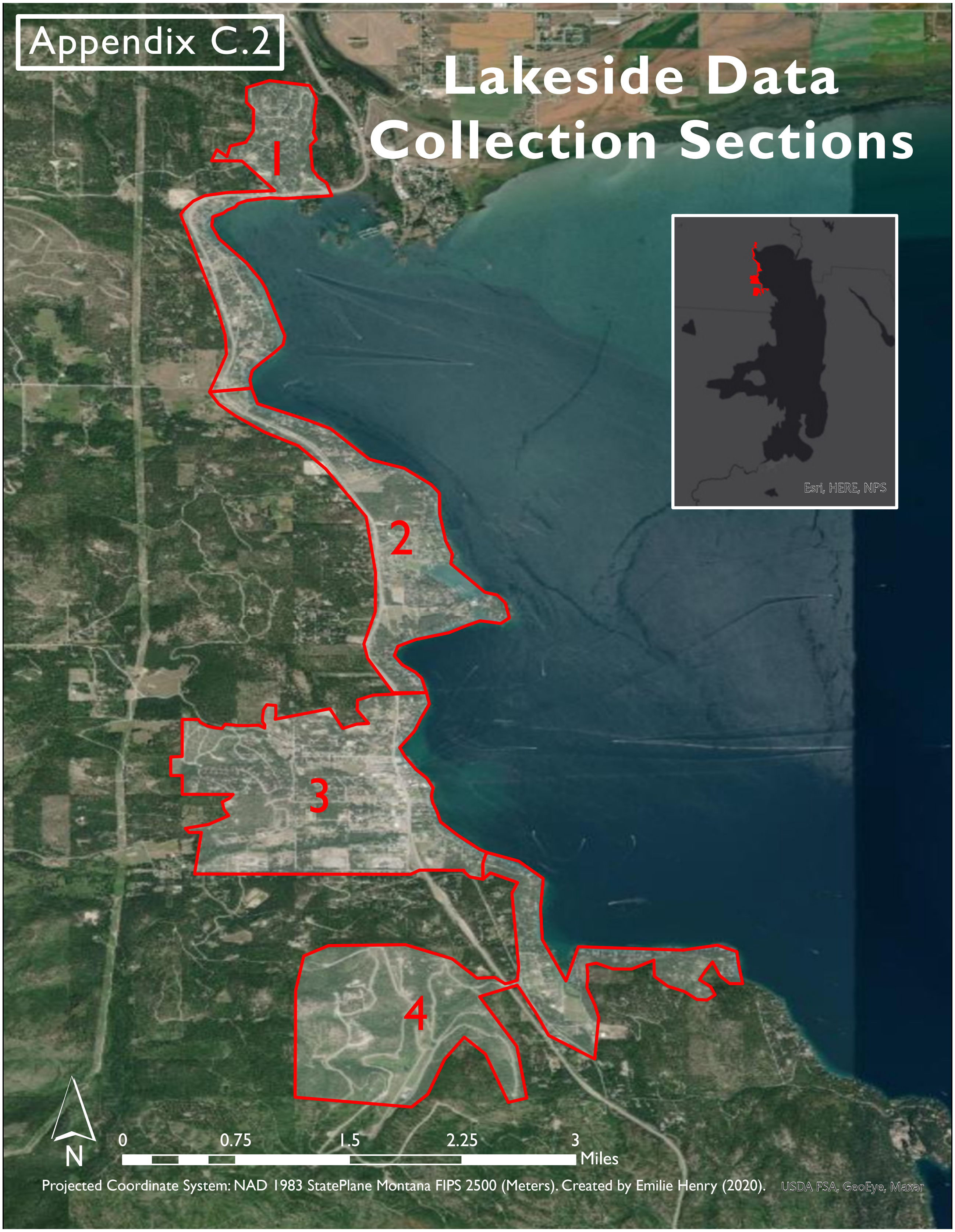
- Section 1: Emilie Henry, 07/21/2020
- Section 2: Emilie Henry, 07/29/2020
- Section 3: Emilie Henry and Mikaela Richardson, 07/31/2020
- Section 4: Emilie Henry, 07/29/2020

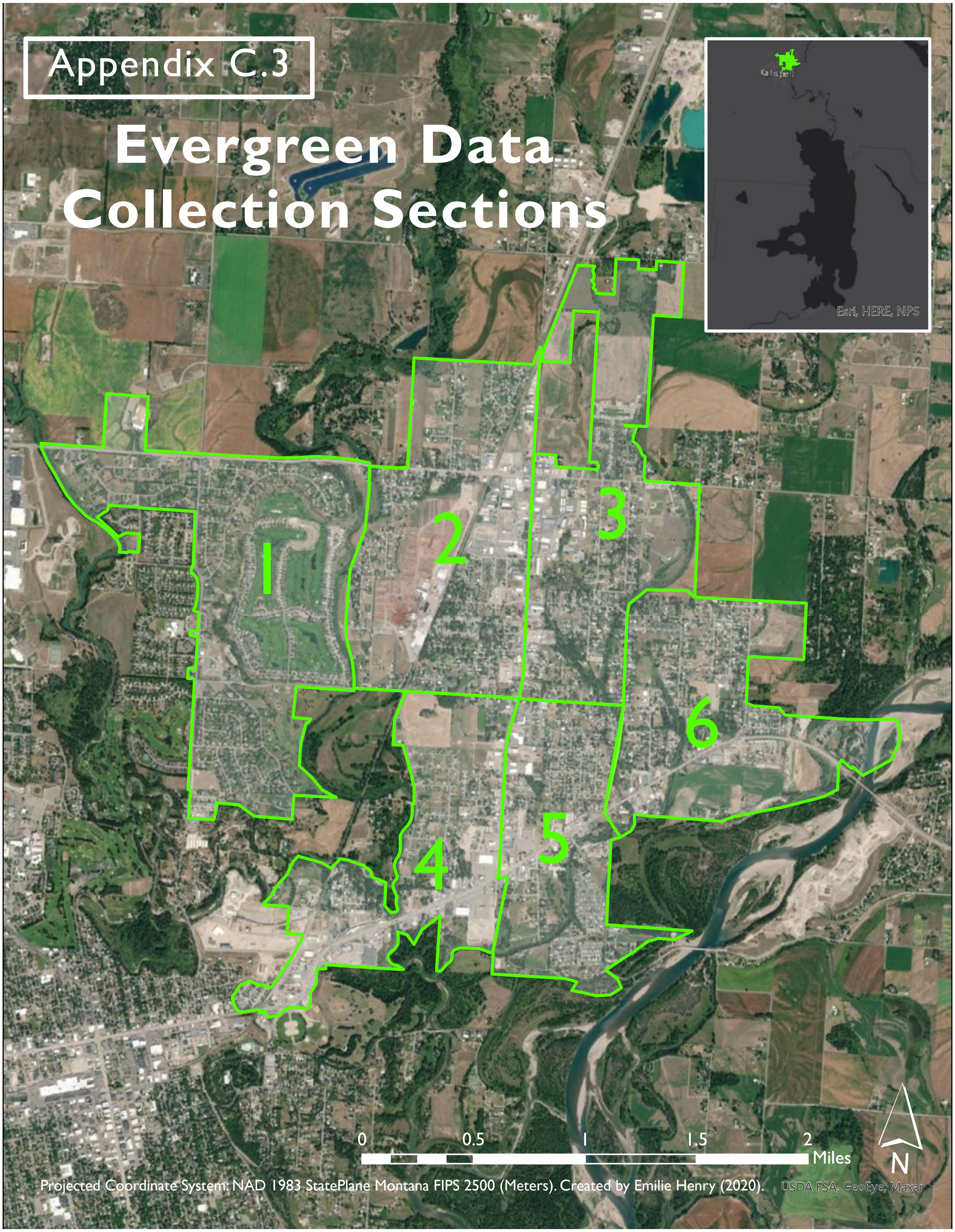
Evergreen

The stormwater data for the Town of Evergreen was collected on different dates according to the data collection section (See Appendix C.3). Those responsible for collecting the data and the dates on which data was collected for each section are as follows:

- Section 1: Emilie Henry, 09/01/2020
- Section 2: Emilie Henry, 09/01/2020
- Section 3: Emilie Henry, 09/03/2020
- Section 4: Emilie Henry, 09/08/2020
- Section 5: Emilie Henry, 09/08/2020
- Section 6: Emilie Henry, 09/08/2020


Appendix C.1
Polson Data Collection Sections
1
2
3
4
5
6
7
8
9
10
11
12
13
Esri, HERE, NPS
N
0
0.2
0.4
0.6
0.8
Miles
Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).
USDA FSA, GeoEye, Maxar


Appendix C.2
Lakeside Data Collection Sections
1
2
3
4
Esri, HERE, NPS
N
0 0.75 1.5 2.25 3 Miles
Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).
USDA FSA, GeoEye, Maxar


Appendix C.3
Evergreen Data Collection Sections
1
2
3
4
5
6
Kalispell
Esri, HERE, NPS
0
0.5
1
1.5
2
Miles
N
Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).
USDA FSA, GeoEye, Maxar

CATCH BASIN #: _____

Type: Curb Inlet / Area Inlet

Grate Size (in): _________

N

W E

S

Condition: Good / Poor

Catch Basin Depth (in): _______

INFLOW PIPES	**#1** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______	**#2** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______
OUTFLOW PIPES	**#1** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______	**#2** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______

NOTES:

CATCH BASIN #: _____

Type: Curb Inlet / Area Inlet

Grate Size (in): _________

N

W E

S

Condition: Good / Poor

Catch Basin Depth (in): _______

INFLOW PIPES	**#1** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______	**#2** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______
OUTFLOW PIPES	**#1** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______	**#2** Diameter (in): ______ Depth (in): ______ Material: PVC / RCP / HDPE / CMP Flow from: ______

NOTES:

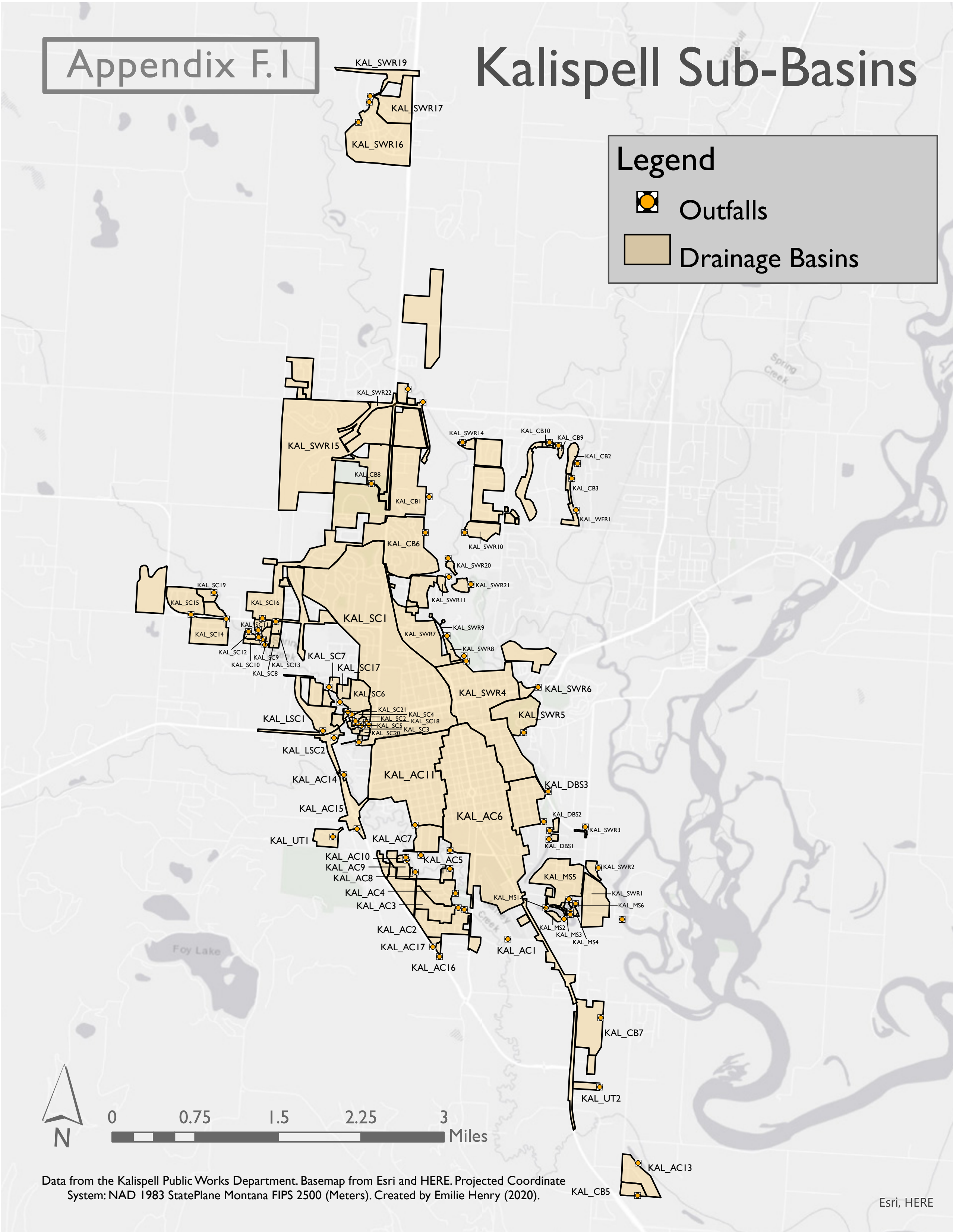
Appendix E: Storm Manhole and Outfall Data Tables

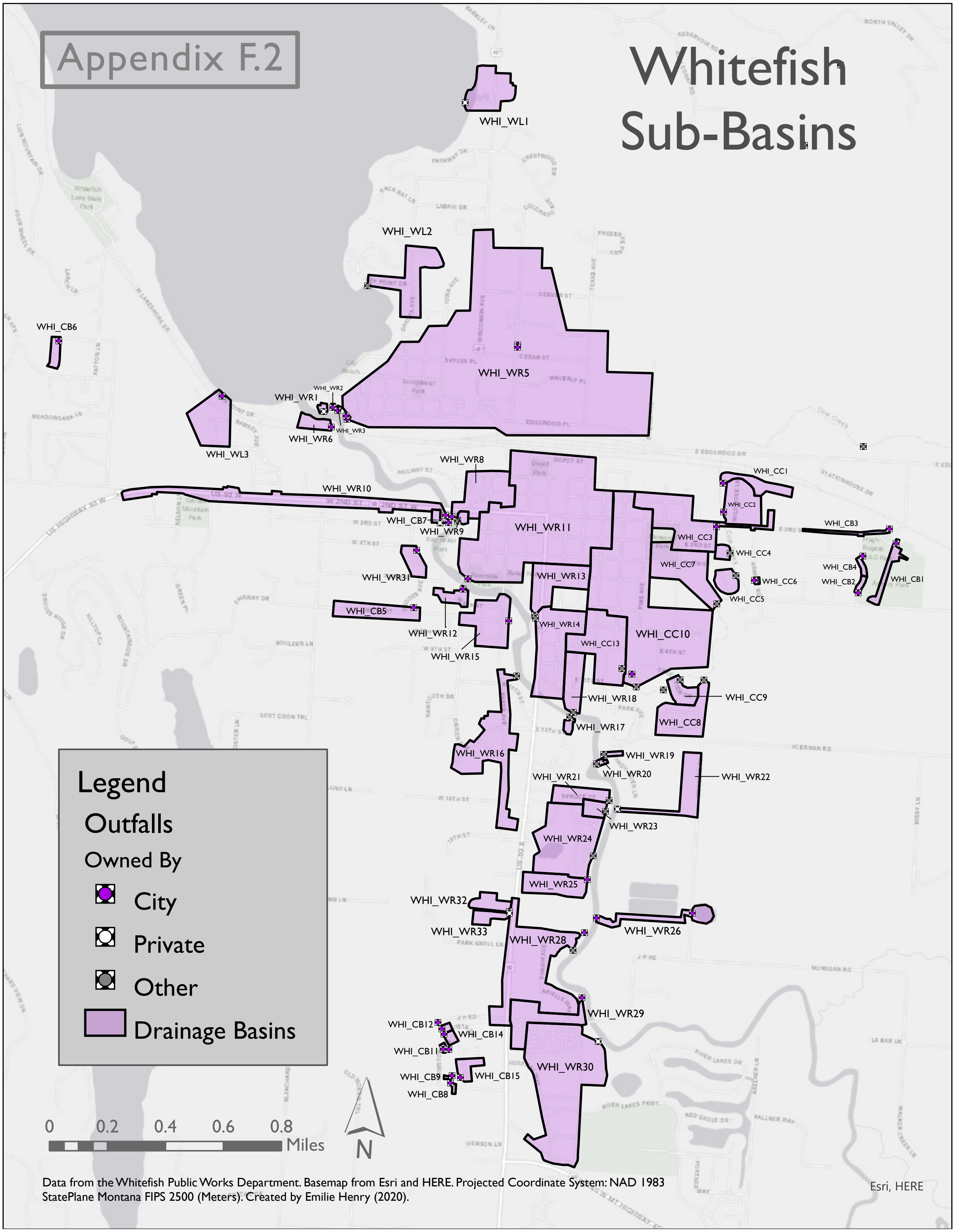
Location: ______________

Section #: _____

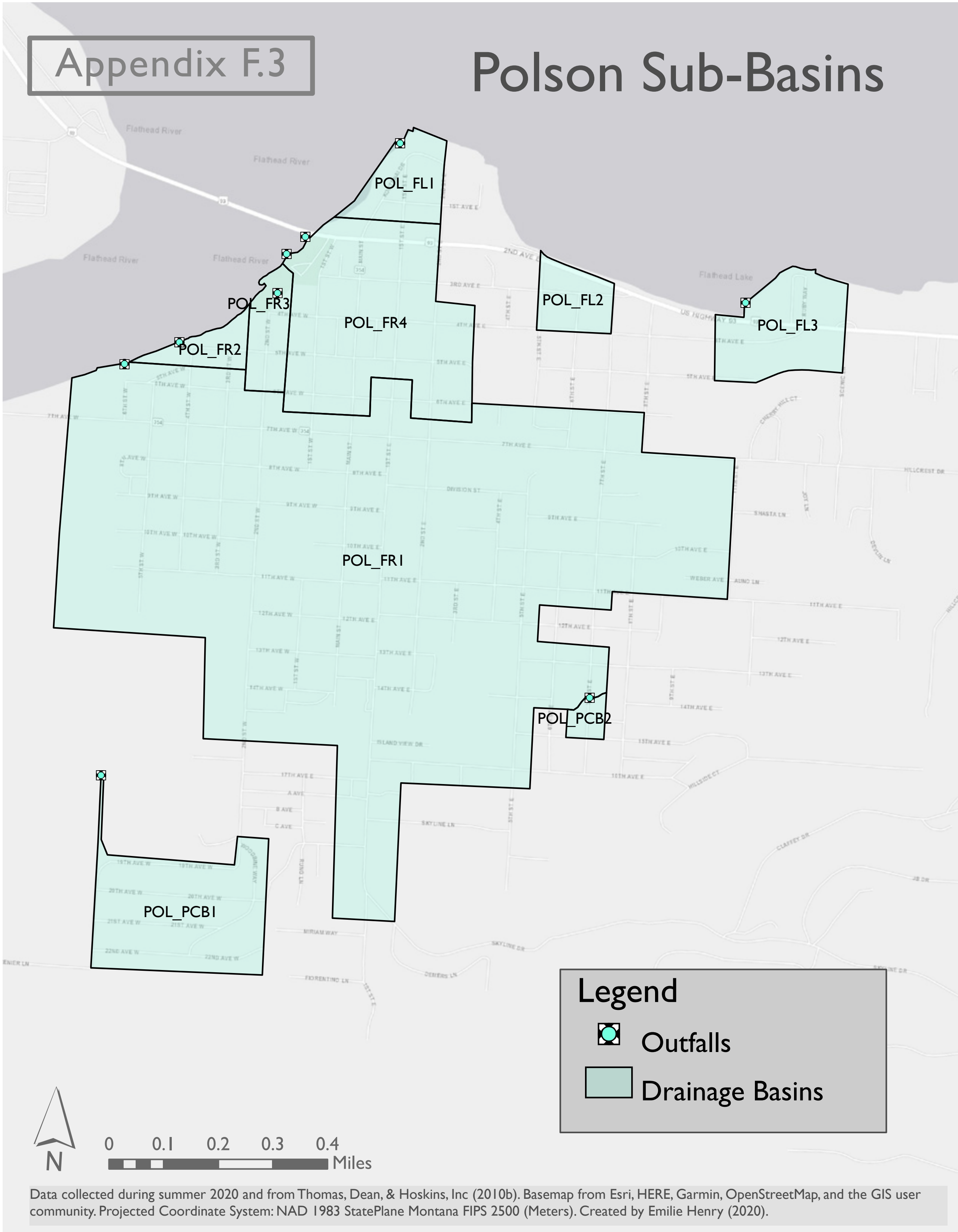
Manhole Data Table		
Manhole #	**What it Says on the Cover**	**Notes**
1	Storm / Storm Sewer / Blank	
2	Storm / Storm Sewer / Blank	
3	Storm / Storm Sewer / Blank	
4	Storm / Storm Sewer / Blank	
5	Storm / Storm Sewer / Blank	
6	Storm / Storm Sewer / Blank	
7	Storm / Storm Sewer / Blank	
8	Storm / Storm Sewer / Blank	
9	Storm / Storm Sewer / Blank	
10	Storm / Storm Sewer / Blank	
11	Storm / Storm Sewer / Blank	
12	Storm / Storm Sewer / Blank	
13	Storm / Storm Sewer / Blank	
14	Storm / Storm Sewer / Blank	
15	Storm / Storm Sewer / Blank	
16	Storm / Storm Sewer / Blank	
17	Storm / Storm Sewer / Blank	
18	Storm / Storm Sewer / Blank	
19	Storm / Storm Sewer / Blank	
20	Storm / Storm Sewer / Blank	

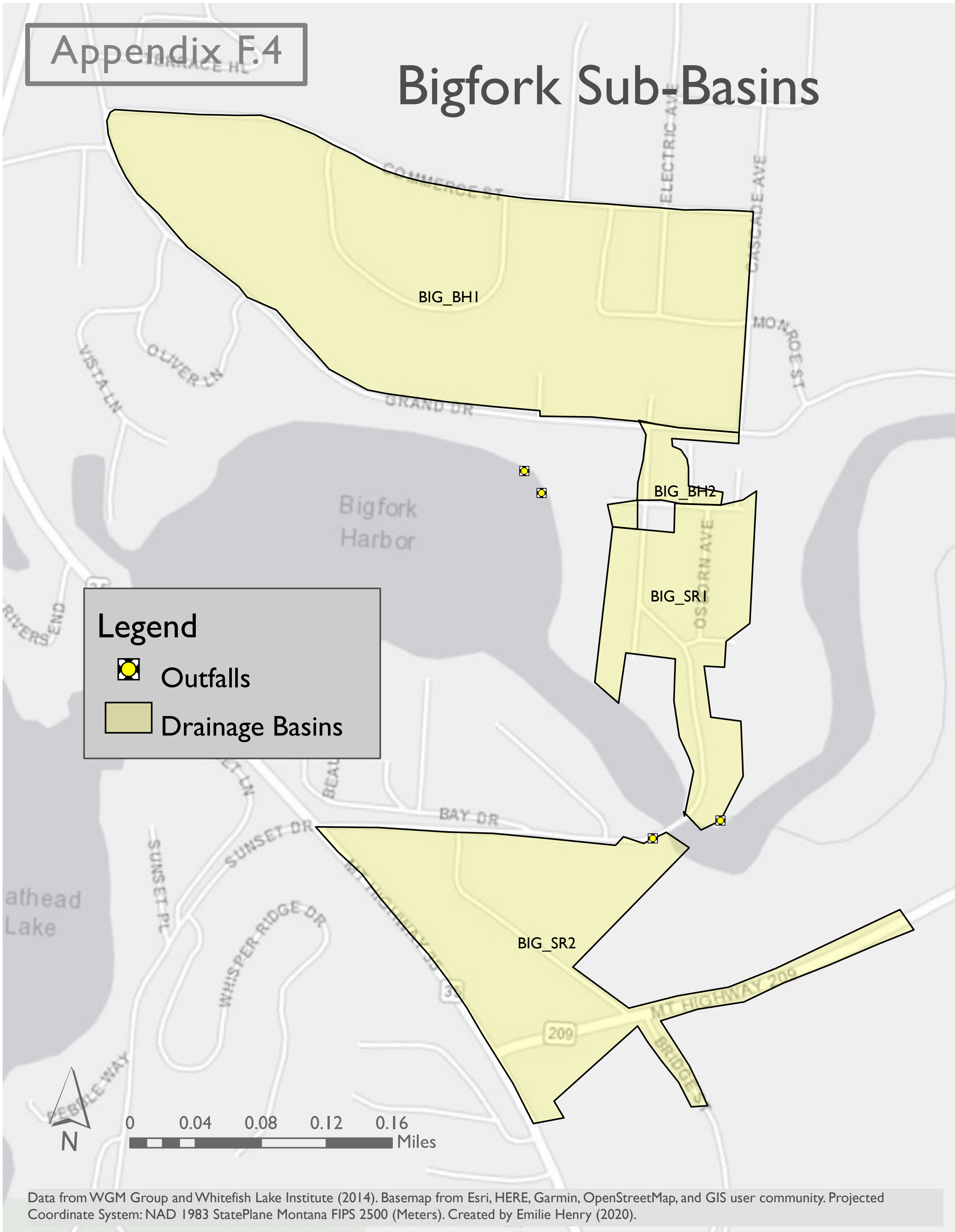
Outfall Data Table				
Outfall #	**Flow To**	**Material**	**Diameter (in)**	**Notes**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

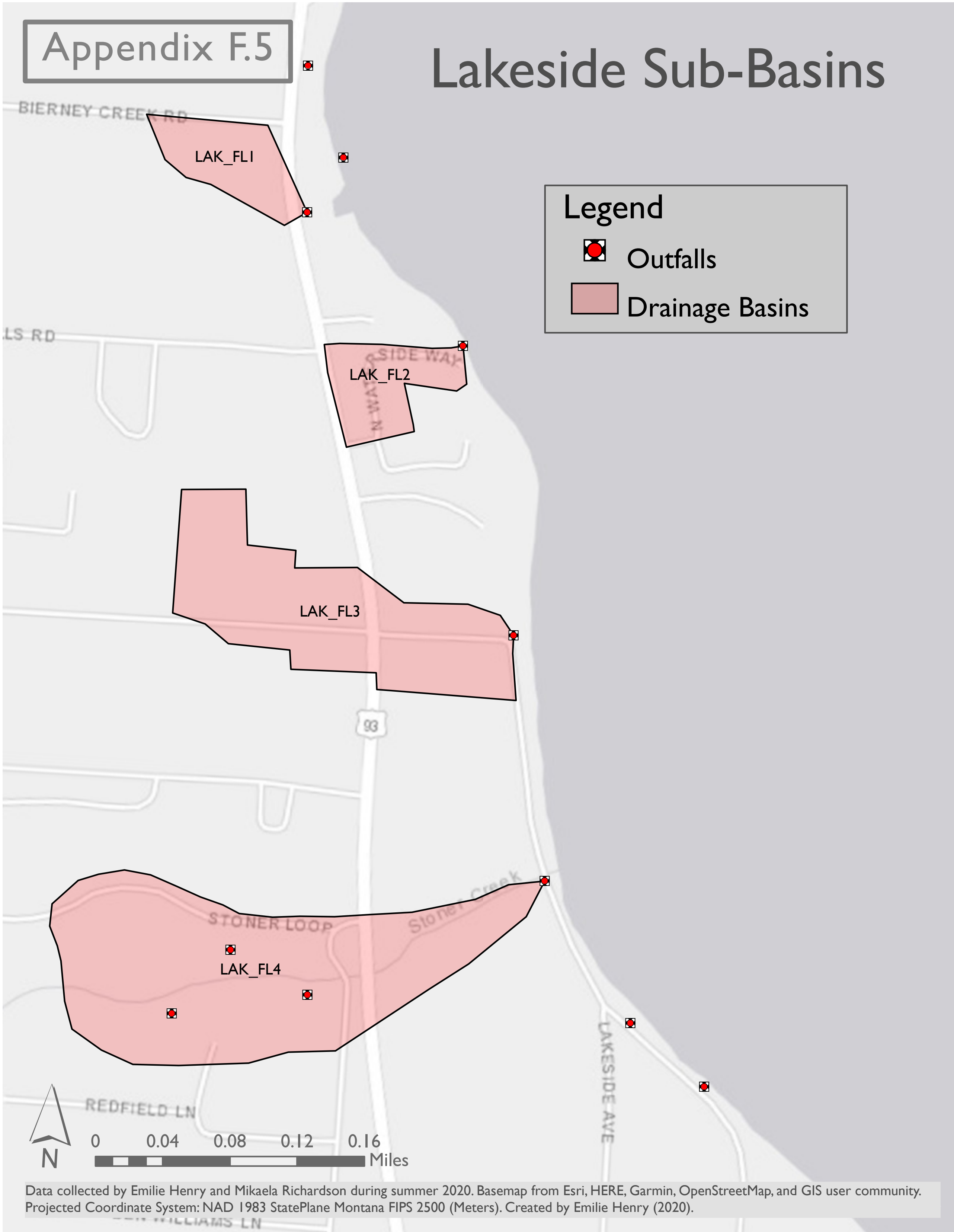

Appendix F.1
Kalispell Sub-Basins
Legend
Outfalls
Drainage Basins
KAL_SWR19
KAL_SWR17
KAL_SWR16
KAL_SWR15
KAL_SWR14
KAL_CB10
KAL_CB9
KAL_CB2
KAL_CB3
KAL_WFR1
KAL_SWR10
KAL_CB8
KAL_CB1
KAL_CB6
KAL_SWR20
KAL_SWR21
KAL_SWR11
KAL_SC19
KAL_SC15
KAL_SC16
KAL_SC14
KAL_SC1
KAL_SWR7
KAL_SWR9
KAL_SWR8
KAL_SC7
KAL_SC17
KAL_SC6
KAL_SWR4
KAL_SWR6
KAL_SWR5
KAL_LSC1
KAL_LSC2
KAL_AC14
KAL_AC11
KAL_DBS3
KAL_AC15
KAL_AC6
KAL_DBS2
KAL_SWR3
KAL_DBS1
KAL_UT1
KAL_AC7
KAL_AC10
KAL_AC9
KAL_AC8
KAL_AC5
KAL_SWR2
KAL_MS5
KAL_SWR1
KAL_MS6
KAL_MS1
KAL_AC4
KAL_AC3
KAL_MS2
KAL_MS3
KAL_MS4
KAL_AC2
KAL_AC17
KAL_AC1
KAL_AC16
KAL_CB7
KAL_UT2
KAL_AC13
KAL_CB5
Foy Lake
Spring Creek
N
0 0.75 1.5 2.25 3 Miles
Data from the Kalispell Public Works Department. Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).
Esri, HERE



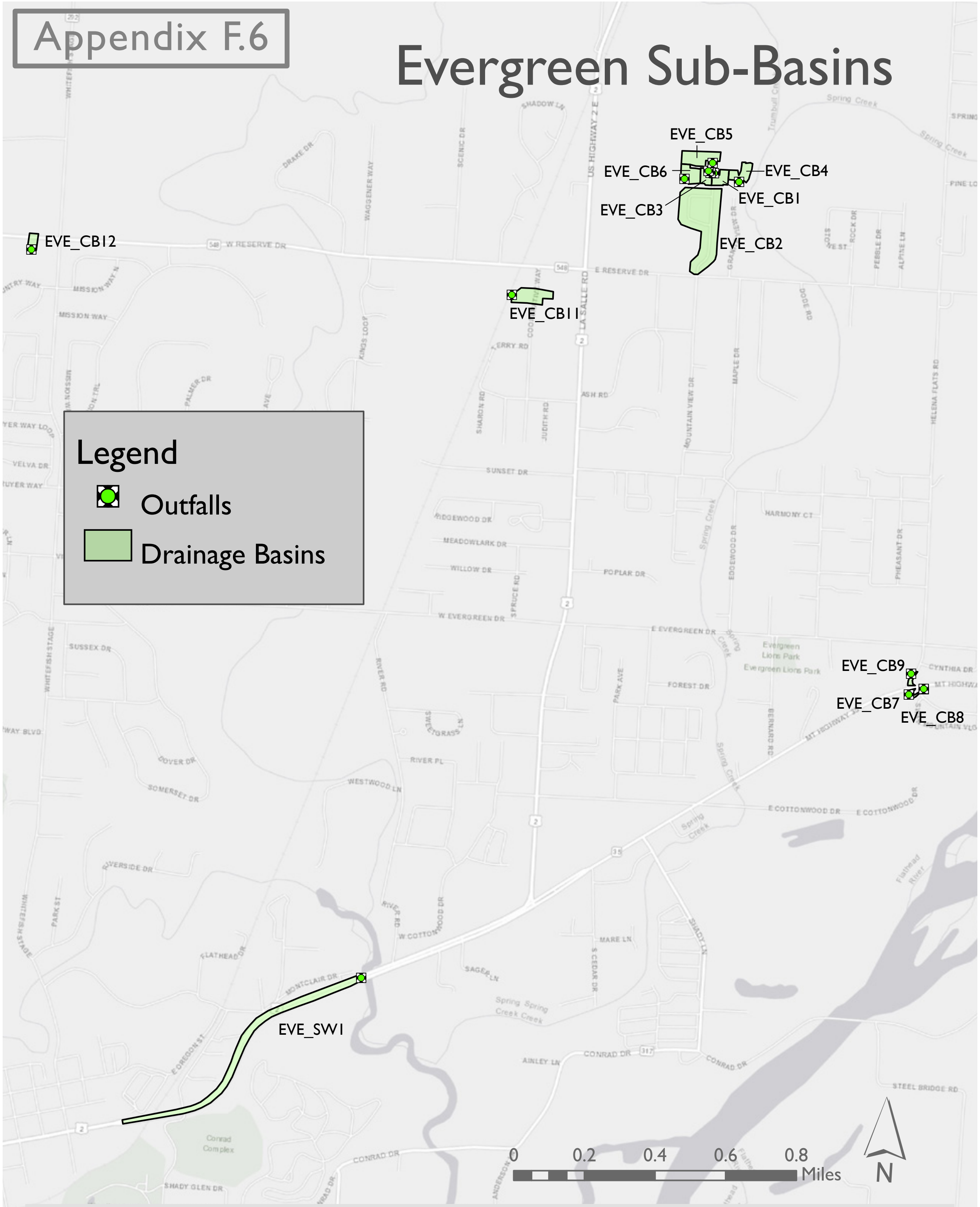
Data from the Whitefish Public Works Department. Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).


Appendix F.3
Polson Sub-Basins
POL_FL1
POL_FL2
POL_FL3
POL_FR1
POL_FR2
POL_FR3
POL_FR4
POL_PCB1
POL_PCB2
Legend
Outfalls
Drainage Basins
N
0 0.1 0.2 0.3 0.4
Miles
Data collected during summer 2020 and from Thomas, Dean, & Hoskins, Inc (2010b). Basemap from Esri, HERE, Garmin, OpenStreetMap, and the GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

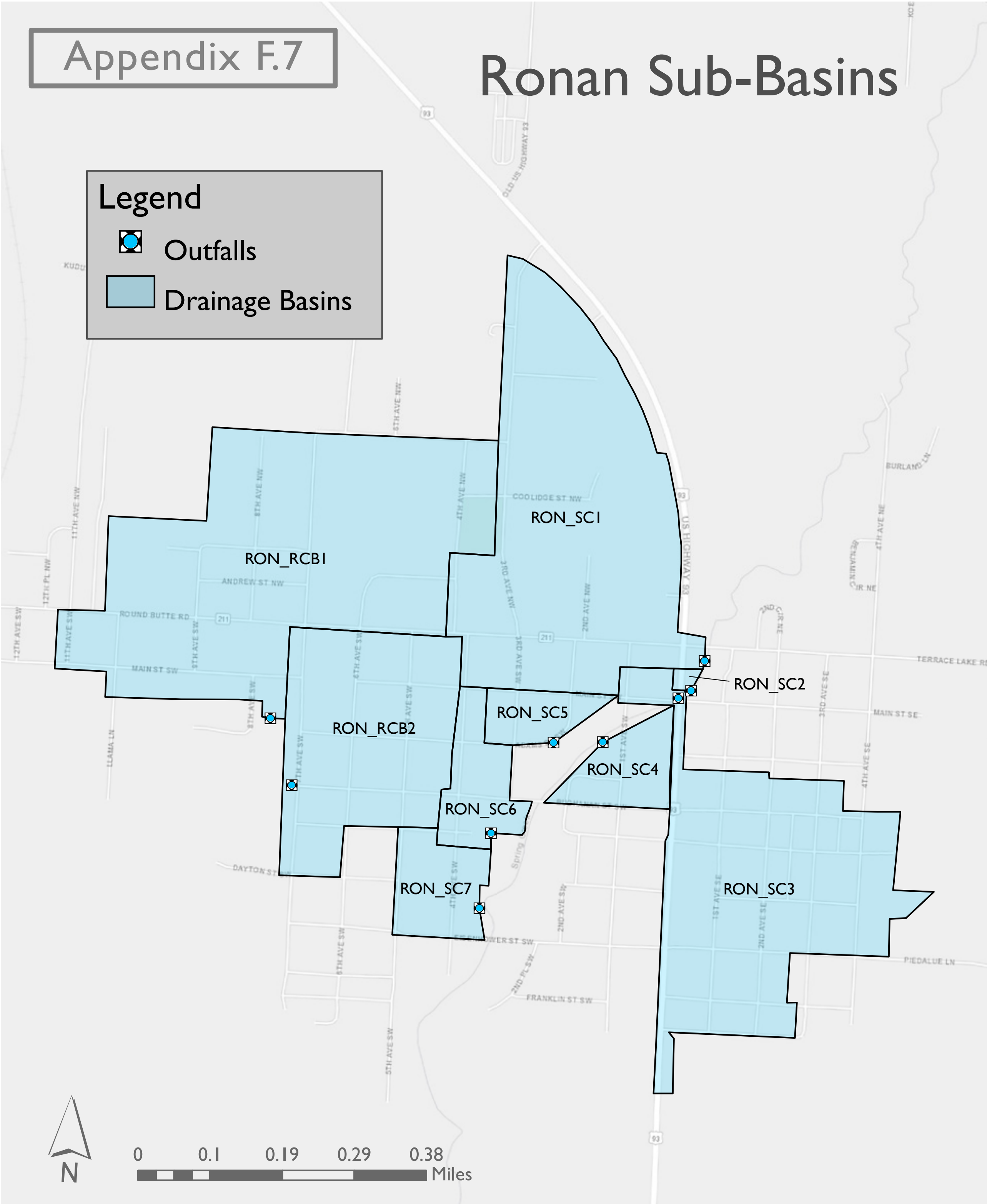

Appendix F.4
Bigfork Sub-Basins
BIG_BH1
BIG_BH2
BIG_SR1
BIG_SR2
Bigfork Harbor
Flathead Lake
Legend
Outfalls
Drainage Basins
COMMERCE ST
ELECTRIC AVE
CASCADE AVE
MONROE ST
GRAND DR
OLIVER LN
VISTA LN
OSBORN AVE
BAY DR
SUNSET DR
SUNSET PL
WHISPER RIDGE DR
MT HIGHWAY 35
MT HIGHWAY 209
BRIDGE ST
PEBBLE WAY
RIVERS END
209
35
N
0 0.04 0.08 0.12 0.16 Miles
Data from WGM Group and Whitefish Lake Institute (2014). Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).



Data collected by Emilie Henry and Mikaela Richardson during summer 2020. Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).



Data collected by Emilie Henry during summer 2020. Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).



Data from Thomas, Dean, & Hoskins, Inc (2010a). Basemap from Esri, HERE, Garmin, OpenStreetMap, and GIS user community. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Appendix F.8

Columbia Falls Sub-Basins

Data from Stanford et al. (1997). Basemap from Esri and HERE. Projected Coordinate System: NAD 1983 StatePlane Montana FIPS 2500 (Meters). Created by Emilie Henry (2020).

Name	Area Ranking: Area (acres)	Area Ranking: Area Ranking	Impairment Ranking: Receiving Waterbody	Impairment Ranking: Impaired Classification	Impairment Ranking: Pollutants of Impairment	Impairment Ranking: Impairment Ranking	Land Use Ranking: Commercial/Industrial	Developed (Open Space)	Railroad	Roads	Mining & Resource Extraction	Agriculture	Harvested Forest	Insect-Killed Forest	Recently Burned	High intensity Residential	Low Intensity Residential	Grassland & Steppe	Open Water	Shrubland	Introduced Vegetation	Wetland/Marsh/Bog, Floodplain, & Riparian	Cliff, Canyon, & Talus	Coniferous & Deciduous Woodland	Alpine Sparse & Barren	Highest Percent Land Use Classification	Land Use Ranking	Total
KAL_SC1	701.64	2	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	24	5	2	40	0	0	0	0	0	5	22	2	0	0	0	0	0	0	0	Roads	2	6
KAL_AC6	545.47	2	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	28	3	0	56	0	0	0	0	0	3	9	1	0	0	0	0	0	0	0	Roads	2	6
KAL_AC11	293.73	2	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	7	2	0	76	0	0	0	0	0	3	13	0	0	0	0	0	0	0	0	Roads	2	6
WHI_WR5	260.04	2	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	5	17	0	36	0	0	0	0	0	8	24	9	0	0	0	0	0	1	0	Roads	2	6
KAL_SC16	118.11	2	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	9	0	48	0	0	0	0	0	5	28	9	0	0	0	0	0	0	0	Roads	2	6
WHI_WR11	103.39	2	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	11	3	71	0	0	0	0	0	0	5	7	2	0	0	0	0	0	0	0	Railroad	2	6
POL_FR1	440.82	2	Flathead River	Not Tested	N/A	1	17	7	0	38	0	0	0	0	0	7	21	6	0	0	0	5	0	0	0	Roads	2	5
KAL_SWR15	403.86	2	Stillwater River	Impaired with One Pollutant	Sediment	1	28	1	0	13	0	33	0	0	0	0	2	24	0	0	0	0	0	0	0	Agriculture	2	5
KAL_SWR4	265.80	2	Stillwater River	Impaired with One Pollutant	Sediment	1	12	1	2	71	0	0	0	0	0	1	12	1	0	0	0	0	0	0	0	Roads	2	5
KAL_SWR16	135.11	2	Stillwater River	Impaired with One Pollutant	Sediment	1	0	37	0	39	0	9	0	0	0	0	3	10	0	0	0	2	0	0	0	Roads	2	5
WHI_WR30	57.47	1	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	24	24	0	44	0	0	0	0	0	6	1	2	0	0	0	0	0	0	0	Roads	2	5
KAL_SC14	51.11	1	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	31	0	45	0	1	0	0	0	0	17	6	0	0	0	0	0	0	0	Roads	2	5
KAL_CB1	212.90	2	Closed Basin	Closed Basin	N/A	0	46	30	0	9	0	3	0	0	0	1	3	8	0	0	0	0	0	0	0	Commercial/Industrial	2	4
KAL_CB6	154.63	2	Closed Basin	Closed Basin	N/A	0	13	10	0	39	0	0	0	0	0	16	19	2	0	0	0	0	0	0	0	Roads	2	4
KAL_SWR7	95.71	1	Stillwater River	Impaired with One Pollutant	Sediment	1	15	28	0	39	0	0	0	0	0	6	9	2	0	0	0	0	0	0	0	Roads	2	4
RON_RCB1	89.12	1	Ronan Canal B	Not Tested	N/A	1	5	4	0	34	0	0	0	0	0	20	23	13	0	0	0	0	0	0	0	Roads	2	4
WHI_CC10	85.83	1	Cow Creek	Not Tested	N/A	1	12	9	0	48	0	0	0	0	0	13	16	2	0	0	0	1	0	1	0	Roads	2	4
KAL_DBS3	77.43	1	Dry Bridge Slough	Not Tested	N/A	1	0	0	0	78	0	0	0	0	0	1	18	2	0	0	0	0	0	0	0	Roads	2	4
KAL_SWR17	71.18	1	Stillwater River	Impaired with One Pollutant	Sediment	1	0	60	0	23	0	0	0	0	0	1	1	14	1	0	0	0	0	0	0	Developed (Open Space)	2	4
POL_FR4	66.67	1	Flathead River	Not Tested	N/A	1	22	4	0	46	0	0	0	0	0	8	17	0	1	0	0	3	0	0	0	Roads	2	4
KAL_SWR5	63.08	1	Stillwater River	Impaired with One Pollutant	Sediment	1	13	32	11	26	0	0	0	0	0	2	1	8	7	0	0	0	0	0	0	Developed (Open Space)	2	4
RON_SC3	60.93	1	Spring Creek	Not Tested	N/A	1	6	4	0	58	0	0	0	0	0	3	24	4	0	0	0	0	0	0	0	Roads	2	4
KAL_LSC1	53.23	1	Little Spring Creek	Not Tested	N/A	1	11	10	0	43	0	6	0	0	0	2	4	23	0	0	0	0	0	0	0	Roads	2	4
KAL_AC2	49.16	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	4	0	45	0	0	0	0	0	10	35	6	0	0	0	0	0	0	0	Roads	2	4
KAL_SC15	44.40	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	7	0	42	0	1	0	0	0	9	27	14	0	0	0	0	0	0	0	Roads	2	4
KAL_AC13	40.30	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	68	0	0	28	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	Commercial/Industrial	2	4
WHI_WR28	39.63	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	36	6	0	33	0	0	0	0	0	15	0	10	0	0	0	0	0	0	0	Commercial/Industrial	2	4
KAL_AC3	36.87	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	1	0	47	0	0	0	0	0	21	32	0	0	0	0	0	0	0	0	Roads	2	4
KAL_SC6	34.64	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	79	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	4
KAL_AC15	33.72	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	2	0	0	51	0	0	0	0	0	0	9	35	0	2	0	1	0	0	0	Roads	2	4
WHI_WR24	29.56	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	33	0	0	34	0	0	0	0	0	0	4	4	9	3	0	7	0	7	0	Roads	2	4
KAL_AC1	27.93	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	33	0	0	58	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	Roads	2	4
WHI_WR16	26.49	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	42	4	0	46	0	0	0	0	0	0	4	3	0	0	0	0	0	1	0	Roads	2	4
WHI_WR10	25.47	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	6	12	0	55	0	0	0	0	0	2	18	8	0	0	0	0	0	0	0	Roads	2	4
WHI_WR14	23.72	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	7	1	0	71	0	0	0	0	0	2	17	2	0	0	0	0	0	0	0	Roads	2	4
KAL_UT1	22.05	0	Unnamed Tributary	Impaired with More Than One Pollutant	DO and Temp	2	0	6	0	50	0	0	0	0	0	17	12	14	0	0	0	0	0	0	0	Roads	2	4
KAL_AC9	17.88	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	5	0	56	0	0	0	0	0	7	30	3	0	0	0	0	0	0	0	Roads	2	4

Appendix G: Outfall Prioritization Ranking Chart

Name	Area Ranking: Area (acres)	Area Ranking	Impairment Ranking: Receiving Waterbody	Impaired Classification	Pollutants of Impairment	Impairment Ranking	Land Use Ranking: Commercial/Industrial	Developed (Open Space)	Railroad	Roads	Mining & Resource Extraction	Agriculture	Harvested Forest	Insect-Killed Forest	Recently Burned	High intensity Residential	Low Intensity Residential	Grassland & Steppe	Open Water	Shrubland	Introduced Vegetation	Wetland/Marsh/Bog, Floodplain, & Riparian	Cliff, Canyon, & Talus	Coniferous & Deciduous Woodland	Alpine Sparse & Barren	Highest Percent Land Use Classification	Land Use Ranking	Total
WHI_WR8	15.18	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	10	0	0	78	0	0	0	0	0	4	4	4	0	0	0	0	0	0	0	Roads	2	4
WHI_WR15	13.94	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	3	0	0	56	0	0	0	0	0	2	29	5	0	0	0	5	0	0	0	Roads	2	4
WHI_WR13	13.71	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	3	0	0	85	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	Roads	2	4
POL_FL1	13.69	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	3	1	0	44	0	0	0	0	0	0	17	4	16	0	0	12	0	3	0	Roads	2	4
LAK_FL4	13.63	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	22	26	0	26	0	0	0	0	0	3	17	6	0	0	0	0	0	0	0	Developed (Open Space)	2	4
WHI_WL3	13.57	0	Whitefish Lake	Impaired with More than One Pollutant	Mercury and PCBs	2	0	19	10	33	0	0	0	0	0	10	25	0	0	0	0	0	0	2	0	Roads	2	4
WHI_WR29	11.95	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	47	7	0	37	0	0	0	0	0	4	3	0	0	0	0	1	0	0	0	Commercial/Industrial	2	4
KAL_SC17	11.14	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	22	32	0	21	0	0	0	0	0	10	14	0	0	0	0	0	0	0	0	Developed (Open Space)	2	4
WHI_WR22	10.51	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	1	0	19	0	52	0	0	0	0	4	16	0	0	0	4	0	6	0	Agriculture	2	4
POL_FL2	10.15	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	9	0	0	62	0	0	0	0	0	2	26	0	0	0	0	0	0	0	0	Roads	2	4
KAL_SC11	9.13	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	0	0	65	0	0	0	0	0	8	17	10	0	0	0	0	0	0	0	Roads	2	4
WHI_WR18	8.14	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	62	0	0	0	0	0	2	36	0	0	0	0	0	0	0	0	Roads	2	4
LAK_FL3	8.03	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	15	0	0	39	0	0	0	0	0	33	10	0	4	0	0	0	0	0	0	Roads	2	4
KAL_SC8	7.16	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	52	0	26	0	0	0	0	0	0	19	3	0	0	0	0	0	0	0	Developed (Open Space)	2	4
WHI_WR26	7.10	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	41	0	5	0	16	0	0	0	0	0	0	21	0	0	0	0	17	0	Developed (Open Space)	2	4
KAL_SC13	6.65	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	24	0	41	0	0	0	0	0	0	30	5	0	0	0	0	0	0	0	Roads	2	4
KAL_SC9	6.32	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	0	0	53	0	0	0	0	0	0	1	45	0	0	0	0	0	0	0	Roads	2	4
KAL_SC10	4.75	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	41	0	53	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	Roads	2	4
KAL_SC2	4.27	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	79	0	0	8	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	Commercial/Industrial	2	4
KAL_SC4	4.18	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	78	0	0	17	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	Commercial/Industrial	2	4
KAL_AC17	4.08	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	99	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Developed (Open Space)	2	4
WHI_WR32	4.08	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	97	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	Commercial/Industrial	2	4
WHI_WR31	4.03	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	7	0	52	0	0	0	0	0	11	30	0	0	0	0	0	0	0	0	Roads	2	4
KAL_SC12	3.63	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	38	0	51	0	0	0	0	0	6	4	1	0	0	0	0	0	0	0	Roads	2	4
WHI_WR12	3.26	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	7	0	59	0	0	0	0	0	7	23	1	0	0	0	4	0	0	0	Roads	2	4
KAL_SC18	3.22	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	4
WHI_WR33	2.85	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	65	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	7	0	Commercial/Industrial	2	4
WHI_WR23	2.83	0	Whitefish River	Impaired with More Than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	67	0	0	0	0	0	0	27	1	0	0	0	0	0	5	0	Roads	2	4
KAL_AC10	2.74	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	0	0	41	0	0	0	0	0	16	32	11	0	0	0	0	0	0	0	Roads	2	4
KAL_AC16	2.60	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	7	85	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	Developed (Open Space)	2	4
KAL_SC21	2.19	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	90	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	4
LAK_FL2	2.16	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	0	0	0	77	0	0	0	0	0	10	0	0	13	0	0	0	0	0	0	Roads	2	4
LAK_FL1	2.14	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	57	0	0	11	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	Commercial/Industrial	2	4
WHI_WR17	0.96	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	20	2	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Roads	2	4
WHI_WR9	0.93	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	43	0	32	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	Developed (Open Space)	2	4
WHI_WR19	0.62	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	17	0	31	0	0	0	0	0	0	24	0	0	28	0	0	0	0	0	Roads	2	4
KAL_MS5	82.36	1	Muscrat Slough	Not Tested	N/A	1	0	7	0	35	0	0	0	0	0	10	47	1	0	0	0	0	0	0	0	Low Intensity Residential	1	3

Appendix G: Outfall Prioritization Ranking Chart

Name	Area Ranking		Impairment Ranking				Land Use Ranking																					Total
	Area (acres)	Area Ranking	Receiving Waterbody	Impaired Classification	Pollutants of Impairment	Impairment Ranking	Commercial/Industrial	Developed (Open Space)	Railroad	Roads	Mining & Resource Extraction	Agriculture	Harvested Forest	Insect-Killed Forest	Recently Burned	High intensity Residential	Low Intensity Residential	Grassland & Steppe	Open Water	Shrubland	Introduced Vegetation	Wetland/Marsh/Bog, Floodplain, & Riparian	Cliff, Canyon, & Talus	Coniferous & Deciduous Woodland	Alpine Sparse & Barren	Highest Percent Land Use Classification	Land Use Ranking	
RON_SC1	76.67	1	Spring Creek	Not Tested	N/A	1	25	8	0	22	0	0	0	0	0	27	3	13	0	0	0	1	0	0	0	High Intensity Residential	1	3
KAL_SWR1	60.03	1	Stillwater River	Impaired with One Pollutant	Sediment	1	20	16	0	28	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
KAL_CB8	55.50	1	Closed Basin	Closed Basin	N/A	0	62	1	0	8	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	Commercial/Industrial	2	3
KAL_SWR22	43.19	0	Stillwater River	Impaired with One Pollutant	Sediment	1	4	11	0	44	0	40	0	0	0	0	0	0	0	0	0	1	0	0	0	Roads	2	3
RON_RCB2	39.82	0	Ronan Canal B	Not Tested	N/A	1	22	1	0	53	0	0	0	0	0	1	20	4	0	0	0	0	0	0	0	Roads	2	3
KAL_AC4	37.96	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	0	0	49	0	0	0	0	0	1	50	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
KAL_SWR19	36.95	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	47	0	40	0	4	0	0	0	0	0	8	0	0	0	0	0	0	0	Developed (Open Space)	2	3
KAL_AC7	35.89	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	4	0	37	0	0	0	0	0	8	50	1	0	0	0	0	0	0	0	Low Intensity Residential	1	3
BIG_BH1	29.51	0	Bigfork Harbor	Not Tested	N/A	1	31	0	0	31	0	0	0	0	0	13	22	3	0	0	0	0	0	1	0	Commercial/Industrial	2	3
KAL_LSC2	25.45	0	Little Spring Creek	Not Tested	N/A	1	26	23	2	43	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	Roads	2	3
POL_FL3	24.73	0	Flathead Lake	Impaired with More Than One Pollutant	TN and TP	2	12	2	0	27	0	0	0	0	0	50	2	1	6	0	0	0	0	0	0	High Intensity Residential	1	3
WHI_CC3	23.40	0	Cow Creek	Not Tested	N/A	1	0	9	0	58	0	0	0	0	0	1	29	1	0	0	0	0	0	2	0	Roads	2	3
WHI_CC13	22.54	0	Cow Creek	Not Tested	N/A	1	0	1	0	57	0	0	0	0	0	4	30	0	0	2	0	2	0	3	0	Roads	2	3
WHI_CC7	18.15	0	Cow Creek	Not Tested	N/A	1	21	45	0	17	0	0	0	0	0	0	12	5	0	0	0	0	0	0	0	Developed (Open Space)	2	3
WHI_WL2	15.64	0	Whitefish Lake	Impaired with More than One Pollutant	Mercury and PCBs	2	0	7	0	45	0	0	0	0	0	0	47	0	0	0	0	0	0	1	0	Low Intensity Residential	1	3
BIG_SR2	13.83	0	Swan River	Not Tested	N/A	1	12	16	0	57	0	0	0	0	0	2	5	0	0	0	0	1	0	6	0	Roads	2	3
WHI_WL1	12.48	0	Whitefish Lake	Impaired with More than One Pollutant	Mercury and PCBs	2	24	0	0	14	0	0	0	0	0	52	6	2	0	0	0	1	0	0	0	High Intensity Residential	1	3
KAL_SC19	10.14	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	0	0	0	19	0	0	0	0	0	3	41	36	0	0	0	1	0	0	0	Low Intensity Residential	1	3
EVE_SW1	10.09	0	Stillwater River	Impaired with One Pollutant	Sediment	1	3	0	3	87	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	Roads	2	3
POL_FR3	9.97	0	Flathead River	Not Tested	N/A	1	0	31	0	37	0	0	0	0	0	0	27	0	4	0	0	2	0	0	0	Roads	2	3
RON_SC6	9.81	0	Spring Creek	Not Tested	N/A	1	0	3	0	56	0	0	0	0	0	0	29	11	0	0	0	0	0	0	0	Roads	2	3
KAL_UT2	9.61	0	Unnamed Tributary	Not Tested	N/A	1	93	2	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	Commercial/Industrial	2	3
KAL_WFR1	8.68	0	Whitefish River	Impaired with One Pollutant	Sediment	1	1	12	0	57	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SWR2	8.49	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	35	0	56	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	Roads	2	3
RON_SC4	8.39	0	Spring Creek	Not Tested	N/A	1	42	0	0	28	0	0	0	0	0	11	12	8	0	0	0	0	0	0	0	Commercial/Industrial	2	3
KAL_AC5	8.16	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	3	0	43	0	0	0	0	0	3	47	4	0	0	0	0	0	0	0	Low Intensity Residential	1	3
KAL_SWR6	8.12	0	Stillwater River	Impaired with One Pollutant	Sediment	1	33	0	18	21	0	0	0	0	0	22	0	7	0	0	0	0	0	0	0	Commercial/Industrial	2	3
KAL_SWR8	8.03	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	4	0	58	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	Roads	2	3
POL_FR2	7.16	0	Flathead River	Not Tested	N/A	1	0	24	0	29	0	0	0	0	0	3	25	0	16	0	0	2	0	0	0	Roads	2	3
BIG_SR1	6.85	0	Swan River	Not Tested	N/A	1	25	0	0	61	0	0	0	0	0	5	5	0	0	0	0	0	0	4	0	Roads	2	3
KAL_MS2	6.78	0	Muscrat Slough	Not Tested	N/A	1	0	11	0	54	0	0	0	0	0	3	27	0	4	0	0	0	0	0	0	Roads	2	3
KAL_SC7	6.45	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	16	0	0	33	0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	High Intensity Residential	1	3
WHI_WR21	6.44	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	13	0	39	0	0	0	0	0	40	4	0	0	0	0	3	0	0	0	High Intensity Residential	1	3
KAL_SWR11	6.18	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	0	0	76	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SWR14	6.03	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	2	0	67	0	0	0	0	0	0	29	0	0	0	0	1	0	0	0	Roads	2	3
RON_SC5	5.94	0	Spring Creek	Not Tested	N/A	1	16	0	0	72	0	0	0	0	0	8	4	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SC20	4.66	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	8	0	0	10	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	High Intensity Residential	1	3

	Area Ranking		Impairment Ranking				Land Use Ranking																					
Name	Area (acres)	Area Ranking	Receiving Waterbody	Impaired Classification	Pollutants of Impairment	Impairment Ranking	Commercial/Industrial	Developed (Open Space)	Railroad	Roads	Mining & Resource Extraction	Agriculture	Harvested Forest	Insect-Killed Forest	Recently Burned	High intensity Residential	Low Intensity Residential	Grassland & Steppe	Open Water	Shrubland	Introduced Vegetation	Wetland/Marsh/Bog, Floodplain, & Riparian	Cliff, Canyon, & Talus	Coniferous & Deciduous Woodland	Alpine Sparse & Barren	Highest Percent Land Use Classification	Land Use Ranking	Total
WHI_CC9	4.39	0	Cow Creek	Not Tested	N/A	1	0	18	0	48	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	Roads	2	3
KAL_DBS2	4.03	0	Dry Bridge Slough	Not Tested	N/A	1	0	4	0	81	0	0	0	0	0	1	14	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SC3	3.44	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	3	0	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	0	High Intensity Residential	1	3
KAL_SC5	3.15	0	Spring Creek	Impaired with More Than One Pollutant	TN, TP, Sed, and DO	2	38	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	0	High Intensity Residential	1	3
POL_PCB2	3.06	0	Polson Canal B	Not Tested	N/A	1	0	5	0	50	0	0	0	0	0	0	34	0	0	0	0	11	0	0	0	Roads	2	3
KAL_AC8	3.05	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	14	0	23	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
WHI_WR6	2.95	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	12	32	0	0	0	0	0	11	38	5	0	0	0	3	0	0	0	Low Intensity Residential	1	3
KAL_DBS1	2.56	0	Dry Bridge Slough	Not Tested	N/A	1	0	0	0	49	0	0	0	0	0	0	48	0	3	0	0	0	0	0	0	Roads	2	3
KAL_MS4	2.32	0	Muscrat Slough	Not Tested	N/A	1	0	0	0	82	0	0	0	0	0	17	1	0	0	0	0	0	0	0	0	Roads	2	3
KAL_MS3	2.17	0	Muscrat Slough	Not Tested	N/A	1	0	0	0	82	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SWR3	1.38	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	0	0	95	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	Roads	2	3
KAL_SWR9	1.37	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	75	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	3
BIG_BH2	1.23	0	Bigfork Harbor	Not Tested	N/A	1	18	0	0	81	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Roads	2	3
WHI_WR1	0.60	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	6	0	0	0	0	0	19	56	0	0	0	0	19	0	0	0	Low Intensity Residential	1	3
RON_SC2	0.57	0	Spring Creek	Not Tested	N/A	1	56	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	3
WHI_WR20	0.44	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
WHI_CC6	0.25	0	Cow Creek	Not Tested	N/A	1	0	0	0	79	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	Roads	2	3
WHI_WR3	0.14	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
WHI_WR2	0.11	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	Low Intensity Residential	1	3
POL_PCB1	43.18	0	Polson Canal B	Not Tested	N/A	1	0	2	0	45	0	0	0	0	0	2	48	2	0	1	0	0	0	0	0	Low Intensity Residential	1	2
KAL_SWR10	25.67	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	3	0	36	0	0	0	0	0	0	48	7	0	0	0	6	0	0	0	Low Intensity Residential	1	2
KAL_CB5	15.36	0	Closed Basin	Closed Basin	N/A	0	84	0	0	10	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0	Commercial/Industrial	2	2
COL_CB1	13.44	0	Closed Basin	Closed Basin	N/A	0	3	0	0	88	0	0	0	0	0	1	2	4	0	0	0	3	0	0	0	Roads	2	2
WHI_CC8	13.15	0	Cow Creek	Not Tested	N/A	1	0	7	0	44	0	4	0	0	0	0	44	1	0	0	0	0	0	0	0	Low Intensity Residential	1	2
KAL_CB2	11.80	0	Closed Basin	Closed Basin	N/A	0	1	38	0	40	0	0	0	0	0	19	2	0	0	0	0	0	0	0	0	Roads	2	2
WHI_CC2	11.11	0	Cow Creek	Not Tested	N/A	1	0	20	0	16	0	16	0	0	0	0	45	0	0	0	0	0	0	3	0	Low Intensity Residential	1	2
RON_SC7	9.91	0	Spring Creek	Not Tested	N/A	1	0	4	0	35	0	0	0	0	0	2	47	12	0	0	0	0	0	0	0	Low Intensity Residential	1	2
WHI_WR25	9.87	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	1	0	0	1	0	0	0	0	0	0	10	44	0	5	0	11	0	29	0	Grassland & Steppe	0	2
WHI_CB5	9.39	0	Closed Basin	Closed Basin	N/A	0	0	20	0	41	0	0	0	0	0	3	32	5	0	0	0	0	0	1	0	Roads	2	2
KAL_CB3	5.54	0	Whitefish River	Closed Basin	N/A	0	0	8	0	54	0	0	0	0	0	26	12	0	0	0	0	0	0	0	0	Roads	2	2
KAL_CB9	4.21	0	Closed Basin	Closed Basin	N/A	0	5	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
WHI_CC5	3.69	0	Cow Creek	Not Tested	N/A	1	0	0	0	19	0	0	0	0	0	0	70	10	0	0	0	0	0	0	0	Low Intensity Residential	1	2
WHI_CB1	3.48	0	Closed Basin	Closed Basin	N/A	0	0	81	0	3	0	0	0	0	0	0	5	11	0	0	0	0	0	0	0	Developed (Open Space)	2	2
KAL_MS1	3.01	0	Muscrat Slough	Not Tested	N/A	1	29	0	0	11	0	0	0	0	0	48	3	9	0	0	0	0	0	0	0	High Intensity Residential	1	2
WHI_CB15	3.00	0	Closed Basin	Closed Basin	N/A	0	2	30	0	52	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	Roads	2	2
EVE_CB11	2.63	0	Closed Basin	Closed Basin	N/A	0	78	0	2	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	2
EVE_CB5	2.41	0	Closed Basin	Closed Basin	N/A	0	0	0	0	0	0	90	0	0	0	0	10	0	0	0	0	0	0	0	0	Agriculture	2	2

	Area Ranking		Impairment Ranking				Land Use Ranking																					
Name	Area (acres)	Area Ranking	Receiving Waterbody	Impaired Classification	Pollutants of Impairment	Impairment Ranking	Commercial/Industrial	Developed (Open Space)	Railroad	Roads	Mining & Resource Extraction	Agriculture	Harvested Forest	Insect-Killed Forest	Recently Burned	High intensity Residential	Low Intensity Residential	Grassland & Steppe	Open Water	Shrubland	Introduced Vegetation	Wetland/Marsh/Bog, Floodplain, & Riparian	Cliff, Canyon, & Talus	Coniferous & Deciduous Woodland	Alpine Sparse & Barren	Highest Percent Land Use Classification	Land Use Ranking	Total
WHI_CB3	1.81	0	Closed Basin	Closed Basin	N/A	0	0	0	0	96	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	Roads	2	2
KAL_CB10	1.75	0	Closed Basin	Closed Basin	N/A	0	5	29	0	43	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	Roads	2	2
WHI_CC4	1.57	0	Cow Creek	Not Tested	N/A	1	0	13	0	22	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	Low Intensity Residential	1	2
EVE_CB4	1.44	0	Closed Basin	Closed Basin	N/A	0	0	0	0	0	0	74	0	0	0	0	26	0	0	0	0	0	0	0	0	Agriculture	2	2
EVE_CB1	1.09	0	Closed Basin	Closed Basin	N/A	0	0	0	0	0	0	68	0	0	0	0	32	0	0	0	0	0	0	0	0	Agriculture	2	2
KAL_MS6	1.07	0	Muscrat Slough	Not Tested	N/A	1	0	0	0	32	0	0	0	0	0	67	0	0	0	0	0	0	0	0	0	High Intensity Residential	1	2
WHI_CB14	1.04	0	Closed Basin	Closed Basin	N/A	0	0	28	0	61	0	0	0	0	0	0	1	11	0	0	0	0	0	0	0	Roads	2	2
WHI_CB4	0.85	0	Closed Basin	Closed Basin	N/A	0	0	69	0	3	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
KAL_AC14	0.82	0	Ashley Creek	Impaired with More Than One Pollutant	TN, TP, Sed, DO, and Temp	2	0	0	0	36	0	0	0	0	0	0	0	64	0	0	0	0	0	0	0	Grassland & Steppe	0	2
WHI_CB2	0.77	0	Closed Basin	Closed Basin	N/A	0	0	50	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	8	0	Developed (Open Space)	2	2
EVE_CB12	0.76	0	Closed Basin	Closed Basin	N/A	0	67	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Commercial/Industrial	2	2
WHI_CB12	0.66	0	Closed Basin	Closed Basin	N/A	0	0	38	0	54	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	Roads	2	2
EVE_CB9	0.37	0	Closed Basin	Closed Basin	N/A	0	0	0	0	95	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	Roads	2	2
WHI_CB8	0.31	0	Closed Basin	Closed Basin	N/A	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
WHI_CB9	0.23	0	Closed Basin	Closed Basin	N/A	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
WHI_CB11	0.19	0	Closed Basin	Closed Basin	N/A	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
EVE_CB8	0.18	0	Closed Basin	Closed Basin	N/A	0	39	0	0	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Roads	2	2
WHI_WR4	0.11	0	Whitefish River	Impaired with More than One Pollutant	Oil & Grease, PCBs, and Temp	2	0	0	0	26	0	0	0	0	0	0	0	74	0	0	0	0	0	0	0	Grassland & Steppe	0	2
WHI_CB10	0.11	0	Closed Basin	Closed Basin	N/A	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Developed (Open Space)	2	2
EVE_CB7	0.09	0	Closed Basin	Closed Basin	N/A	0	35	0	0	54	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	Roads	2	2
KAL_CB7	66.26	1	Closed Basin	Closed Basin	N/A	0	3	44	0	3	0	1	0	0	0	0	0	49	0	0	0	0	0	0	0	Grassland & Steppe	0	1
EVE_CB2	12.37	0	Closed Basin	Closed Basin	N/A	0	0	0	0	40	0	1	0	0	0	0	59	0	0	0	0	0	0	0	0	Low Intensity Residential	1	1
KAL_SWR21	9.23	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	7	0	0	0	0	0	0	0	0	0	43	1	0	0	46	0	2	0	Wetland/Marsh/Bog	0	1
WHI_CC1	5.22	0	Cow Creek	Not Tested	N/A	1	0	11	4	0	0	8	0	0	0	0	18	19	0	2	0	8	0	30	0	Woodland	0	1
KAL_SWR20	4.00	0	Stillwater River	Impaired with One Pollutant	Sediment	1	0	0	0	0	0	0	0	0	0	0	0	53	3	0	0	45	0	0	0	Grassland & Steppe	0	1
WHI_CB6	2.24	0	Closed Basin	Closed Basin	N/A	0	0	0	0	13	0	0	0	0	0	83	0	3	0	0	0	0	0	1	0	High Intensity Residential	1	1
EVE_CB6	1.42	0	Closed Basin	Closed Basin	N/A	0	0	0	0	0	0	49	0	0	0	0	51	0	0	0	0	0	0	0	0	Low Intensity Residential	1	1
WHI_CB7	0.83	0	Closed Basin	Closed Basin	N/A	0	0	9	0	0	0	0	0	0	0	42	49	0	0	0	0	0	0	0	0	Low Intensity Residential	1	1
EVE_CB3	0.69	0	Closed Basin	Closed Basin	N/A	0	0	0	0	0	0	21	0	0	0	0	79	0	0	0	0	0	0	0	0	Low Intensity Residential	1	1

Stormwater Sampling Data Sheet														
Date:														
Sampler Name:														
			Kalispell			**Whitefish**				**Columbia Falls**				
Total Accumulated Precipitation at Time of Sampling (in):														
Storm Duration from Beginning to Time of Sampling (hrs):														
					DO Meter				**pH Meter**					
Site Name	**Location**	**Type**	**Sample Spot**	**Time**	**DO (mg/L)**	**Sample Temp (°C)**	**Pressure (hPa)**	**% of Air Sat**	**pH**	**Sample Temp (°C)**	**Air Temp (°F)**	**Precip**	**Weather**	
Evergreen - HWY 2	Under bridge over Stillwater River on HWY 2 - 48°12'39" N 114°17'14" W	Com	1											
Kalispell - City Shop	Near City Shops off of 1st Ave W - 48°11'0.31"N 114°18'45.06"W	Com/Res	1											
Whitefish - City Beach	Near City Beach just north of railroad - 48°24'53" N 114°21'3" W	Ind/Res	1											
Columbia Falls - HWY 2	Off of HWY 2 near C. Falls Marine Services - 48°22'3.81"N 114°10'30.32"W	Com	1											
Date Equipment Last Calibrated:														
Delivered to ME Lab on:														
Delivered by:														
Key														
Precipitation: 1-No Rain, **2**- Lt. Rain, **3**-Rain, **4**- Heavy Rain/Storm Event, **5**-Snow														
Weather: 1 - 0 to 5% (Clear), **2** - 5 to 25%, **3** - 25 to 75%, **4** - 75 to 99%, **5** - 100% (Rain)														
Sample Spot: 1 - end of pipe, **2** - inside CB, **3** - In stream, **4** - In manhole														
Type: Residential (Res), Industrial (Ind), Commercial (Com)														

Appendix I: Stormwater Sampling Weather Tracker

May 2020										
		Kalispell			Whitefish			Columbia Falls		
Date	Description	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	Sampling Event & Notes
5/1	Mostly Sunny	63.9	36.5	0.00	63.0	34.3	0.00	63.0	36.7	0.01	-
5/2	Mostly Sunny	74.5	30.2	0.00	72.9	28.8	0.00	79.9	28.4	0.00	-
5/3	Mostly Cloudy	55.9	38.8	0.07	57.6	35.2	0.19	57.4	39.9	0.39	-
5/4	Mostly Sunny	61.0	30.6	0.00	62.2	28.6	0.00	64.4	33.8	0.00	-
5/5	Mostly Sunny	73.4	31.6	0.00	70.9	29.3	0.00	80.4	26.8	0.00	-
5/6	Scattered Showers	59.0	39.9	0.00	56.8	36.7	0.20	59.7	37.8	0.13	-
5/7	Cloudy	52.3	39.2	0.20	49.5	37.6	0.37	53.8	37.8	0.15	Not ready to sample yet
5/8	Cloudy	63.7	42.1	0.00	63.0	39.9	0.04	65.5	40.5	0.01	-
5/9	Mostly Sunny	68.5	34.2	0.00	67.3	32.2	0.00	68.4	32.2	0.00	-
5/10	Mostly Sunny	65.5	35.4	0.00	62.2	45.9	0.00	60.4	48.4	0.00	-
5/11	Cloudy	62.2	35.8	0.00	60.3	41.5	0.00	58.3	43.5	0.00	-
5/12	Scattered Showers	55.8	41.5	0.34	50.4	40.6	0.22	57.2	40.3	0.19	Event 1, Part A
5/13	Cloudy	61.2	44.2	0.24	59.4	40.1	0.55	60.4	40.5	0.38	Event 1, Part B
5/14	Cloudy	70.2	39.4	0.00	68.9	42.3	0.00	71.4	43.3	0.00	-
5/15	Cloudy	53.8	41.0	0.01	53.8	45.0	0.00	54.1	38.8	0.00	-
5/16	Cloudy	69.6	37.6	0.00	68.2	44.4	0.00	68.2	37.4	0.00	-
5/17	Cloudy	74.8	44.1	0.13	72.9	41.4	0.09	75.4	39.9	0.07	-
5/18	Mostly Sunny	68.7	50.7	0.07	66.7	47.3	0.04	72.5	47.7	0.04	-
5/19	Cloudy	72.3	50.5	0.04	73.4	48.0	0.04	70.5	46.4	0.05	-
5/20	Scattered Showers	61.2	52.3	0.48	57.4	48.0	0.68	57.9	49.3	0.31	First flush at night
5/21	Cloudy	57.9	44.8	0.61	53.6	39.0	1.00	55.9	45.3	0.92	-
5/22	Cloudy	56.5	36.0	0.00	51.8	35.1	0.00	52.2	43.3	0.00	-
5/23	Cloudy	62.6	44.6	0.00	60.8	42.1	0.00	65.3	43.5	0.00	-
5/24	Cloudy	65.5	42.6	0.00	62.6	40.8	0.02	67.3	40.6	0.00	-
5/25	Foggy	69.1	41.1	0.02	69.8	37.2	0.02	70.5	36.0	0.20	-
5/26	Cloudy	71.6	52.3	0.15	72.5	49.6	0.12	72.1	49.1	0.08	First flush at night
5/27	Foggy	73.6	48.4	0.04	74.1	45.5	0.12	80.8	44.8	0.11	-
5/28	Mostly Sunny	82.4	43.3	0.00	79.3	41.0	0.00	86.9	38.8	0.00	-
5/29	Mostly Sunny	86.9	50.2	0.00	87.3	46.4	0.00	92.8	46.4	0.00	-
5/30	Mostly Sunny	89.6	53.6	0.00	92.1	50.2	0.00	99.0	51.6	0.00	-
5/31	Scattered Showers	74.5	61.7	0.12	77.0	46.0	1.08	75.2	46.9	0.49	-

Appendix I: Stormwater Sampling Weather Tracker

June 2020											
		Kalispell			Whitefish			Columbia Falls			
Date	Description	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	Sampling Event & Notes
6/1	Mostly Sunny	67.5	48.6	0.34	70.9	39.2	0.00	71.4	37.2	0.00	-
6/2	Mostly Sunny	76.5	44.4	0.00	75.6	39.0	0.00	73.6	38.3	0.00	-
6/3	Mostly Sunny	75.0	46.2	0.00	74.8	44.4	0.00	76.5	50.2	0.00	-
6/4	Cloudy	74.1	50.9	0.00	70.7	48.6	0.00	74.5	44.6	0.00	-
6/5	Mostly Sunny	72.7	45.9	0.17	73.0	43.3	0.10	80.4	39.9	0.04	-
6/6	Cloudy	66.7	52.9	0.63	63.1	50.4	0.43	66.0	51.1	0.52	First flush at night
6/7	Cloudy	55.8	50.4	0.69	56.1	45.1	0.70	61.3	44.8	0.30	-
6/8	Cloudy	63.1	46.9	0.41	52.3	41.0	0.69	57.0	43.3	1.00	-
6/9	Cloudy	63.0	44.4	0.00	61.7	40.1	0.00	63.7	43.0	0.00	-
6/10	Cloudy	72.3	50.0	0.00	70.3	48.0	0.00	72.3	48.9	0.00	-
6/11	Foggy	82.8	47.8	0.00	83.3	42.8	0.00	90.3	42.3	0.00	-
6/12	Mostly Sunny	88.5	52.2	0.00	85.5	48.4	0.00	95.5	48.2	0.00	-
6/13	Mostly Sunny	77.9	50.2	0.07	80.4	46.8	0.71	80.4	49.6	0.56	Not enough accum in Kal
6/14	Cloudy	65.8	45.5	0.00	66.2	43.9	0.01	65.5	48.2	0.00	-
6/15	Cloudy	65.1	44.1	0.00	62.2	42.8	0.00	62.8	47.5	0.00	-
6/16	Cloudy	71.2	47.5	0.01	71.8	42.6	0.00	79.5	45.1	0.09	-
6/17	Mostly Sunny	73.0	48.7	0.39	72.9	43.5	0.42	75.0	43.9	0.28	Precip too late in C. Falls
6/18	Cloudy	72.9	54.5	0.12	74.8	48.4	0.08	80.1	48.9	0.06	-
6/19	Mostly Cloudy	75.7	54.9	0.05	79.3	52.2	0.04	79.2	51.4	0.02	-
6/20	Cloudy	71.6	54.7	0.08	73.0	48.0	0.05	75.7	47.8	0.06	-
6/21	Cloudy	75.9	54.9	0.17	75.2	52.7	0.54	68.9	54.0	0.15	Showers for many days
6/22	Mostly Sunny	81.7	53.8	0.00	83.3	47.3	0.00	No Data	No Data	No Data	-
6/23	Mostly Sunny	86.9	53.8	0.00	90.1	49.1	0.00	No Data	No Data	No Data	-
6/24	Mostly Sunny	85.1	57.9	0.12	84.0	54.5	0.57	91.4	55.4	0.63	Rain wasn't predicted
6/25	Mostly Sunny	85.8	54.1	0.00	84.6	49.3	0.00	89.8	46.9	0.00	-
6/26	Mostly Sunny	86.5	56.1	0.00	89.1	52.0	0.00	87.1	51.1	0.00	-
6/27	Mostly Sunny	77.2	54.3	0.00	78.6	56.7	0.00	79.9	62.2	0.00	-
6/28	Mostly Sunny	71.8	49.3	0.00	72.5	46.6	0.03	77.0	46.0	0.01	-
6/29	Scattered Showers	65.3	52.2	0.27	66.4	51.4	0.11	65.7	51.1	0.28	First flush at night
6/30	Scattered Showers	66.7	55.4	0.96	56.5	48.9	1.48	59.9	49.1	0.89	-

Appendix I: Stormwater Sampling Weather Tracker

July 2020											
		Kalispell			Whitefish			Columbia Falls			
Date	Description	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	Sampling Event & Notes
7/1	Cloudy	63.3	47.3	0.00	57.2	47.3	0.05	61.3	51.1	0.03	-
7/2	Cloudy	74.1	46.2	0.00	68.2	45.9	0.00	74.3	46.6	0.00	-
7/3	Mostly Sunny	88.2	45.3	0.00	87.6	39.4	0.00	95.2	39.4	0.00	-
7/4	Mostly Sunny	84.7	53.1	0.00	82.9	46.6	0.00	84.4	49.3	0.00	-
7/5	Mostly Sunny	81.9	46.0	0.00	83.5	43.5	0.00	86.0	43.0	0.00	-
7/6	Mostly Sunny	84.9	50.4	0.00	86.2	45.7	0.00	91.0	45.1	0.00	-
7/7	Thunderstorm	72.9	54.5	0.18	71.1	52.0	0.24	68.6	54.1	0.00	-
7/8	Cloudy	71.1	52.0	0.00	72.1	49.7	0.00	68.4	51.6	0.00	-
7/9	Mostly Sunny	81.3	47.8	0.00	81.7	43.0	0.00	80.1	44.4	0.00	-
7/10	Cloudy	78.6	55.2	0.08	82.8	52.5	0.34	76.1	55.0	0.00	-
7/11	Mostly Sunny	85.5	48.2	0.00	87.8	44.4	0.00	84.7	46.4	0.00	-
7/12	Mostly Sunny	-	-	-	77.4	52.7	0.01	78.6	56.5	0.00	Kalispell - No Data
7/13	Mostly Sunny	-	-	-	76.3	43.7	0.03	74.7	45.5	0.00	Kalispell - No Data
7/14	Mostly Sunny	-	-	-	82.4	40.5	0.00	79.7	41.2	0.00	Kalispell - No Data
7/15	Mostly Sunny	-	-	-	87.6	45.0	0.00	85.1	45.3	0.00	Kalispell - No Data
7/16	Mostly Sunny	87.1	50.7	0.00	87.4	48.4	0.00	86.7	48.9	0.00	-
7/17	Mostly Sunny	80.1	59.2	0.00	82.0	55.4	0.00	79.2	59.2	0.00	-
7/18	Mostly Sunny	87.4	50.9	0.00	87.1	47.5	0.00	84.6	48.9	0.00	-
7/19	Mostly Sunny	84.6	48.9	0.00	87.6	48.0	0.00	85.3	48.2	0.00	-
7/20	Mostly Sunny	88.2	58.5	0.00	90.1	52.0	0.00	88.0	60.4	0.00	-
7/21	Mostly Sunny	90.7	55.0	0.00	91.6	50.9	0.00	90.0	55.2	0.00	-
7/22	Mostly Sunny	92.3	54.9	0.00	95.4	51.8	0.00	94.6	54.7	0.00	-
7/23	Mostly Sunny	87.3	58.1	0.01	89.4	54.7	0.00	88.7	57.4	0.00	-
7/24	Mostly Sunny	84.0	49.3	0.00	85.1	47.7	0.00	84.0	48.7	0.00	-
7/25	Mostly Sunny	84.6	44.8	0.00	84.7	45.7	0.00	81.1	44.6	0.00	-
7/26	Mostly Sunny	89.4	47.8	0.00	88.7	46.2	0.00	85.3	47.3	0.00	-
7/27	Mostly Sunny	96.1	51.4	0.00	96.3	48.0	0.00	91.9	54.0	0.00	-
7/28	Mostly Sunny	94.8	54.9	0.00	95.5	52.9	0.00	94.8	55.4	0.00	-
7/29	Mostly Sunny	92.8	55.2	0.00	96.3	53.2	0.00	91.8	54.7	0.00	-
7/30	Mostly Sunny	99.0	55.9	0.00	98.2	54.3	0.00	94.8	58.3	0.00	-
7/31	Mostly Sunny	100.6	60.6	0.00	99.5	60.4	0.00	98.4	69.3	0.00	-

August 2020											
		Kalispell			Whitefish			Columbia Falls			
Date	Description	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	Sampling Event & Notes
8/1	Mostly Sunny	100.8	64.0	0.00	96.8	64.2	0.22	94.1	68.9	0.01	-
8/2	Mostly Sunny	97.7	64.2	0.00	96.6	60.8	0.00	96.3	68.2	0.00	-
8/3	Mostly Sunny	87.6	56.1	0.00	90.7	56.1	0.00	90.9	56.3	0.00	-
8/4	Mostly Sunny	89.4	50.7	0.00	90.1	50.5	0.00	88.3	51.1	0.00	-
8/5	Mostly Sunny	95.5	53.1	0.00	95.4	50.7	0.00	93.2	56.5	0.00	-
8/6	Mostly Sunny	86.7	53.8	0.02	84.4	53.1	0.00	83.5	55.8	0.00	-
8/7	Cloudy	74.3	52.2	0.08	75.9	49.5	0.02	70.9	51.8	0.00	-
8/8	Cloudy	74.8	44.6	0.00	73.4	44.4	0.00	72.7	44.2	0.00	-
8/9	Mostly Sunny	81.3	52.3	0.00	82.0	50.0	0.00	79.0	49.6	0.00	-
8/10	Mostly Sunny	86.7	44.2	0.00	88.0	43.5	0.00	84.2	43.5	0.00	-
8/11	Mostly Sunny	90.0	48.2	0.00	89.1	48.0	0.00	88.3	48.7	0.00	-
8/12	Mostly Sunny	69.6	49.1	0.00	69.1	46.8	0.00	72.9	52.5	0.00	-
8/13	Mostly Sunny	78.1	42.1	0.00	77.7	40.5	0.00	75.2	41.7	0.00	-
8/14	Mostly Sunny	83.7	40.5	0.00	83.8	40.5	0.00	81.0	40.3	0.00	-
8/15	Mostly Sunny	90.1	45.0	0.00	89.8	45.1	0.00	86.7	46.2	0.00	-
8/16	Mostly Sunny	84.6	49.5	0.00	96.3	47.5	0.00	92.8	52.2	0.00	-
8/17	Mostly Sunny	100.8	58.1	0.00	98.2	55.4	0.00	95.0	60.8	0.00	-
8/18	Mostly Sunny	93.4	57.7	0.01	94.5	57.0	0.03	92.3	59.7	0.00	-
8/19	Mostly Sunny	91.0	58.5	0.01	94.3	57.2	0.00	91.6	60.1	0.00	-
8/20	Cloudy	82.9	54.7	0.00	82.4	51.3	0.00	78.6	53.4	0.00	-
8/21	Mostly Sunny	92.7	50.5	0.00	90.9	48.0	0.00	89.1	48.9	0.00	-
8/22	Mostly Sunny	85.6	54.3	0.00	86.5	54.7	0.00	85.6	56.5	0.00	-
8/23	Mostly Sunny	90.7	44.8	0.00	90.7	43.5	0.00	86.9	47.1	0.00	-
8/24	Foggy	89.4	47.8	0.00	90.1	46.8	0.00	88.5	49.8	0.00	-
8/25	Foggy	86.4	53.1	0.00	86.5	52.9	0.00	87.4	53.6	0.00	-
8/26	Foggy	86.9	49.8	0.00	87.4	48.0	0.00	85.1	48.7	0.00	-
8/27	Foggy	88.0	46.0	0.00	88.0	45.1	0.00	85.5	47.3	0.00	-
8/28	Mostly Sunny	87.8	44.1	0.00	88.7	44.8	0.00	85.3	50.5	0.00	-
8/29	Mostly Sunny	85.1	43.0	0.00	87.4	44.2	0.00	84.0	45.0	0.00	-
8/30	Mostly Sunny	78.6	41.9	0.00	78.3	52.2	0.00	75.7	44.4	0.00	-
8/31	Cloudy	65.8	47.5	0.11	59.9	46.4	0.09	60.8	50.4	0.00	-

Appendix I: Stormwater Sampling Weather Tracker

September 2020											
		Kalispell			Whitefish			Columbia Falls			
Date	Description	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	High (°F)	Low (°F)	Precip (in)	Sampling Event & Notes
9/1	Cloudy	82.9	46.8	0.00	84.7	45.0	0.00	79.7	49.8	0.00	-
9/2	Mostly Sunny	84.9	52.7	0.00	85.5	49.8	0.00	81.7	58.8	0.00	-
9/3	Mostly Sunny	91.0	46.4	0.00	88.0	46.9	0.00	84.9	47.1	0.00	-
9/4	Mostly Sunny	94.3	46.8	0.00	90.5	47.1	0.00	87.8	48.7	0.00	-
9/5	Mostly Sunny	95.0	52.2	0.00	92.5	50.7	0.00	89.1	55.0	0.00	-
9/6	Mostly Sunny	90.9	50.5	0.00	91.2	50.0	0.00	88.2	51.4	0.00	-
9/7	Cloudy	73.9	41.7	0.00	67.6	38.1	0.00	69.8	41.2	0.00	-
9/8	Mostly Sunny	65.3	31.1	0.00	66.4	29.7	0.00	65.3	30.7	0.00	-
9/9	Mostly Sunny	76.1	34.5	0.00	79.9	35.2	0.00	75.0	36.1	0.00	-
9/10	Mostly Sunny	84.7	39.7	0.00	86.2	38.7	0.00	81.1	44.1	0.00	-
9/11	Mostly Sunny	83.8	41.2	0.00	86.9	41.0	0.00	82.8	43.3	0.00	-
9/12	Foggy	86.2	43.0	0.00	86.5	43.3	0.00	83.8	49.5	0.00	-
9/13	Foggy	74.1	42.6	0.00	71.8	43.3	0.00	71.2	50.2	0.00	-
9/14	Foggy	68.2	46.9	0.00	66.7	46.0	0.00	66.0	46.6	0.00	-
9/15	Foggy	78.6	48.7	0.00	80.1	44.8	0.00	78.6	44.2	0.00	-
9/16	Foggy	78.1	50.4	0.00	75.7	44.8	0.00	75.2	52.3	0.00	-
9/17	Foggy	78.1	44.8	0.00	77.5	43.0	0.00	75.2	46.0	0.00	-
9/18	Foggy	75.9	46.6	0.00	77.5	43.7	0.00	75.0	51.8	0.00	-
9/19	Foggy	63.9	55.8	0.00	60.8	54.0	0.00	59.9	56.3	0.00	-
9/20	Cloudy	72.0	45.3	0.00	68.0	44.8	0.00	64.4	45.1	0.00	-
9/21	Foggy	75.0	40.3	0.00	76.3	38.7	0.00	72.9	38.5	0.00	-
9/22	Cloudy	61.0	45.5	0.01	60.8	44.8	0.08	58.5	45.7	0.00	-
9/23	Foggy	76.5	43.7	0.00	73.8	41.7	0.00	72.1	42.6	0.00	-
9/24	Cloudy	68.2	46.2	0.01	65.3	50.2	0.00	59.5	53.1	0.00	-
9/25	Cloudy	60.1	39.0	0.19	57.7	41.5	0.50	58.5	45.1	0.00	Not enough accum in C.F.
9/26	Cloudy	62.2	42.8	0.07	61.3	39.9	0.12	57.6	43.2	0.00	-
9/27	Foggy	66.4	35.8	0.01	64.6	32.2	0.00	61.5	33.6	0.00	-
9/28	Mostly Sunny	69.3	35.4	0.00	67.3	33.8	0.00	65.1	33.3	0.00	-
9/29	Foggy	78.3	37.4	0.00	76.3	36.5	0.00	72.7	36.0	0.00	-
9/30	Mostly Sunny	80.2	41.4	0.00	74.1	40.6	0.00	72.1	45.7	0.00	-

CITY OF KALISPELL OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitutde:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential (High Density)
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space ☐ Golf Course
- ☐ Institutional
- Other: ____________________
- Known Industries: ____________________

Notes (e.g.., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Pipe**	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: ________	☐ Circular ☐ Eliptical ☐ Box ☐ Other: ______	☐ Single ☐ Double ☐ Triple ☐ Other: ______	Diameter/Dimensions: ______________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**				
Flow Present?	☐ Yes ☐ No ***If No, Skip to Section 5***				
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Conductivity			EC	Probe
Ammonia			mg/L	Test strip