

Alternatives Analysis Report

Missoula Development Park Regional Stormwater System

Prepared for
City of Missoula

Prepared by
Herrera Environmental Consultants, Inc.

Note:

Some pages in this document have been purposely skipped or blank pages inserted so that this document will print correctly when duplexed.

Alternatives Analysis Report

Missoula Development Park Regional Stormwater System

Prepared for
City of Missoula
Department of Public Works and Mobility
1345 West Broadway
Missoula, Montana 59802

Prepared by
Herrera Environmental Consultants, Inc.
101 East Broadway, Suite 610
Missoula, Montana 59802
Telephone: 406-721-4204

August 14, 2024

This page intentionally left blank

Contents

1. Introduction.....	5
1.1. Purpose.....	5
1.2. Scope.....	5
1.3. Assumptions and Limitations	9
2. Document Review.....	9
3. Conditions Assessment.....	10
3.1. Field Inspections.....	10
3.2. Survey.....	10
3.3. CCTV Inspection	11
4. Capacity Analysis.....	12
4.1. Model inputs.....	13
4.1.1. Precipitation.....	14
4.1.2. Subcatchment Delineation and Basin Attributes	14
4.1.3. Storm Drainage Infrastructure and Hydraulics	18
4.2. Quality Control Checks	21
4.3. Uncertainty and Limitations	23
4.4. Model Results.....	23
4.4.1. 5-year Storm Event Results	41
4.4.2. 100-Year Storm Event Results	42
4.4.3. Areas not Evaluated	44
5. Alternatives Analysis.....	46
5.1. Conditions Assessment Recommendations.....	46
5.1.1. Deferred Maintenance	46
5.1.2. Repair.....	49
5.1.3. Remove and Replace	49
5.1.4. Routine Inspection.....	49

5.2. Capacity Analysis Recommendations.....	49
5.2.1. Deferred Maintenance	49
5.2.2. Repair.....	50
5.2.3. Additional Infrastructure	50
5.2.4. Routine Inspection.....	50
5.2.5. Further Evaluation.....	50
5.3. Design Criteria.....	50
5.4. Construction Schedule Considerations.....	51
5.4.1. Future Inspections and Maintenance	52
5.5. Cost Estimates	52
5.5.1. Deferred Maintenance	54
5.5.2. Repair.....	55
5.5.3. Remove and Replace	55
5.5.4. Additional Infrastructure	56
6. References.....	57

Appendices

Appendix A	Conditions Assessment Photo Log
Appendix B	Conditions Assessment Summaries
Appendix C	Survey Report
Appendix D	CCTV Inspection Reports
Appendix E	Modeling Input File and Results
Appendix F	Recommendations Tables
Appendix G	Cost Estimates

Tables

Table 1.	Model Comparison to City Design Standards.	12
Table 2.	GIS Data Sources.....	14
Table 3.	Design Storm Rainfall Depths.....	14
Table 4.	SWMM Model Hydraulic Attributes.....	18
Table 5.	Recommendation Quantities.....	54

Figures

Figure 1.	Vicinity Map for Missoula Development Park.....	6
Figure 2.	Missoula Development Park Stormwater Infrastructure.....	7
Figure 3.	Subcatchments in Missoula Development Park.....	16
Figure 4.	Hydrologic Soil Groups in Missoula Development Park.....	17
Figure 5.	Missoula Development Park Surcharged Nodes During 5-Year Storm Event.....	25
Figure 6.	Missoula Development Park Flooding During 5-Year Storm Event	27
Figure 7.	Missoula Development Park Flooding During 100-Year Storm Event.....	29
Figure 8.	Missoula Development Park Flooding – Area A	31
Figure 9.	Missoula Development Park Flooding – Area B.....	33
Figure 10.	Missoula Development Park Flooding – Area C.....	35
Figure 11.	Missoula Development Park Flooding – Area D	37
Figure 12.	Missoula Development Park Flooding – Area E.....	39
Figure 13.	Missoula Development Park Conditions Assessment Recommendations.....	47

This page intentionally left blank

1. Introduction

The Missoula Development Park is an approximately 520 acre industrial neighborhood located north of the Missoula Montana Airport (see Figure 1), and contains commercial, industrial, and technology-focused businesses. The Missoula Development Park was annexed in 2018 by the City of Missoula (City) from Missoula County (County).

The Missoula Development Park has continually been developed since 1991. Stormwater in the area is managed by public and privately owned curb and gutter, inlets, conveyance pipes, ditches, culverts, detention facilities, and drywells that ultimately discharge via three outfalls to Butler Creek (two outfalls) and Grant Creek (one outfall), south of West Broadway. The stormwater system is shown in Figure 2.

1.1. Purpose

The City and County are working together to ensure the stormwater system works effectively as a whole and that the individual components are up to standard. As the City adopts the stormwater system in the Missoula Development Park from the County into the City's stormwater utility, it is critical to understand the condition and effectiveness of the stormwater system components to ensure they are functional, meet capacity requirements, and can be operated effectively and maintained efficiently by the City.

The City has asked Herrera Environmental Consultants (Herrera) to provide a conditions assessment, capacity analysis, and alternatives analysis for the stormwater system within the Missoula Development Park. Herrera has developed alternatives and recommendations for maintenance, repairs, removal and replacement, and/or additional infrastructure to ensure the stormwater system is functional.

1.2. Scope

Herrera reviewed existing documentation to gather information on the system, provided conditions assessment of the system, developed a hydraulic model to analyze the conveyance capacity of the system, developed alternatives to address identified condition or capacity issues, and provided recommendations for maintenance, repair, removal and replacement, and/or additional infrastructure to ensure the stormwater system functions to accommodate the 5-year, 24-hour storm event. Although the City stormwater standards require that new systems be designed to manage the 10-year, 24-hour storm event, the existing stormwater system was designed under previous County requirements, and was built to manage a 5-year, 24-hour storm event. Thus, the capacity analysis evaluated the 5-year, 24-hour storm event as the design storm. The hydraulic model also analyzed the 100-year, 24-hour storm event to determine if additional infrastructure is required to achieve the desired level of service according to Chapter 6 of the 2024 Missoula City Public Works Standards and Specifications Manual (MCPWSS) (MCPWSS; Missoula 2024).



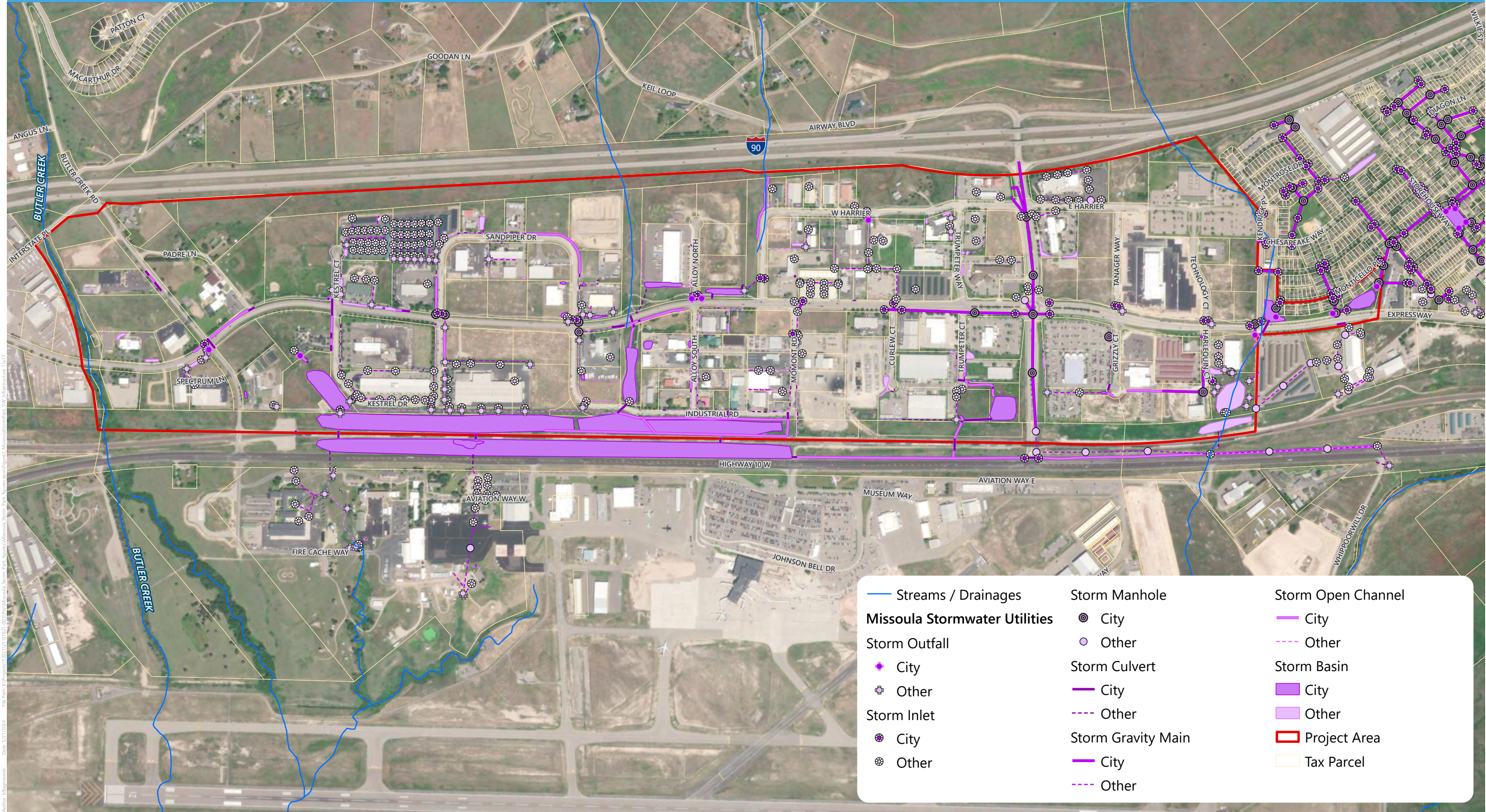
- Streams / Drainages
- Project Area
- Tax Parcel

Area of map detail

City of Missoula

93 200

Figure 2.
Missoula Development Park Stormwater Infrastructure.



— Streams / Drainages	Storm Manhole	Storm Open Channel
Missoula Stormwater Utilities	● City	— City
Storm Outfall	○ Other	- - - Other
● City	Storm Culvert	Storm Basin
⊗ Other	— City	■ City
Storm Inlet	- - - Other	■ Other
⊗ City	Storm Gravity Main	▭ Project Area
⊗ Other	— City	▭ Tax Parcel
	- - - Other	

This page intentionally left blank

1.3. Assumptions and Limitations

This report was prepared based on information provided by the City, publicly available LiDAR data (Montana State Library, 2019), and data collected during site visits. In some cases, information was unavailable or not located related to as-built conditions of system components. This limited the team's ability to assess whether the system was constructed as designed. While the original intent was to identify whether the stormwater system is currently functioning as designed, the team was able to evaluate the current condition and capacity constraints of the system.

Cost estimates prepared for this report should be considered planning level estimates based on best available information and the project team's experience and expertise on similar types of work.

2. Document Review

In order to gather existing information on the system, determine original design parameters, and identify data gaps, Herrera reviewed available documentation of the stormwater system, including as-built drawings where available, the Hydrology Report for Missoula Development Park (DJ&A, 1996), Development Park – Analysis of Existing Parks as Functioning Stormwater Detention Basins Memorandum (City of Missoula, 2022a), City of Missoula GIS data (City of Missoula, 2022b), and LiDAR data (Montana State Library, 2019). Herrera also met with City staff, who had gathered information from County staff, to identify potential issues relevant to the challenges with the operations and maintenance of the stormwater system and opportunities to ease maintenance requirements. Information gathered from the document review was used to prepare a plan for the conditions assessment.

3. Conditions Assessment

Herrera performed a conditions assessment of the stormwater system to determine the functionality, system configuration, and current condition of the system components. This process included a field inspection of all elements within the project boundary, survey of the system's individual elements, and closed circuit television (CCTV) survey of key pipe networks. The goal of the conditions assessment was to identify deferred maintenance requirements and failing infrastructure. The data collected in the conditions assessment was used to provide recommendations for maintenance, repair, replacement, or additional investigations in order to address identified issues, ease maintenance requirements, or increase the effectiveness of the stormwater system. Recommendations were made based on the conditions assessment data, and are provided in Section 5. These recommendations are identified for completion as part of a future design phase.

3.1. Field Inspections

Herrera staff conducted field inspections onsite during the month of August, 2023. Field inspection work consisted of conducting visual inspections of system components within the project boundary to confirm existing configuration, assess system conditions, and identify operational, maintenance, and other concerns. System components inspected include inlets, mainholes, catch basins, drywells, pipes, culverts, detention ponds/basins, swales, and ditches. A photo log is included in Appendix A, which includes photos, stormwater system component identification number (MSO_ID), and a description of the photo.

Table B.1 in Appendix B provides a summary of the data collected during the conditions assessment field inspections, including MSO_ID; stormwater system component length, diameter, and material; feature type; and condition description. A field webmap was created and used for data collection, and includes georeferenced photos, field notes, and identified maintenance/repair issues. The link and password to access the map has been shared with the City of Missoula.

Additional field inspections were conducted in the spring of 2024 to confirm model inputs and provide more information for areas of uncertainty in the model. More information on those field inspections is included in Section 4.2.

3.2. Survey

Field survey of the stormwater system components was conducted by Eli & Associates, Inc. (Eli) between October 2 and November 28, 2023. The survey work consisted of performing field surveys to collect horizontal and vertical data on the stormwater system components designated as City owned (in the City of Missoula GIS data) and those found in the Right-of-Way, including pipe inverts; culvert ends; mainhole, inlet, and drywell rims; and structure bottoms. Topographic data used in the capacity analysis was derived from the existing 2019 lidar data from the Montana Lidar Data Collection for topographic

data (Montana State Library, 2019), and ground truthed by Eli with survey grade GPS. Eli also collected topographic data for swales and ditches that were not apparent in the lidar data.

Data were collected and processed in North American Datum of 1983, 2011 realization (NAD83-2011) Epoch 2010.00, with coordinates projected to Montana State Plane. Vertical data is with reference to the North American Vertical Datum of 1988 (NAVD88). Orthometric heights were generated by applying geoid model GEOID18 separations. A survey report is included in Appendix C, and provides information on the equipment used, control benchmarks, and data collection methods. Due to large file size, a copy of the CAD file from the survey was provided to the City of Missoula through Sharepoint.

3.3. CCTV Inspection

CCTV inspections of the stormwater system were completed between October 24 and October 31, 2023. CCTV inspections consisted of using remote cameras to evaluate the condition of mainhole structures, catch basins, drywells, stormwater inlets, pipes, and other components not visible from the ground surface. Herrera contracted with a local pipe inspector, Nash Enterprises, Inc., to CCTV stormwater pipes to identify cracks, sagging, root intrusion, offset joints, or other issues that may impede conveyance or allow inflow and infiltration.

Pipes were generally CCTV'd from upstream to downstream, however if access was compromised at the upstream position due to location, safety, or storm sewer obstruction, a reverse run from the downstream mainhole was performed.

Work for the CCTV inspection also included jetting of pipes as necessary in order to obtain CCTV footage. CCTV video was collected for approximately 2,160 linear feet of pipe. Sediment and water from jetting activities were dumped at the City of Missoula facility. Table B.2 in Appendix B provides a summary of the issues identified during the CCTV inspections, including the upstream and downstream MSO_IDs, pipe names, condition description and location of identified issue. Observations made during the CCTV inspection were reviewed by Herrera. The team determined recommendations for repair or removal and replacement based on City standards, best practices, and engineering judgement.

CCTV inspection reports are included in Appendix D, and provide information on location, upstream and downstream structure identification numbers, descriptions of each pipe section, and observations. Due to large file sizes, inspection videos in MPG video format and digital photographs in JPEG format were provided to the City of Missoula through SharePoint and on a thumb drive.

4. Capacity Analysis

A hydrologic and hydraulic model was developed using Personal Computer Storm Water Management Model (PCSWMM, Version 7.6.3695) software that uses the industry standard Stormwater Management Model (SWMM, Version 5.2.4) to simulate and evaluate stormwater system conveyance capacity within the Missoula Development Park (study area). The conveyance capacity analysis was conducted to determine whether the existing stormwater system components meet the 5-year, 24-hour storm event level of service and whether the existing stormwater system, combined with surface features, has capacity to convey a 100-year, 24-hour storm event per City standards. The conveyance capacity analysis was used to determine if repairs, additional infrastructure, or other recommendations are needed to achieve the desired level of service.

As shown in Table 1, model results were compared to the design standards for streets provided in Section 6.3.2 of the 2024 MCPWSS. The 5-year storm was evaluated and compared to the City’s requirements for the 10-year storm as described in the Section 1.2.

Table 1. Model Comparison to City Design Standards.

City Design Storm	Model Design Storm	Criterion	Source in 2024 MCPWSS
10-year	5-year	<p>Stormwater facilities: No surcharging of conveyance systems such as channels, pipes, gutters, and culverts</p> <p>Local road: No curb overtopping. Flow may spread to crown of street.</p> <p>Collector road: No curb overtopping. Flow spread must leave at least one, 11-foot lane free of water, 5 feet either side of the street crown</p>	<p>Section 6.3.1</p> <p>Section 6.3.2.A (Table 6-3)</p>
100-year	100-year	<p>Local and collector roads: The depth of water at the gutter flow line shall not exceed 18 inches. Residential dwellings and public, commercial, and industrial buildings shall not be inundated at the ground line unless flood-proofed).</p> <p>Where no curbing exists, stormwater encroachment shall not extend beyond the right of way during the 100-year storm event, unless accommodated by a drainage easement.</p>	<p>Section 6.3.2.A (Table 6-4)</p> <p>Section 6.3.2.B</p>

Roadway GIS data from the Montana Department of Transportation (MDT) was used to identify roadway classifications within the study area for comparison to the City’s maximum street spread standards presented in Table 6-3 and 6-4 of the 2024 MCPWSS. Roadways in the study area are mapped as local roads, with the exception of the following streets mapped as collectors:

- Butler Creek Road
- Expressway
- Airway Boulevard
- Kendrick Place from Expressway to Bordeaux Boulevard

- Bordeaux Boulevard
- Canyon Creek Boulevard

The stormwater system in the study area includes a network of publicly and privately owned pipes, open channels, and detention facilities that convey stormwater south of West Broadway Street to two outfalls that drain to Butler Creek and one outfall that drains to Grant Creek. There is significant off-site contributing area that drains into the study area, including:

- Over 1400 acres of highway (I-90) and hillside to the northeast of I-90 (hillside)
- Approximately three linear miles of Interstate 90 (I-90) to the north
- Residential developments to the east (approximately 100 acres)
- The Knife River facility to the east (approximately 70 acres)

In addition, over 40 acres southwest of the study area do not drain to the study area, but are hydraulically connected to the study area stormwater system. Capacity issues in the area southwest of the study area may create a tailwater condition in the stormwater system.

The created PCSWMM model is a dual drainage system model that includes both a Minor Drainage System (formal conveyance components) consisting of pipes, channels, stormwater detention facilities (basins) and associated drainage structures (mainholes and inlets) as well as a Major Drainage System (informal conveyance components) consisting of overland flow pathways such as roadway curb and gutter and informal open channels.

The PCSWMM model simulates formal and informal runoff flow pathways for the 5-year and 100-year rainfall events. The model was used to evaluate whether a simulated hydraulic grade line (HGL) surcharges above drainage structure rim elevations during the 5-year storm event, resulting in use of the Major Drainage System to convey runoff. The 100-year storm event was evaluated to determine whether conveyance capacity within the public ROW, including roadway curb and gutter capacity, is sufficient per City standards, and if not, to identify potential flooding risks to private property.

4.1. Model inputs

Herrera used data and existing documentation provided by the City to create the PCSWMM model. The model input report is provided in Appendix E. Key data sources include:

- Survey and Conditions Assessment (Section 3) data
 - Information and photographs collected during site visits
 - System component survey data
- City Stormwater GIS data and other GIS data sources (see)
- LiDAR topography data used to generate a digital elevation model (DEM)
- Aerial imagery (see Table 2) and Google Street View

- Hydrology Report for Missoula Development Park (DJ&A, 1996)

Table 2. GIS Data Sources.

Dataset	Data Source
Stormwater Infrastructure – Survey	Eli & Associates, Inc.
Stormwater Infrastructure – GIS	City GIS (Missoula Maps)
Parcels	City GIS (Missoula Maps)
Impervious Land Use Area	National Land Cover Database (NLCD 2019)
LiDAR	Montana State Library
Aerial Imagery	Bing Maps (2024) Esri World Imagery (2024)
Soils	National Resources Conservation Service (NRCS)
Roadway	Montana Department of Transportation

4.1.1. Precipitation

Two SCS Type II 24-hour storm events were evaluated: the 5-year, 24-hour design storm depth of 1.47 inches and the 100-year, 24-hour design storm depth of 2.28 inches (Table 3). The storm depths for each event are based on the Missoula Airport station (Section 6.2.7.B of the 2024 MCPWSS and Appendix B of Chapter 9 of the MDT Hydraulics Manual).

Table 3. Design Storm Rainfall Depths.

Recurrence Interval Year (24-hour Storm Duration)	Storm Depth (Inches)
5-year	1.47
100-year	2.28

4.1.2. Subcatchment Delineation and Basin Attributes

Subcatchments were delineated within the study area for computing hydrologic (rainfall-runoff) response and informal overland runoff flow before runoff enters the formal stormwater system. Subcatchment area, average slope, and percent impervious area attributes were computed via GIS analysis, as described below.

4.1.2.1. Basin Delineation

Herrera used Environmental Systems Research Institute, Inc.’s (Esri) Spatial Analyst Hydrology toolbox to delineate individual subcatchments (drainage subbasins) and assign subcatchment runoff to elements of the stormwater network (e.g., mainholes). Although the Hydrology Report for Missoula Development Park (DJ&A, 1996) prepared for Missoula County in 1996 included basin delineation, the Missoula Development Park has seen considerable development since the time of that report, so new delineation was deemed necessary. LiDAR topography data was used to create a raster (cell-based) DEM of the land surface. The toolbox identifies flowpath networks based on the direction of steepest descent and the accumulated area upstream of each cell in the DEM. Stormwater conveyance information from the City’s

GIS database, was “burned” into the DEM to generate flow accumulation lines that reflect both overland and piped flow. Drainage pour points were then placed on the flow accumulation lines to map upstream subcatchment areas to drainage structures and channel inlets. A manual review of the subcatchment boundaries using contour and stormwater system data was completed to confirm the automated basin delineation.

The subcatchments were further refined in PCSWMM, including the manual delineation of the hillside tributary to the study area. Subcatchments were split in order to better estimate parcel area draining to private detention facilities and to add detail to the model to better reflect drainage pathways (e.g., breaking up a subcatchment into multiple subcatchments to reflect drainage to multiple points along a ditch culvert system). The Hydrology Report for Missoula Development Park (DJ&A, 1996), site visits, and record drawing review were used to identify highway cross culverts conveying flows from the hillside and I-90 to the study area; while the cross culverts were not directly modeled, their location informed assignment of associated subcatchment runoff to the simulated stormwater network.

The PCSWMM model includes 388 subcatchments (Figure 3) covering a total area of 2,320 acres.

4.1.2.2. Percent Impervious and Average Slope

Impervious surface area coverage and average topographic slope are important parameters that influence the volume and timing of runoff entering the stormwater system. For each delineated subcatchment, the percent impervious area was initially estimated using National Land Cover Database (NLCD 2019) data. The percent impervious attribute was checked for all subcatchments and updated as needed based on aerial imagery.

Average topographic slope for each subcatchment was calculated using LiDAR data (Montana State Library, 2019). These GIS data sources are provided in Table 2.

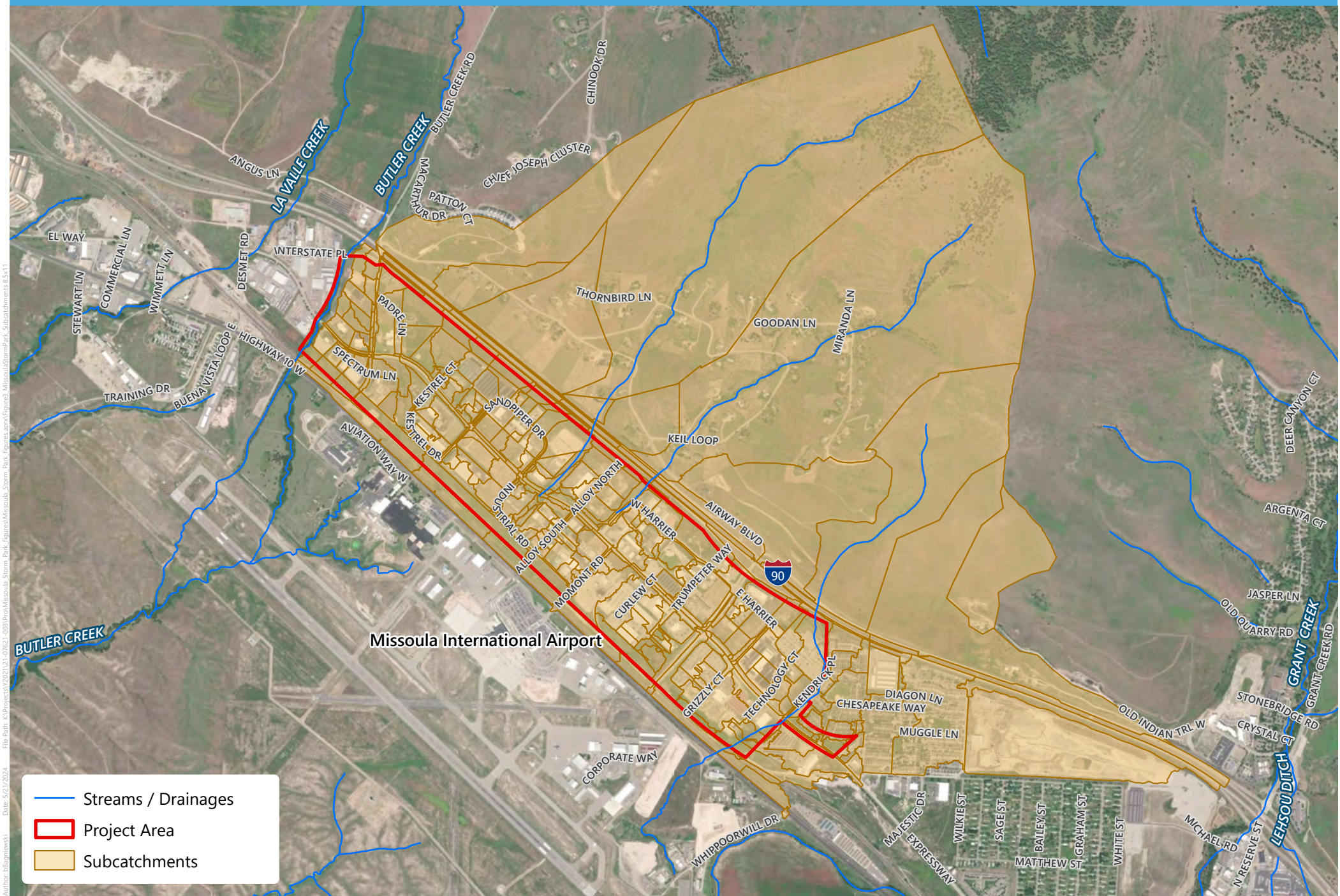
4.1.2.3. Subcatchment Hydrology

The Green Ampt infiltration model was used to simulate hydrology within pervious areas of each subcatchment. Each subcatchment has an assigned suction head value of 3.5 inches. A composite C =conductivity (analogous to vertical hydraulic conductivity) for each subcatchment was calculated by applying the following infiltration rates, approved by the City, to the percent area mapped as each Hydrologic Soil Group (see Figure 4):

- Group A – 3.5 in/hr
- Group B - 1.0 in/hr
- Group C – 0.1 in/hr
- Group D – 0.03 in/hr

Hydrologic Soil Group data was unavailable for the Knife River facility located in the eastern portion of the study area and the Group A infiltration rate of 3.5 in/hr was applied based on infiltration rates the City has documented from infiltration testing at this location.

Figure 3.
Subcatchments in Missoula Development Park.






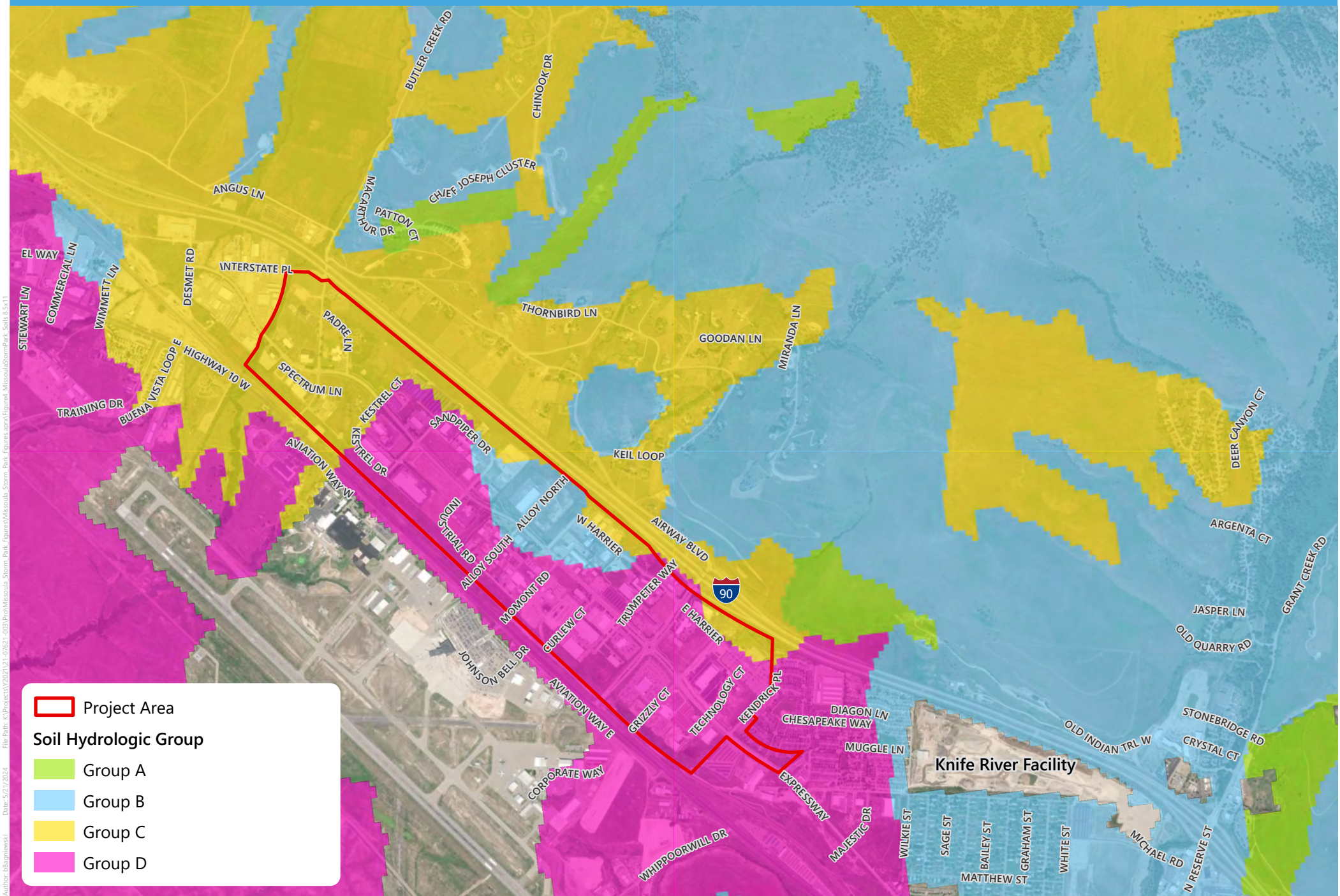
-  Streams / Drainages
-  Project Area
-  Subcatchments

Figure 4.
Hydrologic Soil Groups in Missoula Development Park.



File Path: K:\Projects\2021\21-07621-001\Pro\Missoula_Storm_Park_Figures.aprx\Figure4_MissoulaDevelopmentPark_Soils_8.5x11
 Date: 5/21/2024
 Author: bbagniewski

Five percent of impervious area was routed to pervious area for all subcatchments to account for flow from impervious to pervious areas or stormwater that may not enter the stormwater system (e.g., local ponding or loss through cracks in pavement). Additional impervious area was routed to pervious areas on a case by case basis to account for disconnected downspouts and other areas sheet flowing to pervious services. For example, 45 percent of impervious area from the residential developments in the eastern portion of the study area was routed to pervious area to account for the many sidewalks that drain to landscaped areas and garage roofs with disconnected downspouts.

For other hydrologic parameters, such as depression storage, default PCSWMM parameter values were used.

4.1.3. Storm Drainage Infrastructure and Hydraulics

The model simulations used dynamic wave flow routing with five-minute wet and dry runoff time steps, five-second flow routing time steps, and a one-minute reporting time step. The model reported outputs for all simulated subcatchments, pipes, and nodes (mainholes, catch basins, blind connections, culvert junctions, etc.). Hydraulic attributes included in the model are listed in Table 4 and described in the subsections below.

Table 4. SWMM Model Hydraulic Attributes.	
Attribute	Input Value
Pipe and mainhole elevation	Survey – primary data source GIS, as-built, and fieldwork data – secondary data source
Pipe diameter	Survey – primary data source GIS, as-built, and fieldwork data – secondary data source
Pipe length	Computed in PCSWMM from GIS length
Manning’s Roughness	Corrugated Metal Pipe - 0.024 Corrugated Plastic Pipe – 0.022 PVC – 0.01 All other pipes – 0.012 Roadway – 0.016 Short grass or lawn – 0.02 Dense Grass or vegetation – 0.03 Gravel – 0.025
Entry loss coefficient	0.2 (minor systems) 0 (major systems)
Exit Loss coefficient	0.2 (minor systems) 0 (major systems)
Mainhole and inlet ponded area	200 square feet (minor systems) 0 square feet (major systems)

4.1.3.1. Minor Drainage System

The survey conducted for this project gathered data on pipes and drainage structures inside the study area that were mapped as City owned. This data was used to define pipe invert elevations, drainage

structure rim elevations, pipe diameters, and pipe material (i.e., roughness). Pipe lengths and slopes were calculated in PCSWMM based on the location of survey data points. The majority of open channel cross sections were generated in PCSWMM using the DEM with some open channels modeled using trapezoidal cross sections. All open channels were assumed to have no infiltration (seepage rate set to zero). Drywells are present on some parcels in the study area but were not included in the model due to relatively low infiltration rates within the study area; this is a conservative assumption.

Survey data was not collected for conveyance elements outside of the study area, identified as other or unknown ownership in the City GIS data, or that were not accessible (e.g., located on private property). Drainage structures without survey data are included in the model to properly evaluate conveyance capacity using best professional judgement and assumptions. GIS data, Google Street View, as-built drawings, and/or the DEM were used to populate model attributes in the absence of survey data. The following approaches were used to incorporate conveyance elements into the model without survey data:

- City stormwater GIS data generally does not include pipe elevation data, however in some cases pipe slopes were available, and pipe elevations were estimated using elevation data from connected drainage structures. For example, this was done to extend the stormwater system outside of the study area from Chesapeake Way, along Sonoma Street, to the north of the development on Calistoga Lane to better simulate flows coming from the highway and hillside.
- Links to as-built drawings were sometimes available in the City GIS Stormwater Gravity Main layer and occasionally used to inform elevations and pipe sizes, including elevations and pipe diameters for the MDT storm main on West Broadway Street.
- The DEM was used to estimate drainage structure rim elevations in the absence of survey data.
- The DEM was used to estimate culvert/channel system attributes that were not surveyed including but not limited to most or all of the conveyance along Butler Road, Sandpiper Drive, Alloy South (south of expressway), Momont Road, and Broadway. Where there was question on the conveyance as shown in the DEM, additional field investigations were performed.

Privately owned stormwater infrastructure located within a parcel was generally not included in the model, such as the stormwater system located on the 6900 Kestrel Drive parcel.

A ponding area of 200 square feet was assigned to each Minor Drainage System node to ensure flooding remains associated with the node. The model simulations allow runoff to pond at a flooding node until the connected stormwater system has capacity. All flood waters were directed to the Major Drainage System except in the following limited cases where local ponding was suspected or when inadequate information was available to determine a flood overland flow path.

- Grizzly Court: A Major Drainage System was not included to convey drainage from an overtopping ditch to the south of the Grizzly Court cul-de-sac because the new development on the parcel to the west was not reflected in the DEM. Further evaluation is recommended at this location.
- The northeast intersection of Sandpiper and Expressway (north of Kestrel Drive): Flood waters are expected to cross the sidewalk and drain northeast to an undeveloped parcel and pond until

returning to the culvert inlet. The extent of flooding could not be evaluated because the DEM did not show the developed parcel to the northeast (5975 Sandpiper Drive). Further evaluation of this area may be warranted to confirm that flood waters remain in the undeveloped parcel and do not reach the building.

Detention Facilities

Stage-storage curves were generated by PCSWMM using the DEM for 22 detention facility nodes (denoted as “basins” in the City GIS data). In some cases, the basin invert elevations calculated by PCSWMM were adjusted due to suspected DEM inaccuracies caused by vegetation. Information collected during the conditions assessment and other site visits, including photos, were used to inform modeling of the basins.

Basin outlet structures, if identified in the conditions assessment, were typically modeled as a combination of orifices and/or weirs as appropriate. If no flow control structure was identified or if the basin was not surveyed, the basin was modeled as discharging directly to a pipe; this is a conservative (less attenuation) assumption.

For basins that were not modeled directly, such as basins located on private parcels, all impervious area draining to the facility was modeled as pervious to simulate facilities designed to detain flows to the predeveloped condition.

4.1.3.2. Major Drainage System

For flooding nodes, the DEM was used to determine the most likely surface flow path and to estimate elevations of overland channels. The following cross sections were used to model Major System Drainage:

- Streets: Street cross sections are typically represented with an 18-foot width (one half of the crowned roadway) with a two percent cross slope, and occasionally a 12- or 30-foot width. The curb was assumed to be 0.5 feet high, but the curb height was artificially raised to 18 inches in order to compare results to the 100-year event criteria (no more than 18 inches of depth at the gutter line) and to more accurately model flows deeper than 0.5 feet.
- Street crossings: Street crossings are typically represented with a 20- or 40-foot width rectangular cross section with 0.5-foot depth.
- Other pathways such as in lawns or fields: Other pathways are typically represented with a rectangular cross section of varying width and 0.5-foot depth or a PCSWMM generated cross section using the DEM.

4.2. Quality Control Checks

During model construction and testing, numerous quality control checks were conducted to ensure the conveyance, and subcatchment data generated for the model from multiple sources represent accurate information. The following are examples of checks that were performed:

- Subcatchment connectivity and impervious area. All subcatchments outflows/assignments were reviewed to ensure that flow assignments (outlets) are appropriate for the subcatchment topography. Percent impervious assignments were visually checked against aerial imagery and adjusted when appropriate.
- Pipe and node topography. The GIS pipe data contained several instances of pipe segments not connected to a node (mainhole or inlet). These were visually investigated and, as appropriate, pipe segments combined so that a single pipe segment connects to each node in the model.
- Pipe connectivity. Pipes and channels were reviewed to ensure properly named upstream and downstream connection nodes were assigned.
- Adverse slopes. Pipe slopes with adverse slopes were identified to check for data errors and to confirm that adverse pipe slopes in the model reflect survey data. In addition, the surveyors were asked to review areas with adverse pipe slopes and confirmed that the data accurately reflected the survey.
- Elevations. The model was checked to ensure that each node and conduit were assigned elevations and reviewed for any outliers that could indicate an error.
- Consistency. The model was reviewed for consistency around assumptions such as Manning's roughness values, ponded area, and conductivity (infiltration).
- Model warnings. Model warnings printed by PCSWMM after each simulation were reviewed and addressed if appropriate.
- Flow routing continuity. The model was checked to ensure no flow was lost to flooding and nodes with the highest continuity errors were checked for errors.

In addition to the site visits associated with the conditions assessment, Herrera conducted three follow up site visits to confirm model inputs and/or address areas of uncertainty. Findings of each site visit are summarized below.

- March 15, 2024
 - Residential subdivision east of Kendrick Place: Field staff estimated that approximately 90 percent of downspouts for houses are connected to the storm drain system with the remaining 10 percent of downspouts directed into lawns. The majority of flow from sidewalks disperses to grassed landscape strips or lawn area. Roof drainage from garages were observed to drain to backyard lawns.

- Parking lot drainage to Kendrick Place near Adalaide Lane: A large diameter HDPE pipe coming from the parking lot to the west of Kendrick Place was observed at a mainhole near the southwest corner of the intersection of Kendrick Place and Adalaide Lane.
- Development north of Expressway from Kendrick Place to Airport Boulevard: An unmapped large detention basin was identified at 4890 Technology Court. Site conditions were confirmed for other parcels in the area.
- Grizzly Court Cul-de-sac: Field staff confirmed that flow comes from the west and conveys stormwater around the cul-de-sac along a washed rock ditch that leads to a node that conveys flow to the east.
- April 9, 2024
 - Contributing area north of Old Indian Trail West: Field staff estimated the subcatchment boundaries north of this road and identified a culvert conveying hillside drainage near the north end of Wilkie Street.
 - Sandpiper Drive: The presence of the highway culvert just northeast of the 5900 Sandpiper parcel was confirmed as well as the culvert and parcel drainage flow path. The presence of unmapped detention basins was identified at 5975 Sandpiper Drive and 5845 Sandpiper Drive parcels.
 - Basin SW-BSN-10127 adjacent to Kestrel Drive: Field staff determined that the LiDAR data generally reflected the elevation of the bottom of the pond in relation to the outlet structure.
 - Butler Road: The presence of a shallow (0.5 to 1 feet deep) channel on the northwest side of Butler Road, immediately north of Expressway was confirmed. No culvert was found that would convey runoff across the CM Manufacturing driveway.
- May 2, 2024
 - Padre Lane: Field staff confirmed the major drainage flow path from an overtopping ditch north of the intersection of Butler Creek Road and Padre Lane towards DeSmet School
 - Butler Creek Road immediately north of railroad tracks: A culvert (SW-CULV-10411) is located within 25-feet of the center of railroad tracks and flooding at the inlet of the culvert on the west side of the road would likely cross the roadway as depicted in the model.
 - Trumpeter Way: Field staff observed that major system drainage from Trumpeter Road could reach the FedEx parking lot at 5001 Curlew Court and drain southeast to a curb opening and to conveyance leading to a detention basin (SW-BSN-10108).

4.3. Uncertainty and Limitations

The model was prepared using the best available information and engineering judgment, but is limited by data gaps and other sources of uncertainty, with examples provided below:

- Stormwater infrastructure data was unavailable for the contributing area north of the study area, including approximately 1400 acres of drainage from the I-90 and hillside. Subcatchments were delineated from LiDAR topography.
- Culvert node invert and rim elevations were estimated using the DEM in locations where survey data was unavailable.
- Ditch cross sections were typically created in PCSWMM from one location that appeared to be representative of the entire ditch.
- The Major Drainage System including flow directions and cross sections was developed using LiDAR data, often in relatively flat locations.
- Unmodeled detention facilities were assumed to manage the 100-year flow and may manage more or less flow than assumed.

4.4. Model Results

Surcharging was observed throughout the study area during the 5-year storm as shown in Figure 5. Flooding was observed in both the 5-year and 100-year storm events and is shown in Figure 6 through 12. Flooding areas not meeting the standards defined in Table 1 are detailed in the sections below. The capacity analysis was generally limited to conveyance owned by the City. Some conveyance elements mapped as owned by "other" or "unknown", such as catch basins located within a public roadway, are included in the capacity analysis on a case by case basis.

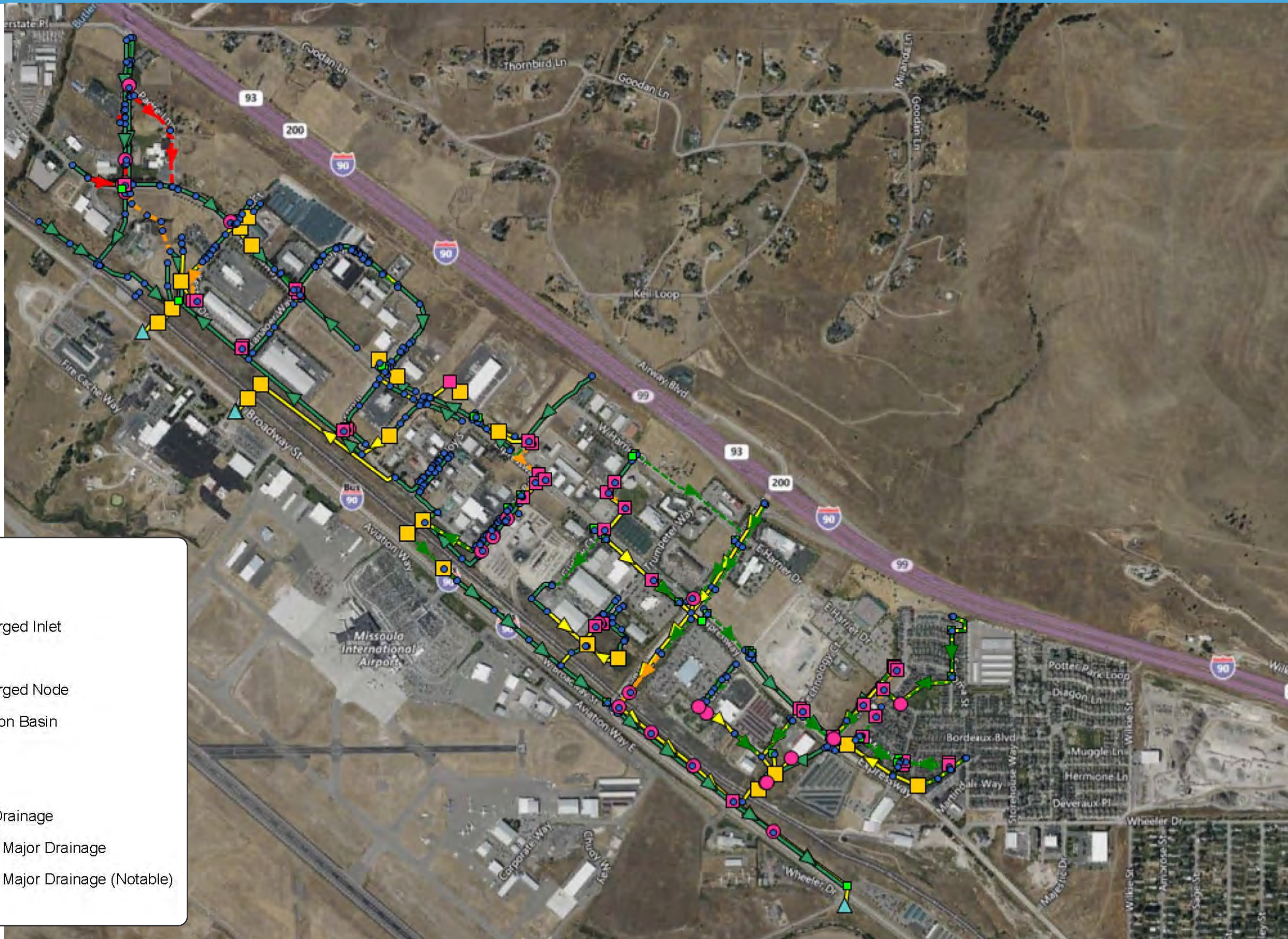
Flooding severity is shown in Tables E.1 and E.2 in Appendix E and were categorized in as follows:

- Low: City standards are met but the model shows the area is otherwise notable
- Moderate: City standards are not met in the model
- High: Flood waters may reach the ground line of a building in the model

Recommendations for addressing these areas with flooding are provided in Table F.1 in Appendix F.

This page intentionally left blank

Figure 5.
Missoula Development Park Surcharged Nodes During 5-Year Storm Event.



Legend

- Inlet
- Surcharged Inlet
- Node
- Surcharged Node
- Detention Basin
- Pipe
- Ditch
- - - → Major Drainage
- - - → Flow in Major Drainage
- - - → Flow in Major Drainage (Notable)

File Path: K:\Projects\2021\21-07821-003\Pro\Missoula_Storm_Park_Figures\Missoula_Storm_Park_Figures.aprx
 Date: 5/21/2024
 Author: @bagniewski

This page intentionally left blank

Figure 6.
Missoula Development Park Flooding During 5-Year Storm Event.

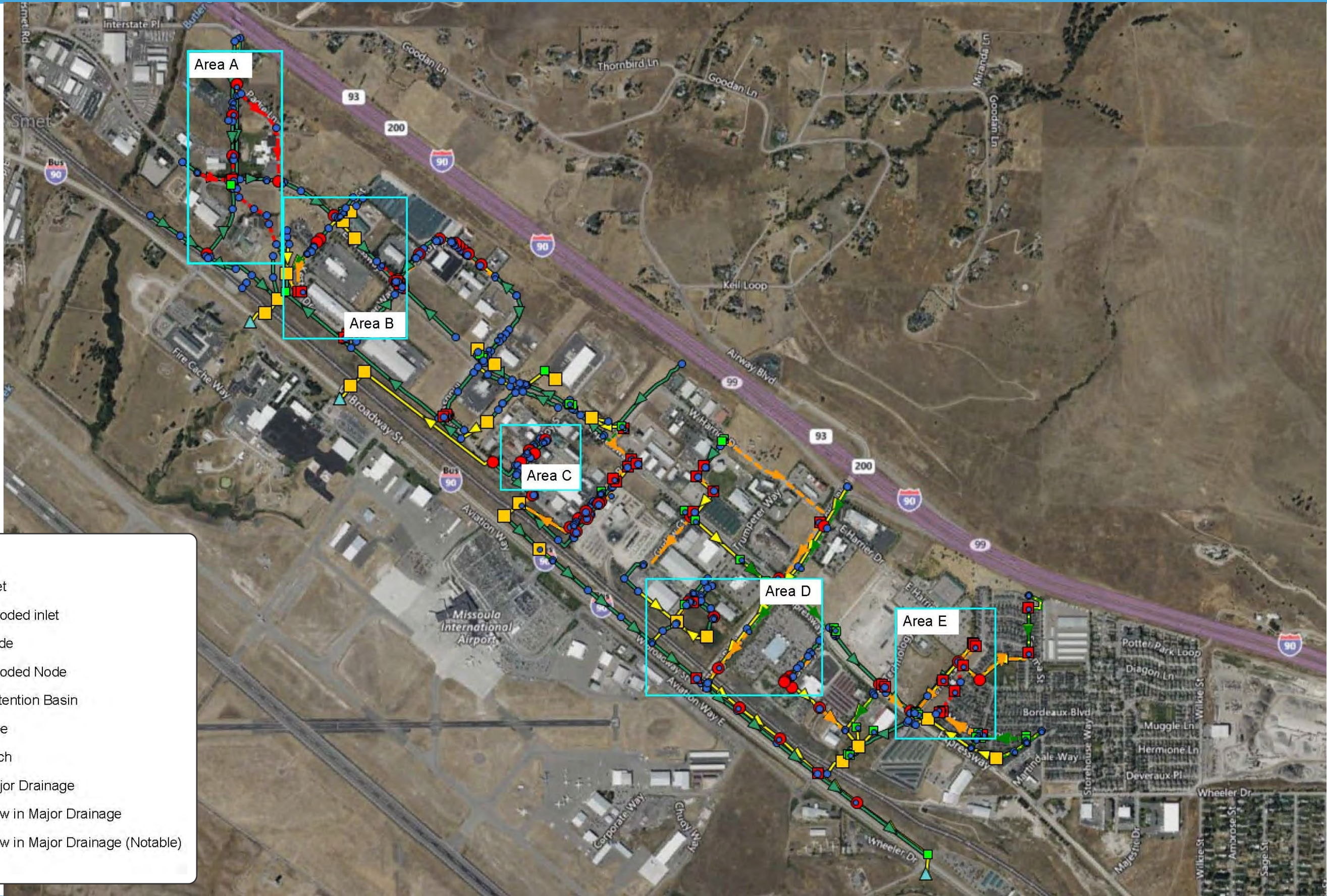


Legend

- Inlet
- Flooded inlet
- Node
- Flooded Node
- Detention Basin
- Pipe
- Ditch
- - - → Major Drainage
- - - → Flow in Major Drainage
- - - → Flow in Major Drainage (Notable)

This page intentionally left blank

Figure 7.
Missoula Development Park Flooding During 100-Year Storm Event.

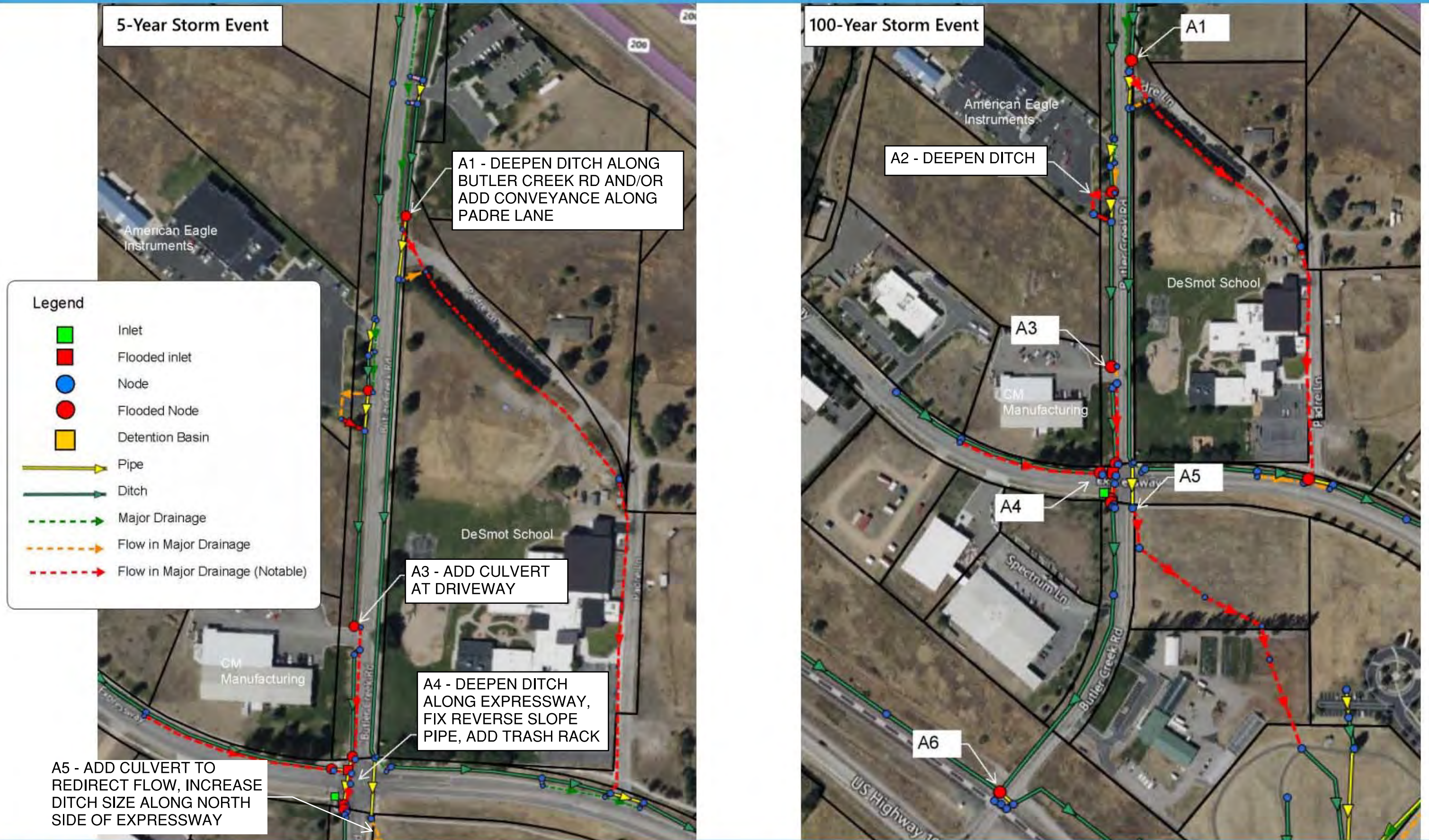


Legend

- Inlet
- Flooded inlet
- Node
- Flooded Node
- Detention Basin
- Pipe
- Ditch
- - - Major Drainage
- - - Flow in Major Drainage
- - - Flow in Major Drainage (Notable)

This page intentionally left blank

Figure 8.
Missoula Development Park Flooding - Area A.



This page intentionally left blank

Figure 9.
Missoula Development Park Flooding - Area B.

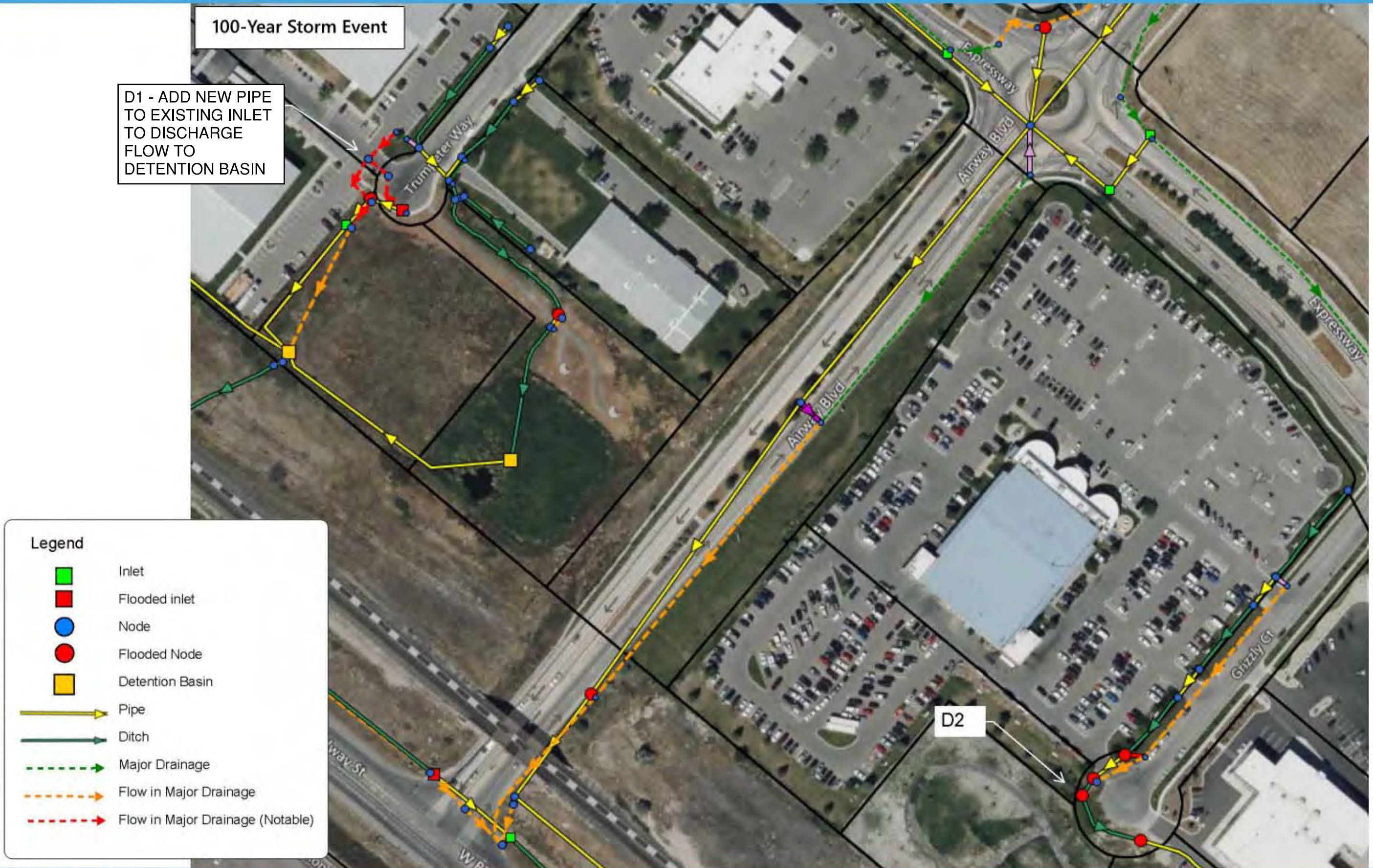


This page intentionally left blank



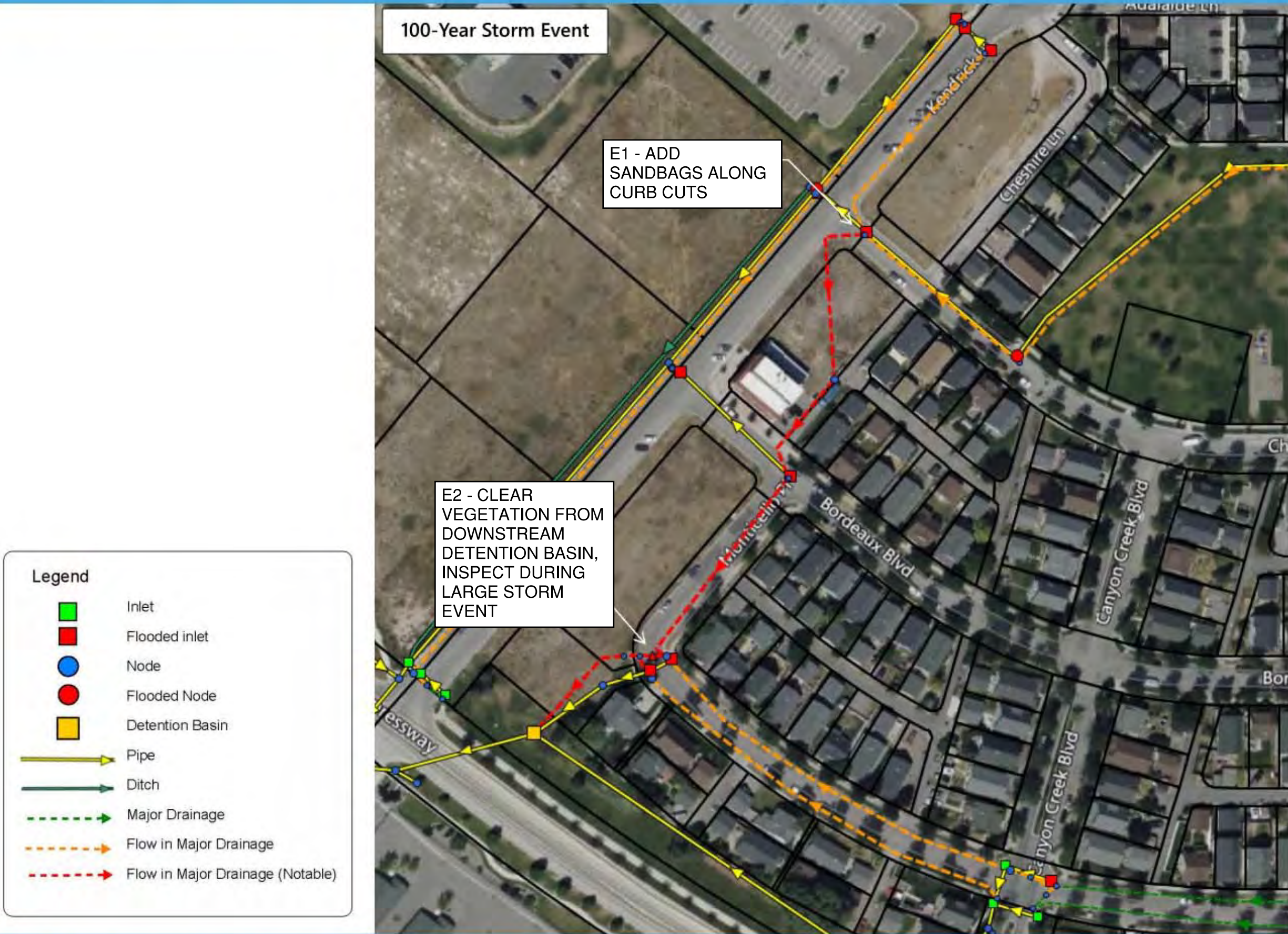
This page intentionally left blank

Figure 11.
Missoula Development Park Flooding - Area D.



This page intentionally left blank

Figure 12.
Missoula Development Park Flooding - Area E.



This page intentionally left blank

Flow monitoring data was not available for model calibration. While the City has no documented flooding complaints in the study area, the flooding in the model was typically of short duration (two or less hours) and may not be reported by neighbors or residents.

4.4.1. 5-year Storm Event Results

Surcharged and flooded conditions were observed in the model run of the 5-year storm event as shown in Figure 5 and Figure 6. Areas of flooding that did not meet the maximum street spread requirements, had potential to inundate buildings at the ground lines, or were otherwise noteworthy are described below, and are detailed in Table E.1 in Appendix E. The model showed that detention facilities (denoted as “basins” in the City GIS data) in the Development Park had sufficient capacity during the 5-year storm event.

The following two locations met the maximum street spread standards in Table 6-3 of the 2024 MCPWSS but were of concern because of proximity of flood waters to a building:

- Butler Creek Road and Padre Lane (Area A1 on Figure 8): The ditch along the east side of Butler Creek Road overtops just north of the intersection of Butler Creek Road and Padre Lane. Flood waters drain to the roadway, appear to cross Padre Lane, and drain south to DeSmet School field. A site visit confirmed that there is a low point near the northeast corner of the school building and that the most northern parking lot slopes towards the building, indicating that the building is at risk of stormwater reaching the ground line of the building. No ditch or conveyance was observed at this location along Padre Lane.
- Alloy South between Expressway and Industrial Road - 6200 Industrial Road Parcel (Area C2 on Figure 10): A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10325) inlet and enters the 6200 Industrial Road parcel (Bishops Storehouse). The hydraulic grade line (HGL) elevation for flooded node is approximately 4.4 inches greater than the estimated building floor elevation. The building is at risk if the drywell located in the parking lot becomes limited in capacity.

The following location is noted because the model showed flood water spread that exceeded the City's maximum street spread standard but did not inundate buildings at the ground line.:

- The west side of the intersection of Expressway and Butler Creek Road (Area A4 on Figure 8): This location floods on both sides of the road, exceeding the maximum street spread requirement for collector roads. The northern pipe entering the inlet structure was surveyed at a lower elevation than the pipe exiting the structure to the south, indicating a reverse slope on the pipe, and contributing to flooding in the area. Flooding occurs for approximately two hours.

The following locations did not exceed the maximum street spread standard or inundate buildings at the ground line, but are noted because the model showed flood water spread to the crown of the road (City standards allow flow to spread to the crown of the street during the 10-year storm event):

- Butler Creek Road near CM Manufacturing (Area A3 on): The ditch system appears to drain directly to Butler Creek Road (no culvert was found) from the northern end of the driveway at 6333 Butler Creek Road (CM Manufacturing property).
- Kestrel Drive at southern bend (Area B2 on Figure 9): Two catch basins flood on the east and west side (SW-INL-11951 and SW-INL-11950 respectively) at the southern bend of Kestrel Drive. These catch basins drain to west to a detention facility (SW-BSN-10127). The depth of water in the detention facility is creating a backwater condition that contributes to the flooding in the two catch basins. A field visit on April 9, 2024 was conducted to confirm model assumptions around the depth of the detention facility.

The model showed a number of areas with minor flooding that did not exceed the City standards. Flooding in these areas did not overtop the curb, reach the crown of the street, or present a risk to buildings. The locations included the ditch system along Butler Creek Road, ditches along Kestrel Court, a ditch to the south of Grizzly Court, and two catch basins on or near Kendrick Place.

4.4.2. 100-Year Storm Event Results

Flooded areas were observed during the model run of the 100-year storm event as shown in Figure 7. For locations with curbs, the model showed no exceedances of the City standard of no more than 18 inches of water depth at the gutter line during the 100-year storm event. Areas that showed flooding during the 100-year storm event included several locations where flooding extended outside of the right-of-way if no curb was present, had the potential to inundate buildings, or was otherwise noteworthy. These locations are described below and detailed in Table E.2 in Appendix E. Flooding duration was two hours or less for the majority of locations. The model showed that detention facilities in the Development Park had sufficient capacity during the 100-year storm event.

The model shows flooding during the 100-year storm event that extends outside of right-of-way and could inundate a building at the ground line at one location:

- Alloy South between Expressway and Industrial Road – 6200 Industrial Road (Area C2 on Figure 10): A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10325) inlet and enters the 6200 Industrial Road parcel (Bishops Storehouse). The hydraulic grade line (HGL) elevation for flooded node is approximately six inches greater than the estimated building floor elevation. The building is at risk if the drywell located in the parking lot becomes limited in capacity. Flooding duration is less than 30 minutes at this location. The model results show that flooding during the 5-year storm also poses a risk to the building.
- Butler Creek Road and Padre Lane (Area A1 on Figure 8): The ditch along the east side of Butler Creek Road overtops. Flood waters drain to the roadway, appear to cross Padre Lane, and drain south to DeSmet School field. A site visit confirmed that there is a low point near the northeast corner of the school building and that the most northern parking lot slopes towards the building, indicating that the building is at risk of stormwater reaching the ground line of the building. No ditch or conveyance was observed at this location along Padre Lane. The duration of flooding is approximately 1.5 hours.

The model shows flooding during the 100-year storm event at the following locations that either extend outside of the right-of-way or do not exceed City standards but are otherwise notable. For areas of notable flooding, we recommend additional investigation to confirm building inundation does not occur at the ground line:

- Intersection of Expressway and Sandpiper Dr North of Tanager Way/Kestrel (Area B3 on Figure 9): Flooding extends outside the right-of-way at this location. It occurs on the northwest side of Sandpiper Drive and extends to both the roadway and to the parcel to the north with no indication of flood waters reaching the building. In addition, flooding at the culvert inlet on the northeast corner of the intersection occurs, overtops the sidewalk, and drains to an undeveloped parcel to the northeast. It is unknown if flood waters from the culvert inlet on the northeast corner of the intersection would extend past the undeveloped parcel to the developed parcel on 5975 Sandpiper Drive because the DEM does not reflect this developed parcel. The culvert that crosses Sandpiper Drive was surveyed as having a reverse slope. The duration of flooding is approximately 2.5 hours.
- Alloy South between Expressway and Industrial Road - 5550 Alloy South Parcel (Area C1 on Figure 10): Flooding extends outside the right-of-way at this location. A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10323) inlet and enters the 5550 Alloy South (D&G Crane Services) parcel but does not reach building. Duration of flooding is less than 30 minutes.
- Grizzly Court (Area D2 on Figure 11): Flooding at this location is notable due to the need for further evaluation. The model shows flooding at both ends of the culvert on the west side of the cul-de-sac. The model also shows flooding in a ditch at the south end of the cul-de-sac. Flooding likely ponds in roadway but there is not enough information to confirm that flood waters do not extend to the parcel (5175 Grizzly Court) to the northeast because the DEM does not reflect recent development of this parcel. Because the DEM does not reflect recent improvements to the ditch or development of parcel 5175 Grizzly Court, additional investigation is recommended to evaluate the potential for flooding at this location.
- Kendrick Place and Chesapeake Way (Area E1 on Figure 12): Flooding extends outside the right-of-way at this location. Catch basin SW-INL-11648 located on Chesapeake Way and Kendrick Place floods and likely drains south to a parcel (4852 Kendrick Place). There are two openings in the curb at this location that could allow flood waters to flow towards to the parcel that would otherwise drain down the gutter line. Flood waters likely drain down Cheshire Lane to a catch basin on Bordeaux Boulevard. Because the building may be in close proximity to flood waters, further evaluation is recommended to confirm that the building will not be affected.

The 100-year storm event model run shows flood waters extending outside of the public right-of-way that do not reach the building ground lines at the following locations:

- Butler Creek Road adjacent to American Eagle instruments (Area A2 on Figure 8): The ditch along with west side of the road overtops at the downstream culvert. Flood waters cross the southern driveway and extend outside of the right-of-way, before returning to the ditch system downstream. No flooding was observed at the parcel's second driveway to the north.
- East side of intersection of Expressway and Butler Creek Road (Area A5 on Figure 8): The ditch system appears to end at the downstream end of the culvert crossing on the east side of

Expressway. Water exiting the culvert appears to drain to the parcels to the southeast until reaching a detention facility (SW-BSN-10127).

- Northwest corner of Kestrel Court and Expressway (Area B1 on Figure 9): Flows from the northwest ditch on Expressway overtop the sidewalk, enter a parcel (6401 Kestrel Court) with a baseball diamond and drain to the ditch on the west side of Kestrel Court. The model does not show flooding in the street at this location. The existing culvert is in poor condition (crushed and filled with sediment and vegetation). Duration of flooding is approximately two hours.
- Trumpeter Way (Area D1 on Figure 11): A catch basin at the southeast end of the cul-de-sac floods as well as two structures immediately downstream. Flooding occurs in the cul-de-sac and parking lot to the west at (5102 Trumpeter Court).
- Monticello Place - West Bend (Area E2 on Figure 12): The model shows flooding at the two catch basins located at a low point in Monticello Place (SW-INL-11576 and SW-INL-11614). Waters appear to pond in the roadway and eventually overtop the curb and drain southwest towards a detention facility (SW-BSN-10084). While the model does not indicate waters extending to the ground line of any building, the HGL of SW-INL-11576 is only approximately 3 inches greater than the ground elevation of the house at 4856 Monticello Place.

The 100-year storm event model run shows the following locations meet City standards but are otherwise notable:

- Butler Creek Road near CM Manufacturing (Area A3 on Figure 8): While City standards are met at this location, the ditch system appears to drain directly to Butler Creek Road (no culvert was found) from the northern end of the driveway at 6333 Butler Creek Road (CM Manufacturing property). Flooding in the street occurs for over 12 hours.
- West side of intersection of Expressway and Butler Creek Road (Area A4 on Figure 8): Flooding occurs at the northwest and southwest corners of the intersection. The northern pipe entering the inlet structure was surveyed at a lower elevation than the pipe exiting the structure to the south, indicating a reverse slope, and contributing to flooding in the area.
- Butler Creek Road north of railroad tracks and West Broadway (Area A6 on Figure 8): A ditch from the west and north connect at a culvert on the west side of Butler Creek Road just north of the railroad tracks. Flooding was observed at the inlet of culvert (SW-CULV-10411). The flood waters appear to drain across the street but may reach the railroad tracks. Further evaluation is recommended to refine model inputs and evaluate the extent of flooding.

4.4.3. Areas not Evaluated

The model indicated that flooding may occur at the following locations that were not further refined or evaluated because they were identified as owned by "other" or "unknown" in the City of Missoula GIS layers.

- East side of Alloy South between Expressway and Industrial Road (see Figure 6 and Figure 7)
- Momont Road with the exception of City owned infrastructure (see Figure 6 and Figure 7)

- Area northeast of the intersection of Expressway and Curlew Ct, and southwest of West Harrier (see Figure 6 and Figure 7)
- Sandpiper near Pelican Chemicals (see Figure 6 and Figure 7)
- Industrial Road just West of Alloy South (see Figure 6 and Figure 7)
- Curlew cul-de-sac (see Figure 7)

Additionally, the model indicated flooding outside of the Missoula Development Park project area in City owned catch basins at the intersection of Airway Boulevard and the City owned ditch West Broadway, as well as the MDT owned pipe conveying stormwater on the north side of West Broadway. Additional investigation may be warranted. This location was not recommended for further evaluation due to its location outside of the project area.

5. Alternatives Analysis

Herrera gathered the data and results from the conditions assessment and capacity analysis and determined the actions required to address the identified deferred maintenance, failing infrastructure, capacity deficits, or opportunities to reduce the maintenance effort or increase effectiveness. Alternatives were developed based on City stormwater standards and best management practices (BMPs).

Herrera analyzed alternatives by considering system needs, implementation requirements, risks, design criteria, schedule constraints, and capital cost implications. The analysis prioritized the alternatives, with critical alternatives having high priority and less critical alternatives having medium priority. Whether alternatives were assigned a high priority or a medium priority, all recommended alternatives should be implemented to have a fully functional stormwater system, and are included in the cost estimate.

5.1. Conditions Assessment Recommendations

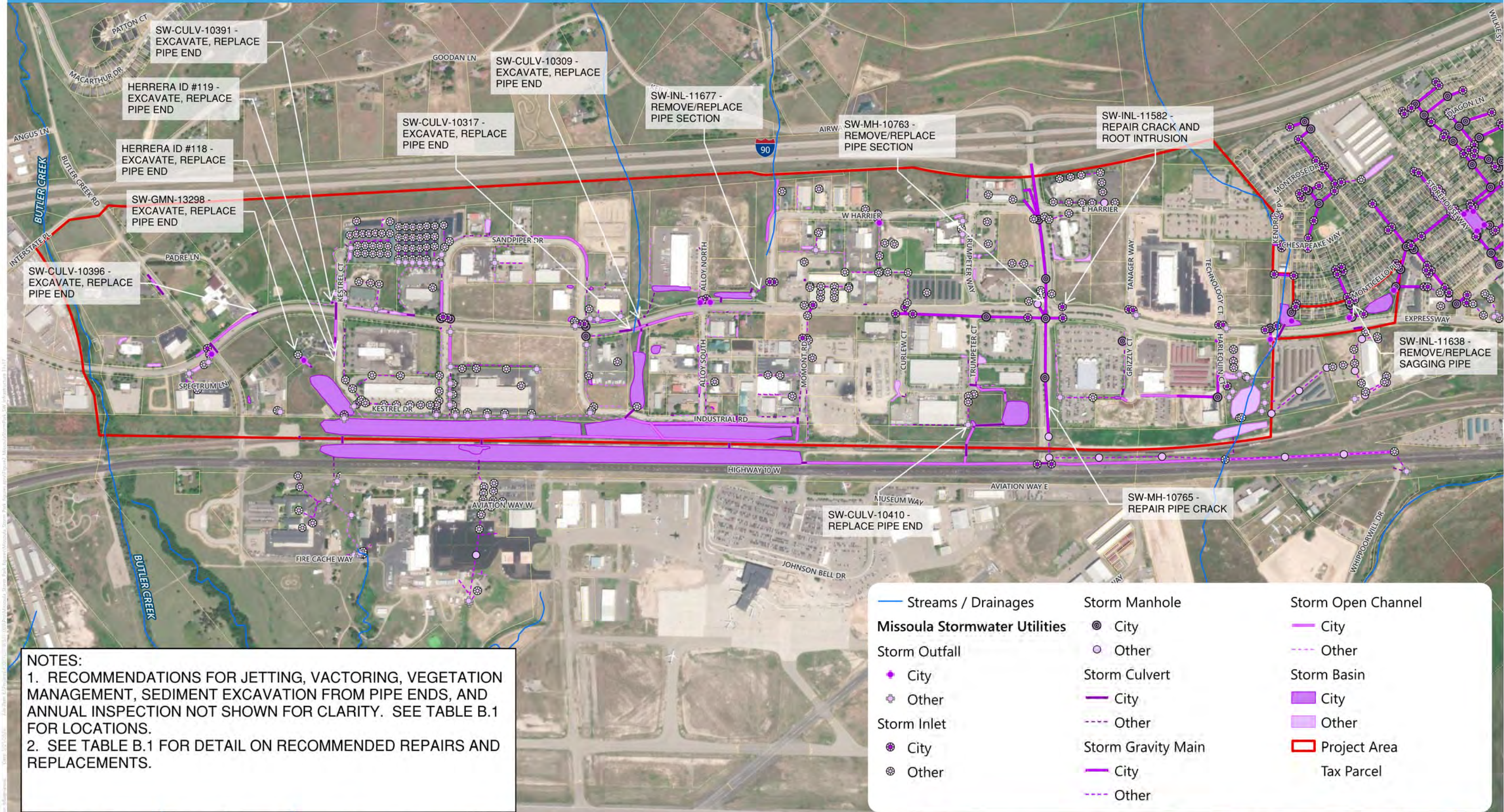
Based on the observations from the field inspections, data from the survey, and footage from the CCTV inspections, Herrera prepared recommendations for mitigating the identified issues, included in Table B.1 in Appendix B. Recommendations include recommendation type, priority, and details. Categories for type of maintenance aided in the decision-making process to maintain, repair, or replace system components in order to bring them up to City standards prior to the turnover of the system. Maintenance categories include deferred maintenance, repair, and remove and replace. All system components are also recommended for routine inspection in the future. Figure 13 shows locations of recommended repairs and replacements. Recommended deferred maintenance locations are not called out for clarity.

5.1.1. Deferred Maintenance

Deferred maintenance is recommended for the stormwater system components that need standard upkeep typical of a stormwater system. In most cases this involves jetting and cleaning a pipe of sediment, vegetation management and control at culvert inlets, in ditches, and in ponds; debris and sediment removal from concrete inlets and mainholes; sediment management in ditches; pipe jetting; and/or invasive weed/vegetation management.

Vegetation management that includes invasive weed removal will also require re-seeding and/or a biodegradable erosion control mat to stabilize the area where vegetation was removed.

Deferred maintenance also includes excavation of deposited sediments at culvert inlets and outfalls, excavation to ensure flow paths from culverts or outlets to swales, grading of the surface post excavation, and revegetation of the disturbed areas. We recommend future routine inspection to ensure flow paths continue to function after deferred maintenance is addressed.



NOTES:
 1. RECOMMENDATIONS FOR JETTING, VACTORING, VEGETATION MANAGEMENT, SEDIMENT EXCAVATION FROM PIPE ENDS, AND ANNUAL INSPECTION NOT SHOWN FOR CLARITY. SEE TABLE B.1 FOR LOCATIONS.
 2. SEE TABLE B.1 FOR DETAIL ON RECOMMENDED REPAIRS AND REPLACEMENTS.

This page intentionally left blank

5.1.2. Repair

Stormwater system components recommended for repair include items that have been damaged but only require a portion of the system component to be repaired, rather than the entire system component to be removed, and replaced. This category includes several damaged or crushed culvert ends since in many cases a short portion of the pipe can be exposed, cut off, and replaced using in-kind pipe and a repair band.

5.1.3. Remove and Replace

Stormwater system components recommended for removal and replacement include components that have been damaged to a point where they cannot be repaired. These items include culverts that have been structurally compromised, and pipes that have been broken or damaged by other utilities and require a full removal and replacement of the system component to bring it up to a functional state and City of Missoula Standards. In most cases, these items also include surface restoration to bring the public roadway, boulevard, or access road back to current condition.

5.1.4. Routine Inspection

Stormwater system components recommended for routine inspection should be inspected for structural integrity, proper function, and maintenance needs each calendar year, or more frequently if needed. Inspection findings will be used to determine if maintenance, repair, or replacement is needed to ensure proper function of the stormwater system.

5.2. Capacity Analysis Recommendations

Based on the results of the modeling showing the areas that flood for the 5-year and 100-year storm events, Herrera prepared recommendations for mitigating the identified issues, included in Table F.1 in Appendix F. Recommendations include recommendation type, priority, and details. Categories for type of maintenance aided in the decision-making process to maintain, repair, or replace system components in order to bring them up to City standards prior to the turnover of the system. Maintenance categories include deferred maintenance, repair, additional infrastructure, routine inspection, and further evaluation.

5.2.1. Deferred Maintenance

Deferred maintenance is recommended for the stormwater system components that need standard upkeep typical of a stormwater system. In most cases this involves jetting and cleaning a pipe of sediment, vegetation management and control at culvert inlets, in ditches, and in ponds; debris and sediment removal from concrete inlets and mainholes; sediment management in ditches; pipe jetting; and/or invasive weed/vegetation management.

Vegetation management that includes invasive weed removal will also require re-seeding and/or a biodegradable erosion control mat to stabilize the area where vegetation was removed.

Deferred maintenance also includes excavation of deposited sediments at culvert inlets and outfalls, excavation to ensure flow paths from culverts or outlets to swales, grading of the surface post excavation, and revegetation of the disturbed areas. We recommend future routine inspection to ensure flow paths continue to function after deferred maintenance is addressed.

5.2.2. Repair

Stormwater system components recommended for repair include items that have been damaged but only require a portion of the system component to be repaired, rather than the entire system component to be removed, and replaced. This category includes several damaged or crushed culvert ends since in many cases a short portion of the pipe can be exposed, cut off, and replaced using in-kind pipe and a repair band.

5.2.3. Additional Infrastructure

For locations where the capacity assessment shows the system does not accommodate the 5-year event, Herrera recommends additional infrastructure. Additional infrastructure includes conveyance upgrades or modifications such as pipes or ditches as well as elements to sufficiently reduce the on-going operations and maintenance efforts such as the addition of a trash rack on a culvert inlet.

5.2.4. Routine Inspection

Stormwater system components recommended for routine inspection should be inspected for structural integrity, proper function, and maintenance needs each calendar year, or more frequently if needed. Inspection findings will be used to determine if maintenance, repair, or replacement is needed to ensure proper function of the stormwater system.

5.2.5. Further Evaluation

Stormwater system components recommended for future evaluation are those for which the model may have shown flooding, but for which there was uncertainty on the model inputs or results, such as influence by private property infrastructure or insufficient data to fully evaluate flooding extents.

5.3. Design Criteria

Recommended actions in this Alternatives Analysis will meet the requirements in the stormwater design criteria for the City of Missoula, included in Chapter 6 – Stormwater System, of the 2024 MCPWSS (City of Missoula, 2024). These standards provide detailed requirements for stormwater management systems within the City, which must convey the expected post-development peak flow without overtopping curbs during a 10-year storm event and without inundating buildings or drainfields during a 100-year event. Although the City stormwater standards require that new systems be designed to manage the 10-year, 24-hour storm event, the existing stormwater system was designed under previous County requirements, and was built to manage a 5-year, 24-hour storm event. Thus, the capacity analysis conducted for this analysis evaluated the 5-year, 24-hour storm event as the design storm.

The drainage systems designed to manage these two requirements are defined in Section 6.2.7 Hydrology of the 2024 MCPWSSM as Minor and Major Drainage Systems, as indicated below.

1. Minor Drainage System. *The Minor Drainage System consists of curbs, gutters, ditches, culverts, storm drains (and other conduits), open channels, pumps, detention/retention basins, infiltration facilities, and outfalls. The Minor Drainage System shall be designed to carry runoff from the peak flow rate from the 10-year storm event.*
2. Major Drainage System. *The Major Drainage System consists of pathways that are provided for runoff to safely flow to natural or engineered channels. The Major Drainage System shall be designed to safely carry runoff from the 100-year storm, without inundating structures and drainfields, overtopping roadways, or interrupting traffic and emergency services. Flows from the 100-year storm event can be carried in the urban street system (within acceptable depth criteria), open channels, storm pipes, and other conveyance facilities.*

When recommending alternative actions required for the stormwater system to be functional, the design criteria listed above will be applied to ensure compliance with City of Missoula requirements.

5.4. Construction Schedule Considerations

For a stormwater system to function properly, maintenance, repair, and replacement requirements must be identified and addressed, and scheduling the work at the proper time of year can aid in the ease of maintenance, as well as maintenance longevity. During the conditions assessment, approximately 7,000 lineal feet of pipe, 42 inlets, and 30 mainholes were observed. Many of these system components were identified as needing some form of maintenance ranging from routine cleaning to removal and replacement of pipe sections. Conducting the recommended maintenance, repairs, removal and replacement, and/or additional infrastructure will help reduce the risk of flooding, avoid the need for emergency repairs, and adequately manage stormwater in the Development Park. The recommendations made in this report address several years of deferred maintenance and may not represent a realistic yearly maintenance assessment or budget.

Scheduling of the maintenance, repairs, removal and replacement, and/or additional infrastructure should be done in the late summer or fall, when stormwater flows are lower so that bypass requirements are minimized. Work should be scheduled so that it is completed prior to asphalt plants closing and the ground freezing, to allow for asphalt patching if required. Typical "end of the season" for asphalt production and ground freeze is October 31st.

Some work elements may be performed by County crews, such as maintenance or small repairs. Other larger repairs, replacements, and/or additional infrastructure will likely be performed by a Contractor. The larger repairs, replacements, and/or additional infrastructure may be compiled into a set of bid documents for a General Contractor to perform the work or sent out as work orders for more specific work (e.g., vegetation management to a landscaping company), or issued as a combination of the two.

5.4.1. Future Inspections and Maintenance

System inspections and evaluations can be conducted by City staff and will provide guidance for upcoming maintenance activities. Each fall, the system's major components (i.e., swales, ponds, etc.) should be inspected for any obvious obstructions including overgrown vegetation or deposited sediment/soils. With winter coming, these obstructions should be removed to maximize capacity since spring snow melt and rain events require the most storage.

In the spring, the system should be cleaned of road sanding material, trash, and any other deleterious material left from the winter that could potentially obstruct flow. This can be accomplished using a high pressure jetting and vacuum truck and be considered as regular maintenance every spring.

During the inspections, individual system components should be identified for repair or replacement, along with the system as a whole. Broken pipes or structures, blocked inlets or outlets, or any other obstruction requiring removal and replacement or repair would fall into this category.

5.4.1.1. Fall Season

The purpose of inspecting the system in the fall is to determine whether obstructions are present that could prevent the system from functioning to convey flow during spring runoff. Capacity should be the main concern, especially as it relates to swales and ponds where overtopping could result in inundation of a structure or drainfield. Vegetation, deposited soils, organic debris, and refuse from illicit dumping are some of the potential items that could compromise capacity and should be addressed.

5.4.1.2. Spring Season

Spring is the best time to clear the system of material left from the winter season like road sand, refuse from illicit dumping, and other deleterious materials. Inlets and pipes should be of main concern as they will collect much of these during the winter season and can be jetted with high pressure water. Once inlets and pipes have been cleared, they should be back in functioning order and able to convey the spring runoff and storm events.

As excavation and surface restoration are not a consideration for this work, once snowmelt has occurred, the cleaning can commence. March 1st is a typical date to start the process, although any time before May should be effective.

5.5. Cost Estimates

Herrera prepared an estimate of probable cost for the recommended maintenance, repair, removal/replacement, and additional infrastructure requirements for the existing infrastructure as determined in the conditions assessment and capacity analysis. Table 5 provides a summary of the recommendations and associated quantities that went into calculating the capital costs. The total estimated cost for the recommended work is \$588,320. Detailed cost estimates are included in Appendix G.

Costs included in the estimate are one-time costs, and do not include future years for recommendations that include annual or routine type activities. Costs associated with recommendations for routine inspection and further evaluation are not included in the cost estimates. It is assumed that City of Missoula staff and crews will conduct future routine inspections of the stormwater system once it is incorporated into the City's overall system.

The cost estimate incorporates the recommendations for deferred maintenance, repair, remove/replace, and additional infrastructure, and typically includes the following:

- Deferred maintenance – work includes jetting the pipes, cleaning debris and sediment out of inlet structures, and vegetation management. This work may need to be completed annually, however costs in the estimate represent only one occurrence to address deferred maintenance. Deferred maintenance activities also include excavation and haul of material at and around culvert inlets and outfalls, grading of the channel to ensure flow once excavation has occurred, and seeding the disturbance left by the grading. These activities may not be required annually; however, the stormwater system should be inspected regularly to ensure flow paths are maintained.
- Repair – work includes repair of existing infrastructure and does not include replacement of the entire system component (i.e., damaged culvert ends).
- Removal and replacement – work includes removal and replacement of existing infrastructure, and may include surface restoration (i.e., paving of a driveway or roadway above a culvert or pipe, revegetation, etc.).
- Additional Infrastructure – work includes installation of pipes and/or ditches as required to address capacity deficiencies in the system. Work also includes installation of trash racks or other items necessary to ensure the system continues to function.

The cost estimate includes construction costs (mobilization, material, labor, equipment), contingency, engineering/technical support, and construction management. Support costs such as mobilization, traffic control, erosion control, and utility protection and relocation were estimated based on the total costs of the project. These general requirement costs may vary depending on how the work is conducted (i.e., Public bid or internal work crews, one large project or smaller projects, etc.). Costs associated with repair and replacement assume the mobilization cost is separate and only labor, equipment, and materials for the actual pipe work are included in the corresponding pipe item. A contingency of 30 percent has been applied to the construction total to account for changes in unit prices at the time of construction/maintenance, modifications to the preliminary alternatives, and other unforeseen price modifications. Engineering design is assumed for only those items that require design, including deepening or regrading of ditches, removal/replacement of pipes, and installation of additional infrastructure; other items may require technical support for the work, such as jetting and vacuuming and repair of culvert ends. Construction management is assumed to be required for the majority of the items in the cost estimate. Although some of the work could be done by County crews, the cost estimate assumes work will be done by a contractor or multiple contractors, in order to provide a conservative estimate.

Table 5 shows the approximate quantities for each recommendation type (deferred maintenance, repair, remove/replace, or additional infrastructure requirements) based on the findings of the conditions assessment and capacity analysis.

Table 5. Recommendation Quantities.			
Recommendation Type	Recommendation Description	Quantity	Unit
Deferred Maintenance			
	Jetting and Vacuum – Mainholes	30	Each
	Jetting and Vacuum – Inlets	42	Each
	Jetting and Vacuum – Pipe	7,000	L.F.
	Vegetation Management	1	LS
	Invasive Weed Management	1	LS
	Swale Excavation and Grading	1	LS
Repair			
	10" CMP – 5' section with repair band	1	Each
	18" CMP – 5' section with repair band	1	Each
	20" CMP – 5' section with repair band	1	Each
	42" CMP – 5' section with repair band	1	Each
	12" ADS – 5' section with repair band	1	Each
	16" ADS – 5' section with repair band	1	Each
	Deepening Ditches, Grading, and Restoring Vegetation	2,500	L.F.
Remove/Replace			
	15" CMP	20	L.F.
	15" CPP	107	L.F.
Additional Infrastructure			
	15" CMP	60	L.F.
	15" CPP	75	L.F.
	18" CPP	30	L.F.
	Ditch Grading	45	L.F.

5.5.1. Deferred Maintenance

Stormwater systems require routine maintenance to ensure sediment, debris and vegetation have not impeded flow, reducing capacity. For maintenance at the Missoula Development Park stormwater system, we assumed that all pipes including culverts should be jetted with high pressure water to ensure they are clean and free flowing. Additionally, each inlet and mainhole should have debris removed and the sediment vacuumed from the floor. Overgrown vegetation should be removed from stormwater flow

paths, including at the inlet/outfall of culverts; invasive weeds should be removed; and the area stabilized with an appropriate seed mix or erosion control mat. Built up sediment and material should be excavated from around the inlet/outfall of culverts and the area graded and reseeded post excavation.

The going rate cost for jetting pipe is approximately \$0.95 per lineal foot. To be conservative, we assumed half the pipes in the project area would need a second jetting, so the cost estimate assumes a unit cost of \$1.43 (or 1.5 times \$0.95). It is assumed that vector trucks will be able to decant and dump sediment at the City's maintenance facility. This may depend on facility capacity and other scheduled operations and maintenance activities at the time of work.

Each inlet/catch basin/mainhole will need to be cleaned of debris and the sediment vacuumed from the structure floor. The going rate for a vacuum truck is \$300 per hour and we assumed approximately 1 hour at each inlet. As mainholes tend to be a bit larger and could require more time, 1.5 hours was assumed at each mainhole.

After the scope of potential vegetation management was assessed, and previous vegetation management costs for similar work was reviewed, an estimate of \$48,000 per year was assumed. Additionally, \$15,000 was included for invasive weed management to account for the removal of Russian Olive trees and other invasive species, as well as herbicide application.

For the excavation of built up sediment and material from around the inlets/outfalls of culverts, it was assumed a small rubber tracked excavator with a ground support laborer would be employed to remove the excess material and load it into a truck for disposal. The cost for the excavation was assumed to be approximately 0.5 hours on each end of the culvert with a truck for support.

5.5.2. Repair

Repair items are those related to the ends of culverts that have been crushed or damaged. In these cases, we assumed that some of the cost of excavation was picked up in the deferred maintenance category with additional excavator time to expose the end of the pipe and repair the damaged end. Once exposed, the crew must cut off the damaged portion of pipe, add a new length of pipe to replace what was removed, and backfill. Pipe materials and repair band costs are included in this item.

Grading and seeding are also included in the deferred maintenance category.

5.5.3. Remove and Replace

These items refer to specific problem areas recognized as needing full removal and replacement of the infrastructure. In these cases, we assumed the need for surface restoration as they occur under asphalt or a median. As the stormwater system components vary depending on the location in question, the costs reflect the material, labor, and equipment to accomplish the work.

5.5.4. Additional Infrastructure

These items address problem areas identified in the capacity analysis. Costs include material, labor, and equipment to accomplish the work, and similar to the remove and replace items, include surface restoration where necessary.

6. References

City of Missoula. 2022a. Development Park – Analysis of Existing Parks as Functioning Stormwater Detention Basins Memorandum.

City of Missoula. 2022b. Missoula Maps – Infrastructure and Utilities. Accessed 2022-2024 at URL <<https://missoulamaps-cityofmissoula.hub.arcgis.com/apps/22b7d99814454e2990e49b7879f64090/explore>>.

City of Missoula. 2024. 2024 Missoula City Public Works Standards and Specifications Manual. January 2024.

Druyvestein Johnson & Anderson. 1996. Hydrology Report for Missoula Development Park including Drainage Calculations and Narrative for Missoula Development Park. Prepared by Druyvestein Johnson & Anderson Consulting Engineers and Land Surveyors, Missoula, Montana. January, 1996.

Montana State Library. 2019. Lidar for Montana (Ver. MISSOULA_2019_ClrkFrkBttrtRvr), accessed January 8, 2024 at URL <<https://montana.maps.arcgis.com/apps/MapSeries/index.html?appid=55cc886ec7d2416d85beca68d05686f4>>.

This page intentionally left blank

Appendix A

Conditions Assessment Photo Log

This page intentionally left blank

MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
1	SW-INL-11612	Inlet



Herrera ID	MSO ID	Feature
2	SW-INL-11612	Manhole





Herrera ID	MSO ID	Feature
3	SW-INL-11652	Inlet





Herrera ID	MSO ID	Feature
4	SW-INL-11652	Manhole





Herrera ID	MSO ID	Feature
5		Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
6	SW-INL-11651	Inlet



Herrera ID	MSO ID	Feature
7	SW-INL-11576	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
8	SW-INL-11614	Inlet



Herrera ID	MSO ID	Feature
9	SW-INL-11637	Inlet





Herrera ID	MSO ID	Feature
10	SW-INL-11636	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
11	SW-INL-11635	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
12	SW-INL-11638	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
13	SW-MH-10706	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
14	SWL-INL-11615	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
15	SWL-INL-11616	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
16	SW-MH-10700	Manhole



Herrera ID	MSO ID	Feature
17		Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
18	SW-DC-10152	Swale



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
19		Manhole





MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
20	SW-MH-10701	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
21	SW-GMN-12315	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
22	SW-BSN-10083	Pond



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
23	SW-INL-11646	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
24	SW-MH-10707	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
25	SW-GMN-12313	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
26	SW-CULV-10264	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
27	SW-GMN-12314	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
28	SW-MH-10699	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
29	SW-INL-11599	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
30		Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
31		Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
32	SW-GMN-13177	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
33	SW-MH-10694	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
34		Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
35		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
36		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
37	SW-GMN-12489	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
38	SW-GMN-12713	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
39	SW-GWM-12714	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
40	SW-INL-11757	Concrete Structure



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
41	SW-INL-11758	Concrete Structure



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
42	SW-DC-10222	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
43	SW-MH-10841	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
44		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
45		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
46		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
47	SW-INL-11773	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
48	SW-GMN-12712	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
49	SW-INL-11987	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
50	SW-DC-10163	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
51	SW-BSN-10132	Swale



Herrera ID	MSO ID	Feature
52		Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
53	SW-GMN-13453	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
54	SW-INL-11548	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
55	SW-INL-11549	Inlet





MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
56	SW-GMN-13162	Pipe End





Herrera ID	MSO ID	Feature
57	SW-GMN-13161	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
58	SW-INL-11547	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
59	SW-INL-11546	Inlet





Herrera ID	MSO ID	Feature
60		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
61	SW-INL-11582	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
62	SW-INL-11581	Inlet





Herrera ID	MSO ID	Feature
63	SW-MH-10765	Manhole





Herrera ID	MSO ID	Feature
64	SW-MH-10766	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
65	SW-BSN-10107	Pond





Herrera ID	MSO ID	Feature
66	SW-CULV-10358	Pipe End





Herrera ID	MSO ID	Feature
67	SW-CULV-10358	Pipe End





Herrera ID	MSO ID	Feature
68	SW-CULV-10353	Concrete Structure





Herrera ID	MSO ID	Feature
69	SW-CULV-10353	Pipe End

MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
70	SW-CULV-10353	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
71	SW-CULV-10410	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
72	SW-CULV-10354	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
73	SW-CULV-10354	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
74	SW-CULV-10356	Pipe End





Herrera ID	MSO ID	Feature
75	SW-CULV-10356	Concrete Structure





Herrera ID	MSO ID	Feature
76	SW-CULV-10355	Pipe End





Herrera ID	MSO ID	Feature
77	SW-CULV-10355	Pipe End





Herrera ID	MSO ID	Feature
78	SW-INL-12018	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
79	SW-CULV-10340	Pipe End





Herrera ID	MSO ID	Feature
80	SW-CULV-10340	Pipe End





Herrera ID	MSO ID	Feature
81	SW-BSN-10135	





Herrera ID	MSO ID	Feature
82		





Herrera ID	MSO ID	Feature
83	SW-CULV-10416	Pipe End





Herrera ID	MSO ID	Feature
84	SW-CULV-10320	Pipe End





Herrera ID	MSO ID	Feature
85	SW-BSN-10093	





Herrera ID	MSO ID	Feature
86	SW-CULV-10320	Concrete Structure





Herrera ID	MSO ID	Feature
87	SW-BSN-10092	





Herrera ID	MSO ID	Feature
88	SW-BSN-10092	Concrete Structure





Herrera ID	MSO ID	Feature
89	SW-BSN-10094	





Herrera ID	MSO ID	Feature
90	SW-BSN-10093	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
91	SW-BSN-10095	



Herrera ID	MSO ID	Feature
92	SW-CULV-10327	Pipe End





Herrera ID	MSO ID	Feature
93	SW-CULV-10327	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
94	SW-MH-10871	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
95	SW-CULV-10365	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
96	SW-CULV-10365	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
97	SW-GMN-13242	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
98	SW-BSN-10134	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
99	SW-CULV-10415	Concrete Culvert



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
100	SW-BSN-10134	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
101	SW-INL-11956	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
102	SW-INL-11951	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
103	SW-INL-11950	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
104	SW-INL-12133	Concrete Structure



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
105	SW-BSN-10127	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
106	SW-DC-10204	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
107	SW-CULV-10414	Concrete Culvert



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
108	SW-BSN-10134	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
109	SW-CULV-10413	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
110		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
111	SW-BSN-101038	



Herrera ID	MSO ID	Feature
112	SW-CULV-10395	Pipe End





Herrera ID	MSO ID	Feature
113	SW-CULV-10395	Pipe End





Herrera ID	MSO ID	Feature
114	SW-GMN-13297	Pipe End





Herrera ID	MSO ID	Feature
115	SW-INL-12132	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
116	SW-GMN-13298	Pipe End





Herrera ID	MSO ID	Feature
117	SW-BSN-10127	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
118		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
119		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
120	SW-CULV-10394	Pipe End



Herrera ID	MSO ID	Feature
121	SW-CULV-10394	Pipe End





Herrera ID	MSO ID	Feature
122	SW-CULV-10393	Pipe End





Herrera ID	MSO ID	Feature
123	SW-CULV-10393	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
124	SW-GMN-13238	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
125	SW-GMN-13239	Pipe End





Herrera ID	MSO ID	Feature
126	SW-INL-11971	Inlet





Herrera ID	MSO ID	Feature
127	SW-MH-10762	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
128	SW-MH-10763	Manhole





Herrera ID	MSO ID	Feature
129	SW-MH-10764	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
130	SW-INL-11583	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
131	SW-MH-10779	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
132	SW-INL-11594	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
133	SW-INL-11592	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
134	SW-INL-11974	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
135	SW-CULV-10326	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
136	SW-CULV-10326	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
137	SW-CULV-10309	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
138	SW-CULV-10319	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
139	SW-CULV-10319	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
140	SW-CULV-10317	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
141	SW-OC-10074	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
142		Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
143	SW-MH-10840	CSI Manhole Riser



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
144	SW-GMN-13169	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
145	SW-CULV-10378	Pipe End





MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
147	SW-CULV-10392	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
148	SW-CULV-10422	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
149	SW-CULV-10421	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
150	SW-CULV-10421	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
151	SW-CULV-10421	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
152	SW-INL-12162	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
153	SW-GMN-13324	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
154	SW-INL-12161	Inlet





Herrera ID	MSO ID	Feature
155	SW-GMN-13323	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
156	SW-CULV-10422	Pipe End





Herrera ID	MSO ID	Feature
157	SW-CULV-10396	Pipe End





Herrera ID	MSO ID	Feature
158	SW-CULV-10396	Pipe End





Herrera ID	MSO ID	Feature
159	SW-CULV-10391	Pipe End





Herrera ID	MSO ID	Feature
160	SW-CULV-10391	Pipe End





Herrera ID	MSO ID	Feature
161	SW-CULV-10392	Pipe End





Herrera ID	MSO ID	Feature
162	SW-CULV-10387	Pipe End





Herrera ID	MSO ID	Feature
163	SW-CULV-10387	Pipe End





Herrera ID	MSO ID	Feature
164	SW-GMN-13138	Pipe End





Herrera ID	MSO ID	Feature
165	SW-MH-10753	Manhole





Herrera ID	MSO ID	Feature
166	SW-GMN-13139	Pipe End





Herrera ID	MSO ID	Feature
167	SW-INL-11579	Inlet





Herrera ID	MSO ID	Feature
168	SW-MH-10754	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
169	SW-GMN-13136	Pipe End





MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
170	SW-BSN-10090	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
171	SW-INL-11969	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
172	SW-GMN-13165	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
173	SW-INL-11578	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
174	SW-INL-11577	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
175	SW-MH-10752	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
176	SW-MH-10752	Manhole



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
177	SW-CULV-10316	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
178	SW-CULV-10316	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
179	SW-GMN-13166	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
180	SW-BSN-10088	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
181	SW-CULV-10309	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
182	SW-CULV-10308	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
183	SW-CULV-10308	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
184	SW-CULV-10307	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
185		Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
186	SW-BSN-10087	



Herrera ID	MSO ID	Feature
187	SW-CULV-10302	Pipe End





Herrera ID	MSO ID	Feature
188	SW-CULV-10302	Pipe End





Herrera ID	MSO ID	Feature
189	SW-INL-12013	Inlet





Herrera ID	MSO ID	Feature
190	SW-INL-12012	Inlet





Herrera ID	MSO ID	Feature
191	SW-CULV-10303	Pipe End





Herrera ID	MSO ID	Feature
192	SW-CULV-10304	Pipe End





Herrera ID	MSO ID	Feature
193	SW-CULV-10303	Pipe End





Herrera ID	MSO ID	Feature
194	SW-CULV-10303	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
195	SW-BSN-10086	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
196	SW-CULV-10306	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
197	SW-CULV-10306	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
198	SW-CULV-10305	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
199	SW-CULV-10305	Pipe End



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
200	SW-INL-11677	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
201	SW-INL-11676	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
202		



Herrera ID	MSO ID	Feature
203	SW-INL-12545	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
204	SW-INL-11593	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
205	SW-INL-12025	Inlet





Herrera ID	MSO ID	Feature
206	SW-INL-11678	Inlet



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
207	SW-MH-10839	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
208	SW-CULV-10413	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG



Herrera ID	MSO ID	Feature
209	SW-BSN-10136	



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
210	SW-CULV-10414	Concrete Culvert



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
211	SW-CULV-10415	Concrete Culvert



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
212	SW-CULV-10416	Concrete Culvert



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
213		



Herrera ID	MSO ID	Feature
214		

MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
215		



Herrera ID	MSO ID	Feature
216		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
217		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
218		



Herrera ID	MSO ID	Feature
219		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
220		



Herrera ID	MSO ID	Feature
221		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
222		



Herrera ID	MSO ID	Feature
223		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
224		



Herrera ID	MSO ID	Feature
225		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
226		



Herrera ID	MSO ID	Feature
227		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
228		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
229		



MISSOULA DEVELOPMENT PARK – PHOTOGRAPHIC LOG

Herrera ID	MSO ID	Feature
230		



Appendix B

Conditions Assessment Summaries

This page intentionally left blank

Table B.1 Conditions Assessment Summary and Recommendations

Herrera GPS Object ID	MSO_ID	Shape Length (ft)	Diameter (in)	Material	Feature Type	Condition Description	Recommendation Type	Recommended Maintenance and/or Repair	Priority	Cost Estimate Line Items
1	SW-INL-11612	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
2	SW-INL-11612	N/A	N/A	CONC	Mainhole	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
3	SW-INL-11652	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
4	SW-INL-11652	N/A	N/A	CONC	Mainhole	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
5	No City ID	N/A	N/A	CONC	Mainhole	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
6	SW-INL-11651	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
7	SW-INL-11576	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris, FROM CCTV on pipe to SE: leaf and gravel dam, possible oblong pipe section	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
8	SW-INL-11614	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris, FROM CCTV on pipe to SE: Vertical pipe protruding, likely privately owned	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
9	SW-INL-11637	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
10	SW-INL-11636	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
11	SW-INL-11635	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
12	SW-INL-11638	N/A	24	CPP	Inlet	Reasonably clean, flow not impacted but some debris, FROM CCTV on pipe to S: Sag in pipe leave dam blocking water flow, oblong	Deferred Maintenance	Jetting and vactoring, replace sagging sections of pipe. Sag identified in CCTV does not appear to affect functionality.	Medium	1.0, 2.0, 8.5
13	SW-MH-10706	N/A	N/A	CONC	Mainhole	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
14	SWL-INL-11615	N/A	N/A	CONC	Inlet	Pipe is half full of debris	Deferred Maintenance	Jetting and vactoring	High	1.0, 2.0
15	SWL-INL-11616	N/A	N/A	CONC	Inlet	Reasonably dirty, debris, FROM CCTV: SW-INL-10616 Obstructed at access point. Jetted and vactored. Recommend annual jetting and vactoring.	Deferred Maintenance	Jetting and vactoring. Pipe was jetted and vactored during CCTV inspection.	High	1.0, 2.0
16	SW-MH-10700	N/A	N/A	CONC	Mainhole	Standing water with pipe submerged, FROM CCTV: Pipe was approx 50% submerged in water. Vactored pipe, however flow filled it up again.	Deferred Maintenance	Jetting and vactoring, large structure. Inspect after vegetation management at SW-GMN-12315 to open flow path - if water is still present in the pipe, inspect for inflow/infiltration or illicit discharge.	High	1.0, 2.0, 3.0
17	No City ID	N/A	N/A	CONC	Mainhole	Standing water	Deferred Maintenance	Jetting and vactoring, check structure for damage after cleaning	High	1.0, 2.0
18	SW-DC-10152	N/A	N/A	Soil	Basin	Grass swale	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
19	No City ID	N/A	N/A	CONC	Mainhole	Standing water	Deferred Maintenance	Jetting and vactoring, large structure	High	1.0, 2.0
20	SW-MH-10701	N/A	N/A	CONC	Mainhole	Standing water	Deferred Maintenance	Jetting and vactoring, large structure	High	1.0, 2.0
21	SW-GMN-12315	38	30	HDPE	Pipe End	HDPE pipe outlet blocked by thick vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path, vegetation management, large diameter	High	1.0, 2.0, 3.0, 4.0
22	SW-BSN-10083	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
23	SW-INL-11646	94	24	CMP	Pipe End	Partially blocked by vegetation but good flow through 24-inch CMP with flared end, FROM CCTV on pipe to E: Leaf dam and gravel at 89 feet to end of pipe	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
24	SW-MH-10707	N/A	N/A	CONC	Mainhole	Clean, FROM CCTV on pipe to E: sag on first 10 ft.	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
25	SW-GMN-12313	25	30	CMP	Pipe End	CMP pipe outlet blocked by vegetation and sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path, large diameter	High	1.0, 2.0, 4.0
26	SW-CULV-10264	129	36	CMP	Pipe End	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
27	SW-GMN-12314	76	18	HDPE	Pipe End	CMP pipe outlet blocked by vegetation and sediment, FROM CCTV: Possible roots at last joint from end of pipe	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path. Root intrusion identified in CCTV does not appear to affect functionality.	Medium	1.0, 2.0, 4.0
28	SW-MH-10699	N/A	N/A	CONC	Mainhole	Reasonable clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
29	SW-INL-11599	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
30	No City ID	N/A	N/A	CONC	Inlet	Reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
31	No City ID	N/A	N/A	CONC	Mainhole	Reasonable clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
32	SW-GMN-13177	42	15	CMP	Pipe End	CMP pipe outlet partially blocked by vegetation	Deferred Maintenance	Vegetation management, inspect annually for blockages/sediment deposition	Medium	1.0, 2.0
33	SW-MH-10694	N/A	N/A	CONC	Mainhole	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
34	No City ID	N/A	N/A	CONC	Mainhole	Standing water, reasonably clean, flow not impacted but some debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
35	No City ID	16	18	CMP	Pipe End	Some rocks in pipe, PVC obstructed (likely private)	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
36	No City ID	72	38	CMP	Pipe End	Pipe inlet blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
37	SW-GMN-12489	96	24	HDPE	Pipe End	Pipe outlet blocked by vegetation	Deferred Maintenance	Jet pipe, remove vegetation and debris, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
38	SW-GMN-12713	42	34	RCP	Pipe End	Pipe outlet partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
39	SW-GWM-12714	42	36	CMP	Pipe End	Pipe outlet partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
40	SW-INL-11757	N/A	N/A	CONC	Concrete Structure	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
41	SW-INL-11758	N/A	N/A	CONC	Concrete Structure	Clean	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
42	SW-DC-10222	Unknown	14	CPP	Pipe End	Pipe outlet partially blocked by vegetation	Deferred Maintenance	Vegetation management, inspect annually for blockages/sediment deposition	Medium	1.0, 2.0
43	SW-MH-10841	N/A	N/A	CONC	Mainhole	Standing water but reasonably clean	Deferred Maintenance	jetting and vactoring	Medium	1.0, 2.0
44	No City ID	22	14	CPP	Pipe End	HDPE flared end damaged/crushed (likely private)	Deferred Maintenance	Remove rock to open plastic flared end	Medium	1.0, 4.0
45	No City ID	22	34	CPP	Pipe End	Clean (likely private)	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
46	No City ID	22	14	PVC	Pipe End	Clean (likely private)	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
47	SW-INL-11773	N/A	N/A	CONC	Inlet	Pipe is half full of debris	Deferred Maintenance	Jetting and vactoring	High	1.0, 2.0
48	SW-GMN-12712	67	15	CMP	Pipe End	Pipe outlet is obstructed with sediment/debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
49	SW-INL-11987	N/A	N/A	CONC	Inlet	Standing water at bottom of inlet	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
50	SW-DC-10163	14	12	PVC	Pipe End	Functional	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
51	SW-BSN-10132	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for blockages/sediment deposition	None	NA
52	No City ID	N/A	N/A	CONC	Mainhole	Standing water but reasonably clean	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
53	SW-GMN-13453	30	30	RCP	Pipe End	Pipe outlet partially blocked by landscaping rock	Deferred Maintenance	Light excavation	Medium	NA

Table B.1 Conditions Assessment Summary and Recommendations

Herrera GPS Object ID	MSO_ID	Shape Length (ft)	Diameter (in)	Material	Feature Type	Condition Description	Recommendation Type	Recommended Maintenance and/or Repair	Priority	Cost Estimate Line Items
54	SW-INL-11548	N/A	N/A	CONC	Inlet	Some debris but flow not restricted	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
55	SW-INL-11549	N/A	N/A	CONC	Inlet	Some debris but flow not restricted	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
56	SW-GMN-13162	43.5	18	CMP	Pipe End	Pipe outlet is buried	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
57	SW-GMN-13161	62.5	15	CMP	Pipe End	Pipe Outlet is half blocked with sediment/debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
58	SW-INL-11547	N/A	N/A	CONC	Inlet	Some debris but flow not restricted	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
59	SW-INL-11546	N/A	N/A	CONC	Inlet	Some debris but flow not restricted	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
60	No City ID	108	15	CMP	Pipe End	Pipe end blocked by sediment/debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
61	SW-INL-11582	N/A	N/A	CONC	Inlet	Dirty, accumulated debris, FROM CCTV on pipe: Small rock crack in bottom of pipe at joint, Roots exposed around service connection	Repair	Jetting and vactoring, repair small crack identified in CCTV, repair service connection with root intrusion identified in CCTV	High	1.0, 2.0, 8.3
62	SW-INL-11581	N/A	N/A	CONC	Inlet	Some debris but flow not restricted	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
63	SW-MH-10765	N/A	N/A	CONC	Mainhole	Clean, FROM CCTV on pipe to NE: Infiltration. Right side going up station.	Repair	Point repair to repair crack	Medium	1.0, 8.3
64	SW-MH-10766	N/A	N/A	CONC	Mainhole	FROM CCTV on pipe to NE: Infiltration @ 214.0 ft. water dropping from top.	Repair	Point repair to repair crack	Medium	1.0, 8.3
65	SW-BSN-10107	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
66	SW-CULV-10358	241	36	CMP	Pipe End	Standing water, partially blocked by vegetation	Deferred Maintenance	Vegetation management	Medium	NA
67	SW-CULV-10358	241	36	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
68	SW-CULV-10353	15	18	CMP	Concrete Structure	Reasonably clean, some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
69	SW-CULV-10353	15	18	CMP	Pipe End	Some debris accumulation and partially blocked by vegetation	Deferred Maintenance	Light excavation	Medium	1.0, 4.0
70	SW-CULV-10353	15	18	CMP	Pipe End	Some debris accumulation, partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
71	SW-CULV-10410	104.5	15	CPP	Pipe End	Culvert end damaged, accumulated sediment	Remove/Replace	Jetting and vactoring, expose pipe end and replace, ensure flow path	High	1.0, 2.0, 4.0
72	SW-CULV-10354	19	18	CPP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
73	SW-CULV-10354	19	18	CPP	Pipe End	Blocked by sediment and vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
74	SW-CULV-10356	10	18	CMP	Pipe End	Some debris accumulation, partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
75	SW-CULV-10356	10	18	CMP	Concrete Structure	Concrete structure is overgrown with vegetation	Deferred Maintenance	vegetation management	Medium	1.0, 3.0
76	SW-CULV-10355	62	18	CMP	Pipe End	Blocked by vegetation and sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
77	SW-CULV-10355	62	18	CMP	Pipe End	Some debris accumulation, partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
78	SW-INL-12018	N/A	N/A	CONC	Mainhole	Standing water but reasonably clean, flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
79	SW-CULV-10340	60	18	CMP	Pipe End	Partially blocked by landscape rock, some ovality	Deferred Maintenance	Remove rock, inspect annually for blockages/sediment deposition	Medium	1.0, 4.0
80	SW-CULV-10340	60	18	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
81	SW-BSN-10135	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
82	No City ID	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
83	SW-CULV-10416	44	36	CMP	Pipe End	Some debris accumulation in culvert	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
84	SW-CULV-10320	137	36	CMP	Pipe End	Some debris accumulation, partially blocked by vegetation	Deferred Maintenance	Jetting and vactoring, vegetation management	Medium	1.0, 2.0
85	SW-BSN-10093	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
86	SW-CULV-10320	139.5	36	CMP	Concrete Structure	Reasonably clean, some debris accumulation, and outside is overgrown with vegetation	Deferred Maintenance	Light excavation, vegetation management	Medium	1.0, 3.0, 4.0
87	SW-BSN-10092	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
88	SW-BSN-10092	N/A	N/A	CONC	Concrete Structure	Concrete structure and non-city owned culvert	Annual Inspection	Inspect annually for sediment deposition	None	NA
89	SW-BSN-10094	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
90	SW-BSN-10093	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
91	SW-BSN-10095	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
92	SW-CULV-10327	53.5	18	RCP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
93	SW-CULV-10327	53.5	18	RCP	Pipe End	Partially blocked by sediment and vegetation	Deferred Maintenance	Jetting and vactoring, vegetation management	Medium	1.0, 2.0
94	SW-MH-10871	N/A	N/A		Mainhole	Did not locate	Annual Inspection	Did not locate	None	NA
95	SW-CULV-10365	56	24	CMP	Pipe End	Clean	Annual Inspection	Inspect annually for sediment deposition	None	NA
96	SW-CULV-10365	56	24	CMP	Pipe End	Clean	Annual Inspection	Inspect annually for sediment deposition	None	NA
97	SW-GMN-13242	457.5	36	HDPE	Pipe End	Culvert end blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path, large diameter	High	1.0, 2.0, 4.0
98	SW-BSN-10134	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
99	SW-CULV-10415	45	37x43	RCP	Concrete Culvert	Horseshoe concrete culvert. Height 37" Width 43" Standing water, accumulation of rock	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
100	SW-BSN-10134	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
101	SW-INL-11956	N/A	N/A	CONC	Inlet	Accumulated sediment	Deferred Maintenance	Jetting and vactoring	High	1.0, 2.0
102	SW-INL-11951	N/A	N/A	CONC	Inlet	Standing water but reasonably clean	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
103	SW-INL-11950	N/A	N/A	CONC	Inlet	Standing water with debris, reasonably dirty	Deferred Maintenance	Jetting and vactoring, clear garbage	High	1.0, 2.0
104	SW-INL-12133	N/A	N/A	CONC	Concrete Structure	Clean	Annual Inspection	Inspect annually for sediment deposition	None	NA
105	SW-BSN-10127	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
106	SW-DC-10204	32	42	CMP	Pipe End	Clean	Annual Inspection	Inspect annually for sediment deposition	None	NA
107	SW-CULV-10414	60	43W x 37H	RCP	Concrete Culvert	Accumulated rocks and sediment	Deferred Maintenance	Light excavation	Medium	1.0, 4.0
108	SW-BSN-10134	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
109	SW-CULV-10413	61	4	HDPE	Pipe End	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
110	No City ID	Unknown	Unknown	Unknown	Pipe End	Functional (likely private, behind locked gate)	Annual Inspection	Inspect annually for sediment deposition	None	NA
111	SW-BSN-101038	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA

Table B.1 Conditions Assessment Summary and Recommendations

Herrera GPS Object ID	MSO_ID	Shape Length (ft)	Diameter (in)	Material	Feature Type	Condition Description	Recommendation Type	Recommended Maintenance and/or Repair	Priority	Cost Estimate Line Items
112	SW-CULV-10395	20	15	CMP	Pipe End	Blocked by sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
113	SW-CULV-10395	20	15	CMP	Pipe End	Partially blocked by sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
114	SW-GMN-13297	71.5	18	CMP	Pipe End	Blocked by sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
115	SW-INL-12132	N/A	N/A	CONC	Mainhole	Some debris accumulation but flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
116	SW-GMN-13298	15	18	CMP	Pipe End	Pipe end is damaged and filled with debris	Remove/Replace	Excavate, remove and replace pipe end, ensure flow path	High	1.0, 6.2
117	SW-BSN-10127	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Inspect annually for sediment deposition	None	NA
118	No City ID	10	15	CMP	Pipe End	Blocked by accumulated sediment, crushed	Remove/Replace	Excavate, remove and replace culvert, A/C surface replacement	High	1.0, 8.1
119	No City ID	10	15	CMP	Pipe End	Blocked by accumulated sediment, crushed	Remove/Replace	Excavate, remove and replace culvert, A/C surface replacement	High	1.0, 8.1
120	SW-CULV-10394	50	20	CMP	Pipe End	Accumulation of debris, some ovality	Deferred Maintenance	Jetting and vactoring, ensure flow path	Medium	1.0, 2.0, 4.0
121	SW-CULV-10394	50	20	CMP	Pipe End	Some accumulation of debris	Deferred Maintenance	Jetting and vactoring, large diameter	Medium	1.0, 2.0
122	SW-CULV-10393	49	30	CMP	Pipe End	Some accumulation of debris	Deferred Maintenance	Jetting and vactoring, ensure flow path	Medium	1.0, 2.0, 4.0
123	SW-CULV-10393	49	30	CMP	Pipe End	Accumulation of debris	Deferred Maintenance	Jetting and vactoring, ensure flow path	Medium	1.0, 2.0, 4.0
124	SW-GMN-13238	213	8	PVC	Pipe End	Partially blocked by sediment and vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
125	SW-GMN-13239	330	8	PVC	Pipe End	Partially blocked by sediment and vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
126	SW-INL-11971	N/A	N/A	CONC	Inlet	Standing water pipe obstructed	Deferred Maintenance	Jetting and vactoring, large diameter	High	1.0, 2.0
127	SW-MH-10762	N/A	N/A	CONC	Mainhole	Sediment accumulation, FROM CCTV on pipe to SW: Hairline crack @ 144, hairline crack on both sides @ 355, hairline crack @ 402, don't appear to have associated infiltration	Deferred Maintenance	Jetting and vactoring. Cracks identified during CCTV do not appear to have associated infiltration, and do not appear to affect functionality. Recommended repeated CCTV inspection in no more than 5 years.	Medium	1.0, 2.0
128	SW-MH-10763	N/A	N/A	CONC	Mainhole	Gravel on shelf, FROM CCTV on pipe to SW: Section missing or pipe separation in the section. Hard to tell exactly what this is. Either a really dirty T section or some cavern. Also there's a huge crack and a wire. Same problem as SW-MH-10764	Remove/Replace	Remove and replace pipe section	High	1.0, 8.2
129	SW-MH-10764	N/A	18	CONC	Mainhole	FROM CCTV on pipe to NE: Yellow wire perpendicular to main w/ intrusion on both side. Same problem as SW-MH-10763	Remove/Replace	Remove and replace pipe section (18" Conc pipe to NE of structure)	High	1.0, 8.2
130	SW-INL-11583	N/A	N/A	CONC	Inlet	Functional, non-standard configuration for drop.	Annual Maintenance	Non-standard configuration for drop. Could break up concrete on bottom and install inside drop on pipe and waterproofing on outside, or could replace structure for approx. \$10K. (Cost not included in cost estimate)	Medium	NA
131	SW-MH-10779	N/A	N/A	CONC	Mainhole	Clean	Annual Inspection	Inspect annually for sediment deposition	None	NA
132	SW-INL-11594	N/A	N/A	CONC	Inlet	Holding water and some debris but flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
133	SW-INL-11592	N/A	N/A	CONC	Inlet	Holding water but reasonably clean	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
134	SW-INL-11974	N/A	N/A	CONC	Inlet	Holding water but reasonably clean	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
135	SW-CULV-10326	20.5	18	CMP	Pipe End	Partially blocked by debris and vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
136	SW-CULV-10326	20.5	18	CMP	Pipe End	Partially blocked by debris and vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
137	SW-CULV-10309	56.5	42	CMP	Pipe End	Partially blocked by debris and vegetation	Deferred Maintenance	Excavate pipe end, jetting and vactoring, and ensure flow path	Medium	1.0, 2.0, 4.0
138	SW-CULV-10319	25	42	CMP	Pipe End	Partially blocked by debris and vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
139	SW-CULV-10319	25	42	CMP	Pipe End	Blocked by vegetation and not visible	Deferred Maintenance	Excavate pipe end, jetting and vactoring, and ensure flow path	High	1.0, 2.0, 4.0
140	SW-CULV-10317	108	10	CMP	Pipe End	Crushed end and blocked by sediment and vegetation	Repair	Excavate, remove and replace pipe end, ensure flow path	High	1.0, 6.1
141	SW-OC-10074	90	12	CMP	Pipe End	Partially blocked by sediment and vegetation	Deferred Maintenance	Excavate pipe end, jetting and vactoring, and ensure flow path	Medium	1.0, 2.0, 4.0
142	No City ID	3211	12	CMP	Pipe End	Partially blocked by sediment and vegetation	Deferred Maintenance	Excavate pipe end, jetting and vactoring, and ensure flow path	Medium	NA
143	SW-MH-10840	N/A	N/A	CONC	CSI Mainhole Riser	Needs lock	Deferred Maintenance	Add lock	Medium	1
144	SW-GMN-13169	74	36	CMP	Pipe End	Grass step in front of outlet is half the pipe height	Deferred Maintenance	Excavate grass step to ensure flow path, replace sod	High	1.0, 4.0
145	SW-CULV-10378	10	12	CPP	Pipe End	HDPE pipe end damaged, partially obstructed by debris and vegetation	Deferred Maintenance	Cut off damage, jet pipe and vacuum debris	Medium	1.0, 2.0
146	SW-CULV-10378	10	12	CPP	Pipe End	Partially filled with rocks and debris	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
147	SW-CULV-10392	146	24	CMP	Pipe End	Blocked by debris and vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
148	SW-CULV-10422	108	15	CMP	Pipe End	Blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
149	SW-CULV-10421	10	15	CMP	Pipe End	Accumulated sediment	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
150	SW-CULV-10421	10	16	CMP	Pipe End	Partially blocked by debris and vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
151	SW-CULV-10421	10	16	CMP	Pipe End	CMP pipe end is partially bent, some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
152	SW-INL-12162	N/A	N/A	CONC	Inlet	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
153	SW-GMN-13324	32	16	CPP	Pipe End	Partially blocked by vegetation and debris, covered with pallet	Deferred Maintenance	Remove pallet, jet pipe, removed debris, excavate pipe end ensuring flow path	Medium	1.0, 2.0, 4.0
154	SW-INL-12161	N/A	N/A	CONC	Inlet	Accumulated debris	Deferred Maintenance	Jetting and vactoring	High	1.0, 2.0
155	SW-GMN-13323	26	15	CMP	Pipe End	Accumulated sediment and debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
156	SW-CULV-10422	108	15	CMP	Pipe End	Blocked by vegetation and accumulated debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
157	SW-CULV-10396	60.5	20	CMP	Pipe End	Blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
158	SW-CULV-10396	60	20	CMP	Pipe End	Crushed end and blocked by sediment and vegetation	Repair	Excavate, remove and replace pipe end, ensure flow path	High	1.0, 6.3
159	SW-CULV-10391	5	12	CPP	Pipe End	Crushed end and blocked by sediment and vegetation	Repair	Excavate, remove and replace pipe end, jetting and vactoring, ensure flow path	High	1.0, 6.5
160	SW-CULV-10391	20.3	12	CPP	Pipe End	Blocked and full of sediment and debris	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
161	SW-CULV-10392	146	24	CMP	Pipe End	Some debris accumulation, partially blocked by vegetation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
162	SW-CULV-10387	70	24	CMP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
163	SW-CULV-10387	70	24	CMP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
164	SW-GMN-13138	21	24	CMP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
165	SW-MH-10753	N/A	N/A	CONC	Mainhole	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0

Table B.1 Conditions Assessment Summary and Recommendations

Herrera GPS Object ID	MSO_ID	Shape Length (ft)	Diameter (in)	Material	Feature Type	Condition Description	Recommendation Type	Recommended Maintenance and/or Repair	Priority	Cost Estimate Line Items
166	SW-GMN-13139	24	18	CMP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
167	SW-INL-11579	N/A	N/A	CONC	Inlet	Inlet protection in place but lots of mud surrounding inlet	Deferred Maintenance	Remove and replace protection, jetting and vactoring	High	1.0, 2.0
168	SW-MH-10754	N/A	N/A	CONC	Mainhole	Holding water	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
169	SW-GMN-13136	22	24	CMP	Pipe End	Holding water, partially blocked by sediment and vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	Medium	1.0, 2.0, 4.0
170	SW-BSN-10090	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
171	SW-INL-11969	N/A	N/A	CONC	Inlet	Clean	Annual Inspection	Annual inspection for sediment deposition	None	NA
172	SW-GMN-13165	89	12	CMP	Pipe End	Some debris and rock accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
173	SW-INL-11578	N/A	N/A	CONC	Inlet	Holding water, flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
174	SW-INL-11577	N/A	N/A	CONC	Inlet	Holding water, some debris, but flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
175	SW-MH-10752	8	24	CMP	Pipe End	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
176	SW-MH-10752	N/A	N/A	CONC	Mainhole	Sediment accumulation, flow not significantly obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
177	SW-CULV-10316	26	4	CPP	Pipe End	Clean	Annual Inspection	Annual inspection for sediment deposition	None	NA
178	SW-CULV-10316	26	4	CPP	Pipe End	Clean	Annual Inspection	Annual inspection for sediment deposition	None	NA
179	SW-GMN-13166	24	36	CMP	Pipe End	Clean	Annual Inspection	Annual inspection for sediment deposition	None	NA
180	SW-BSN-10088	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
181	SW-CULV-10309	56.6	42	CMP	Pipe End	Flared end damaged, partially blocked by vegetation, rocks and debris in culvert	Repair	Excavate pipe end, jetting and vactoring, replace FES, and ensure flow path	High	1.0, 6.4
182	SW-CULV-10308	20	18	CMP	Pipe End	Blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
183	SW-CULV-10308	20	18	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
184	SW-CULV-10307	196	15	CMP	Pipe End	Holding water, end blocked by vegetation	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
185	No City ID	N/A	N/A	CONC	Inlet	Functional	Annual Inspection	Annual inspection for sediment deposition	None	1.0, 2.0
186	SW-BSN-10087	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
187	SW-CULV-10302	44.5	18	CMP	Pipe End	Partially blocked by vegetation, debris	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
188	SW-CULV-10302	44.5	18	CMP	Pipe End	Partially blocked by vegetation, debris	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
189	SW-INL-12013	N/A	N/A	CONC	Inlet	Holding water, flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
190	SW-INL-12012	N/A	N/A	CONC	Inlet	Holding water, flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
191	SW-CULV-10303	16.5	12	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
192	SW-CULV-10304	64	18	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
193	SW-CULV-10303	16.5	12	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
194	SW-CULV-10303	16.5	12	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
195	SW-BSN-10086	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
196	SW-CULV-10306	45	18	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
197	SW-CULV-10306	45	18	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
198	SW-CULV-10305	49	24	CMP	Pipe End	Flared end damaged, partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
199	SW-CULV-10305	49	24	CMP	Pipe End	Partially blocked by vegetation	Deferred Maintenance	Remove minor vegetation and inspect annually for sediment deposition	Medium	1.0, 2.0
200	SW-INL-11677	N/A	N/A	CONC	Inlet	Full of debris, City crews discovered power line breach by NWE	Remove/Replace	Jetting and vactoring, NWE to remove/relocate power line, replace pipe section	High	1.0, 8.3
201	SW-INL-11676	N/A	N/A	CONC	Inlet	Full of debris	Deferred Maintenance	Jetting and vactoring	High	1.0, 2.0
202	No City ID	Unknown	Unknown	Unknown	Pipe End	Functional (inside fence, likely private)	Annual Inspection	Annual inspection for sediment deposition	None	NA
203	SW-INL-12545	N/A	N/A	CONC	Inlet	Reasonably clean, holding water, flow not obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
204	SW-INL-11593	N/A	N/A	CONC	Inlet	Holding water, debris, flow partially obstructed	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
205	SW-INL-12025	N/A	N/A	CONC	Inlet	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
206	SW-INL-11678	N/A	N/A	CONC	Inlet	Some debris accumulation	Deferred Maintenance	Jetting and vactoring	Medium	1.0, 2.0
207	SW-MH-10839	N/A	N/A	CONC	Mainhole	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
208	SW-CULV-10413	61	4	HDPE	Pipe End	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
209	SW-BSN-10136	N/A	N/A	Soil	Basin	Functional	Annual Inspection	Annual inspection for sediment deposition	None	NA
210	SW-CULV-10414	60	36	RCP	Concrete Culvert	Partially blocked	Deferred Maintenance	Light excavation	Medium	1.0, 4.0
211	SW-CULV-10415	45	37x43	RCP	Concrete Culvert	Holding water, partially blocked	Deferred Maintenance	Jetting and vactoring, excavate pipe end ensuring flow path	High	1.0, 2.0, 4.0
212	SW-CULV-10416	44	43W x 37H	CMP	Concrete Culvert	Partially blocked	Deferred Maintenance	Light excavation	Medium	1.0, 4.0

Table B.2 CCTV Summary					
Herrera GPS Object ID	Upstream and Downstream MSO_ID	Pipe Name	Description	CCTV Footage Distance (LF)	Comments/Notes
15 to 14	SW-INL-11616 to SW-INL-11615	S03-18-B2S03-18-B1	Obstruction	0.0	SW-INL-10616 Obstructed at access point. Jetted and vactored. Recommend annual jetting and vactoring.
62 to 129	SW-INL-11581 to SW-MH-10764	S2066-4DS2066-4	General Observation	131.7	45 degree bend
61 to 62	SW-INL-11582 to SW-INL-11581	N/A (not on GIS)	Crack	23.9	Small crack in bottom of pipe at joint
			Service Connection	46.4	Roots exposed around service connection
130 to 129	SW-INL-11583 to SW-MH-10764	S2066-4AS2066-4	General Observation	0.0	Hole too small for camera. Cannot go from downstream to upstream due to access in SW-MH-10764
8 to 28	SW-INL-11614 to SW-INL-10699 to Culvert Outlet	S02-28-G2S02-28-G1 and S02-28-G1S02-28-PT2	General Observation	6.3	Vertical pipe protruding with a float(?)
			Obstruction	17.8	Camera can't get to end. Using zoom function on camera for observation
			Roots	17.8	Possible roots in last joint of 10699
8 to 7	SW-INL-11614 to SW-INL-11576	S02-28-G3S02-28-G2	General Observation	12.6	Leaf and Gravel dam, possible oblong pipe
15 to 16	SW-INL-11616 to SW-MH-10700	S03-18-B1S03-18-A2	N/A	N/A	Pipe was approx 50% submerged in water. Vactored pipe, however flow filled it up again.
12 to 13	SW-INL-11638 to SW-MH-10706	S01-25-B2S01-25-B1	Sag	10.9	Sag in pipe
			Access Point	32.9	SW-MH-10706
			General Observation	62.7	Oblong
			Sag	66.4	Sag in pipe, leaf dam
23 to 24	SW-INL-11646 to SW-MH-10707	S01-25-A2S01-25-A1	General Observation	89.0	Leaf and gravel dam at 89 ft to end of pipe
			Obstruction	94.4	Mud and gravel present
24 to 25	SW-MH-10707 to SW-GMN-12313 (Culvert Outlet)	S01-25-A1S01-25-PT	Sag	10.0	Sag
24 to 23	SW-MH-10707 to SW-INL-11646	S01-25-A2S01-25-A1	Access Point	3.1	SW-MH-10707
127 to 128	SW-MH-10762 to SW-MH-10763	S2066-6S2066-5	Crack	144.1	Crack @ 144, doesn't appear to have associated infiltration
			Crack	355.1	Crack on both sides of pipe, doesn't appear to have associated infiltration
			Crack	402.0	Crack @ 402, doesn't appear to have associated infiltration
127 to 129	SW-MH-10762 to SW-MH-10764	S2066-5S2066-4			Should be marked as starting at 10763 and going to 10764, not starting at 10762, because the previous one ran 10762 to 10763 and was a different pipe
			Point Repair	200.0	Section missing or pipe separation in the section. Hard to tell exactly what this is. Either a really dirty T section or some cavern. Also there's a huge crack and a wire. Same problem as below
129 to 128	SW-MH-10764 to SW-MH-10763	S2066-5S2066-4	Point Repair	154.7	Yellow wire perpendicular to pipe w/ intrusion on both sides
63 to 64	SW-MH10765 to SW-MH-10766 (End of Airway Blvd W)	S2066-3S2066-2	Infiltration	214.0	Infiltration @ 214.0 ft. water dropping from top.
63 to 129	SW-MH-10765 to SW-MH-10764	S2066-4S2066-3	Infiltration	50.4	Infiltration. Right side going up station
			Point Repair	490.9	Top of Pipe

Appendix C

Survey Report

This page intentionally left blank

Missoula Development Park Stormwater Infrastructure Survey

PURPOSE

Eli & Associates, Inc. (Eli) completed a field survey of the publicly owned stormwater infrastructure in the Missoula Development Park. The purpose of this survey was to fill data gaps on the stormwater system components, including pipe invert elevations, manhole rim elevations, and topographic data for use in a capacity analysis to be completed by Herrera Environmental Consultants (Herrera),

Eli performed this fieldwork between October 2 and November 28, 2023. When required Eli coordinated with the City of Missoula to access stormwater system components and Herrera personnel to ensure complete and accurate data collection.

Private stormwater components were not surveyed as part of this project.

METHODS

Eli implemented survey-grade Trimble R12i (Global Navigation Satellite System (GNSS) receivers utilizing corrections from the MSOL Continuously Operating Reference Station (CORS) to gather horizontal and vertical positions of all stormwater system components. Eli also gathered GNSS observations for ground-truthing publicly available lidar Data. Trimble R12i receivers allow for repeatable GNSS observations to be taken even when the rod is not plumb (i.e. at an angle). This technology allowed Eli the capability to confidently gather positional data on stormwater components lying under structure overhangs.

Several control benchmarks were established throughout the project area. Check shot observations were collected regularly each day in the field to ensure equipment was properly functioning. Data was downloaded and processed at the end of each field day. Quality assurance and control procedures were applied to ensure data quality and consistency were maintained.

All data were collected and processed in North American Datum of 1983, 2011 realization (NAD83-2011) Epoch 2010.00 with coordinates projected to Montana State Plane. All vertical data is with reference to the North American Vertical Datum of 1988 (NAVD88). Orthometric heights were generated by applying geoid model GEOID18 separations.

Each component was numbered to match the naming convention established by Herrera. Attributes of each component were collected and logged in the field (see Attribute Table Excel file). The following figures illustrate typical observation locations on various stormwater components.



Culvert (with FETS)



Curb Inlet



Round Inlet



Drainline in Mainhole



Mainhole Cover (center of lid elevation = rim elevation)



Beehive Inlet

LIDAR SURFACE

Eli downloaded available lidar data from the Montana State Library to produce a ground surface of the area. Lidar data was collected May 23 - June 16, 2019 as part of a Montana Department of Resources and Conservation project. Eli generated a 3-foot grid bare earth Digital Elevation Model (DEM).

GNSS ground truthing data was found to agree within 0.2' (vertical) of the surface produced from the lidar data. An in-depth review of the surface shows that roadside ditches, swales, and retention areas are expressed. Due to sampling frequency in the DEM, the true bottom of small ditches may not be expressed in the surface. No areas of apparent earthwork or sedimentation were found during our ground-truthing analysis.

Extensive development on private property has occurred since the lidar data was collected. Therefore, infrastructure such as vehicle approaches and stormwater retention areas on and along these properties is not reflected in the surface generated by Eli.

If required, Eli has the capability and equipment needed to collect unmanned aerial vehicle (UAV) lidar data which would reflect current conditions and would more accurately show smaller ditches and swales.



Joshua G. Phillips, PLS
President – Eli & Associates, Inc.



Appendix D

CCTV Inspection Reports

This page intentionally left blank



^Note: Distances are indicated from the Downstream MH.




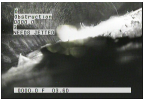
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-10616	Downstream MH SW-INL10615	Date 24-Oct-2023
Surveyor MIRANDA	Street CANYON CREEK		City MISSOULA	Weather Dry
Size	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments GOING FROM DOWNSTREAM TO UPSTREAM			Pre-Cleaning	TV Length 0

SW-INL-10616		Ftg.	Code	Description	Position	Severity	Comment
		0.0	AP	Access Point - Other			SW-INL-10616
		0.0	O	Obstruction		3	NEEDS JETTED



SW-INL10615



Owner NASH	Customer HERRARA	Upstream MH SW-INL-10616	Downstream MH SW-INL10615	Date 24-Oct-2023
----------------------	----------------------------	------------------------------------	-------------------------------------	----------------------------

Surveyor MIRANDA	Street CANYON CREEK	City MISSOULA	Weather Dry
----------------------------	-------------------------------	-------------------------	-----------------------

Size	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
-------------	--	--------------------------------	--------------------------------------	---------------

Comments GOING FROM DOWNSTREAM TO UPSTREAM	Pre-Cleaning	TV Length 0
--	---------------------	-----------------------



AP - Access Point - Other @ 0.0 ft. SW-INL-10616

O - Obstruction @ 0.0 ft. NEEDS JETTED



^Note: Distances are indicated from the Downstream MH.

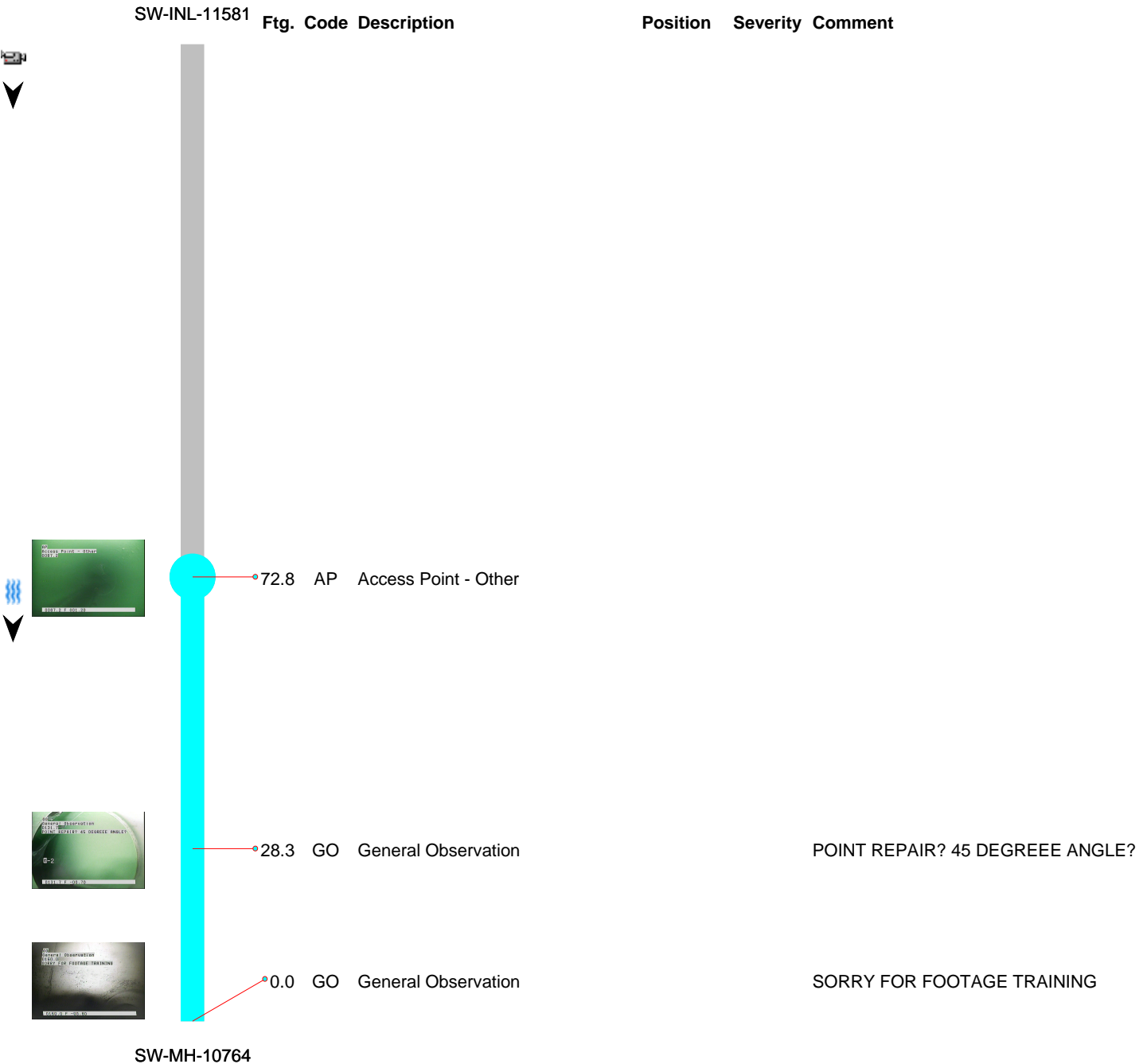
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11581	Downstream MH SW-MH-10764	Date 25-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD		City MISSOULA	Weather Dry
Size 12	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length

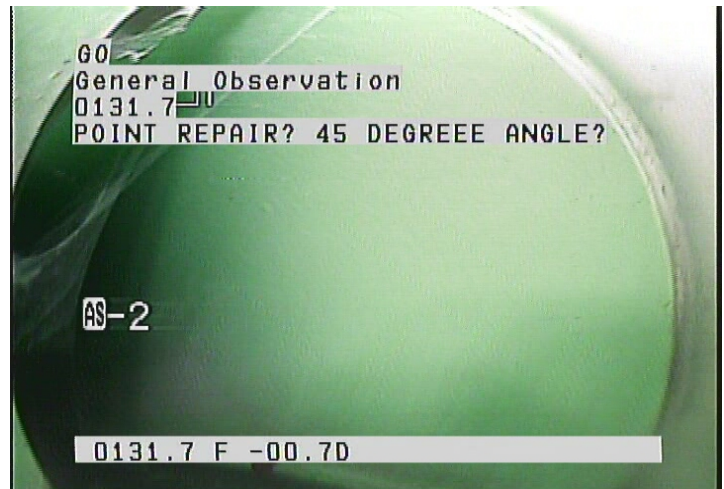




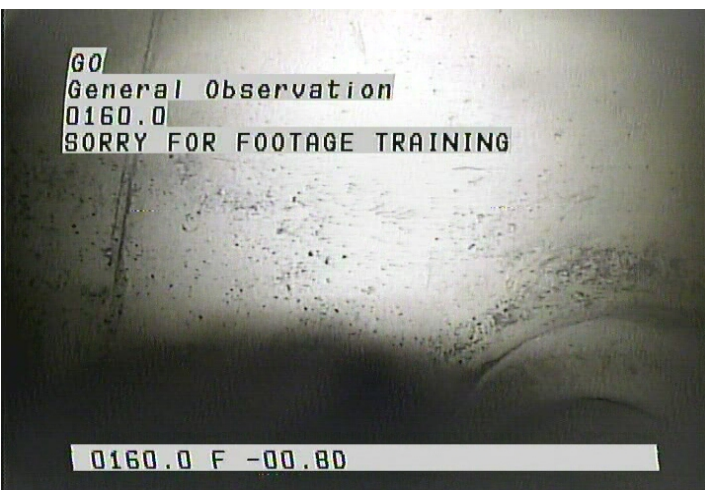
Owner NASH	Customer HERRARA	Upstream MH SW-INL-11581	Downstream MH SW-MH-10764	Date 25-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry	
Size 12	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length



AP - Access Point - Other @ 87.2 ft.



GO - General Observation @ 131.7 ft.
POINT REPAIR? 45 DEGREEE ANGLE?



GO - General Observation @ 160.0 ft.
SORRY FOR FOOTAGE TRAINING



^Note: Distances are indicated from the Downstream MH.

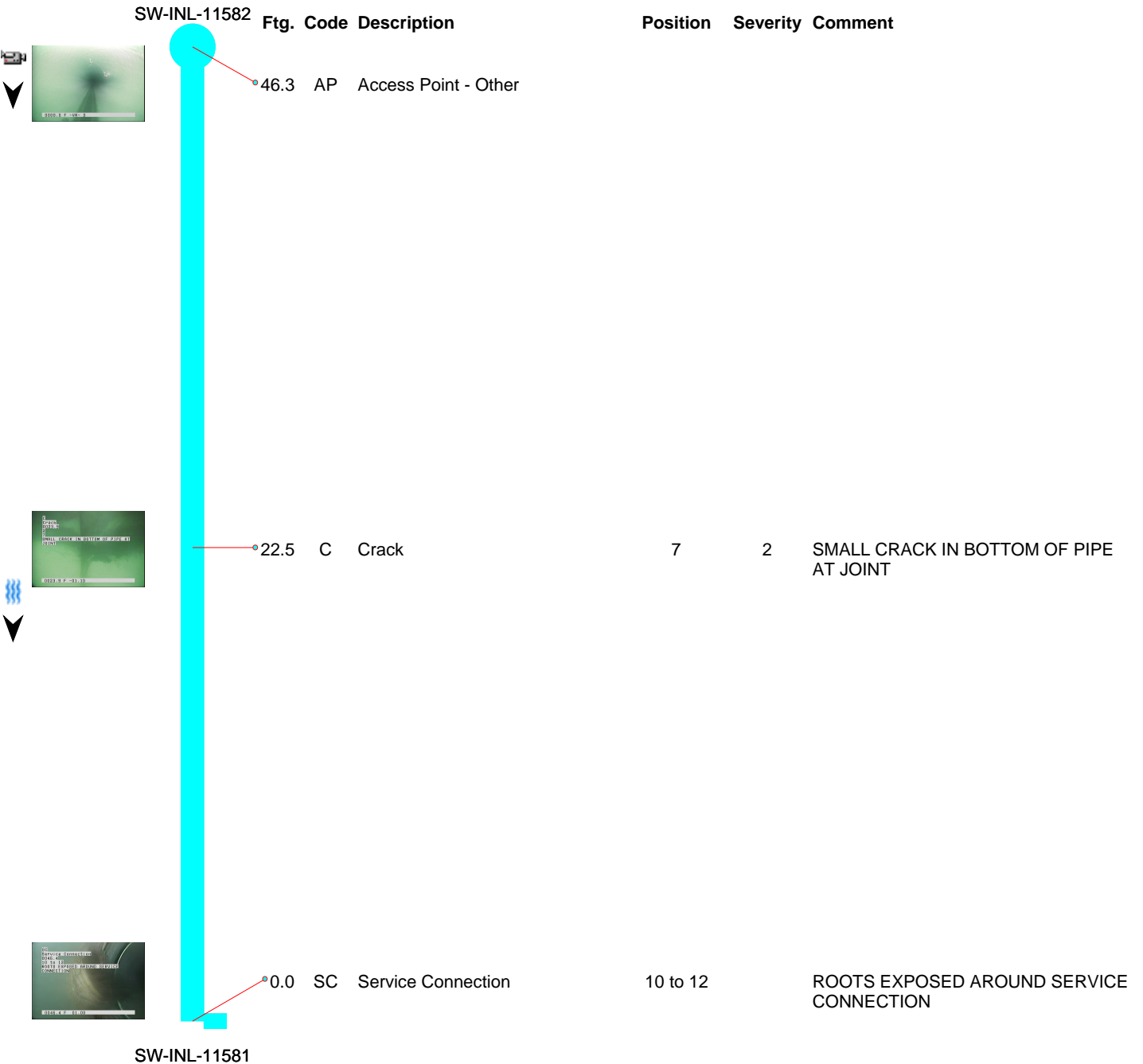
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11582	Downstream MH SW-INL-11581	Date 25-Oct-2023
Surveyor MIRANDA	Street EXPRESSWAY RD		City MISSOULA	Weather Dry
Size 12	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 46.4

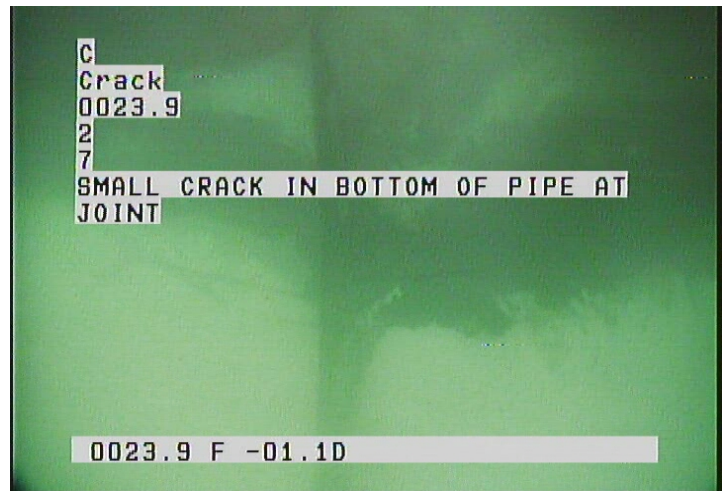




Owner NASH	Customer HERRARA	Upstream MH SW-INL-11582	Downstream MH SW-INL-11581	Date 25-Oct-2023
Surveyor MIRANDA	Street EXPRESSWAY RD		City MISSOULA	Weather Dry
Size 12	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 46.4



AP - Access Point - Other @ 0.1 ft.



C - Crack @ 23.9 ft. SMALL CRACK IN BOTTOM OF PIPE AT JOINT



SC - Service Connection @ 46.4 ft. ROOTS EXPOSED AROUND SERVICE CONNECTION



^Note: Distances are indicated from the Downstream MH.





Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRERA	Upstream MH SW-INL-11583	Downstream MH SW-MH-10764	Date 25-Oct-2023
Surveyor MIRANDA	Street EXPRESSWAY RD		City MISSOULA	Weather Snow
Size 12	Material Reinforced Concrete Pipe	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments DOWNHILL STREAM TOWARD MAIN MANHOLE 10764			Pre-Cleaning	TV Length 0

SW-INL-11583		Ftg.	Code	Description	Position	Severity	Comment
		0.0	AP	Access Point - Other			SW-INL-11583
		0.0	GO	General Observation			HOLE TOO SMALL FOR CAMERA CANNOT GO FROM DOWN STREAM TO UP STREAM DUE TO ACCESS IN SW-MH-10764



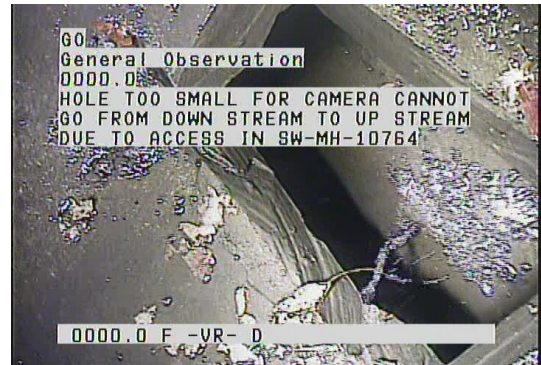
SW-MH-10764



Owner NASH	Customer HERRERA	Upstream MH SW-INL-11583	Downstream MH SW-MH-10764	Date 25-Oct-2023
Surveyor MIRANDA	Street EXPRESSWAY RD		City MISSOULA	Weather Snow
Size 12	Material Reinforced Concrete Pipe	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments DOWNHILL STREAM TOWARD MAIN MANHOLE 10764			Pre-Cleaning	TV Length 0



AP - Access Point - Other @ 0.0 ft. SW-INL-11583



GO - General Observation @ 0.0 ft. HOLE TOO SMALL FOR CAMERA CANNOT GO FROM DOWN STREAM TO UP STREAM DUE TO ACCESS IN SW-MH-10764



^Note: Distances are indicated from the Downstream MH.

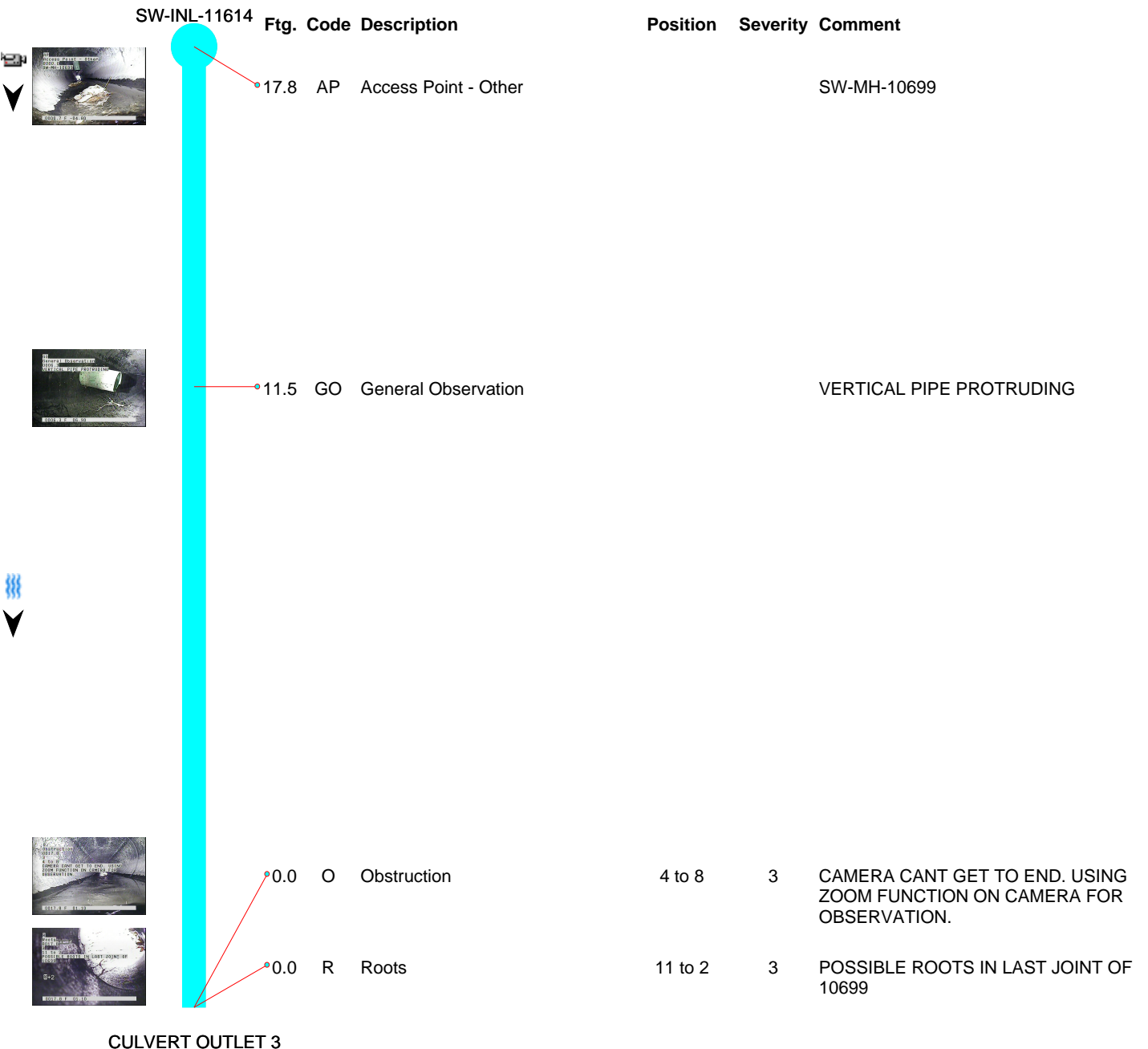
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH CULVERT OUTLET 3	Date 25-Oct-2023
Surveyor MIRANDA	Street MONTICELLO		City MISOULA	Weather Dry
Size 36	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments DOWNHILL STREAM			Pre-Cleaning	TV Length 17.8





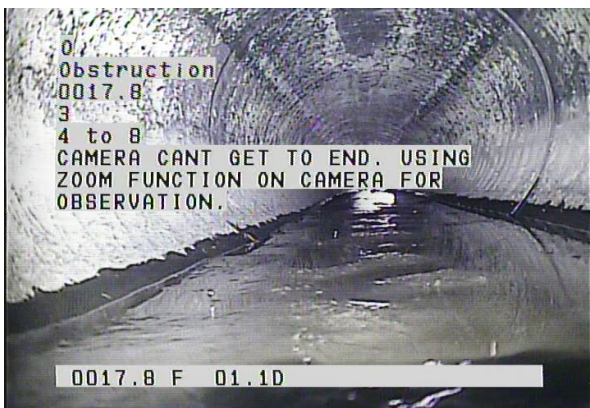
Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH CULVERT OUTLET 3	Date 25-Oct-2023
Surveyor MIRANDA	Street MONTICELLO		City MISOULA	Weather Dry
Size 36	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments DOWNHILL STREAM				Pre-Cleaning
				TV Length 17.8



AP - Access Point - Other @ 0.0 ft. SW-MH-10699



GO - General Observation @ 6.3 ft. VERTICAL PIPE PROTRUDING



O - Obstruction @ 17.8 ft. CAMERA CANT GET TO END. USING ZOOM FUNCTION ON CAMERA FOR OBSERVATION.



R - Roots @ 17.8 ft. POSSIBLE ROOTS IN LAST JOINT OF 10699



^Note: Distances are indicated from the Downstream MH.

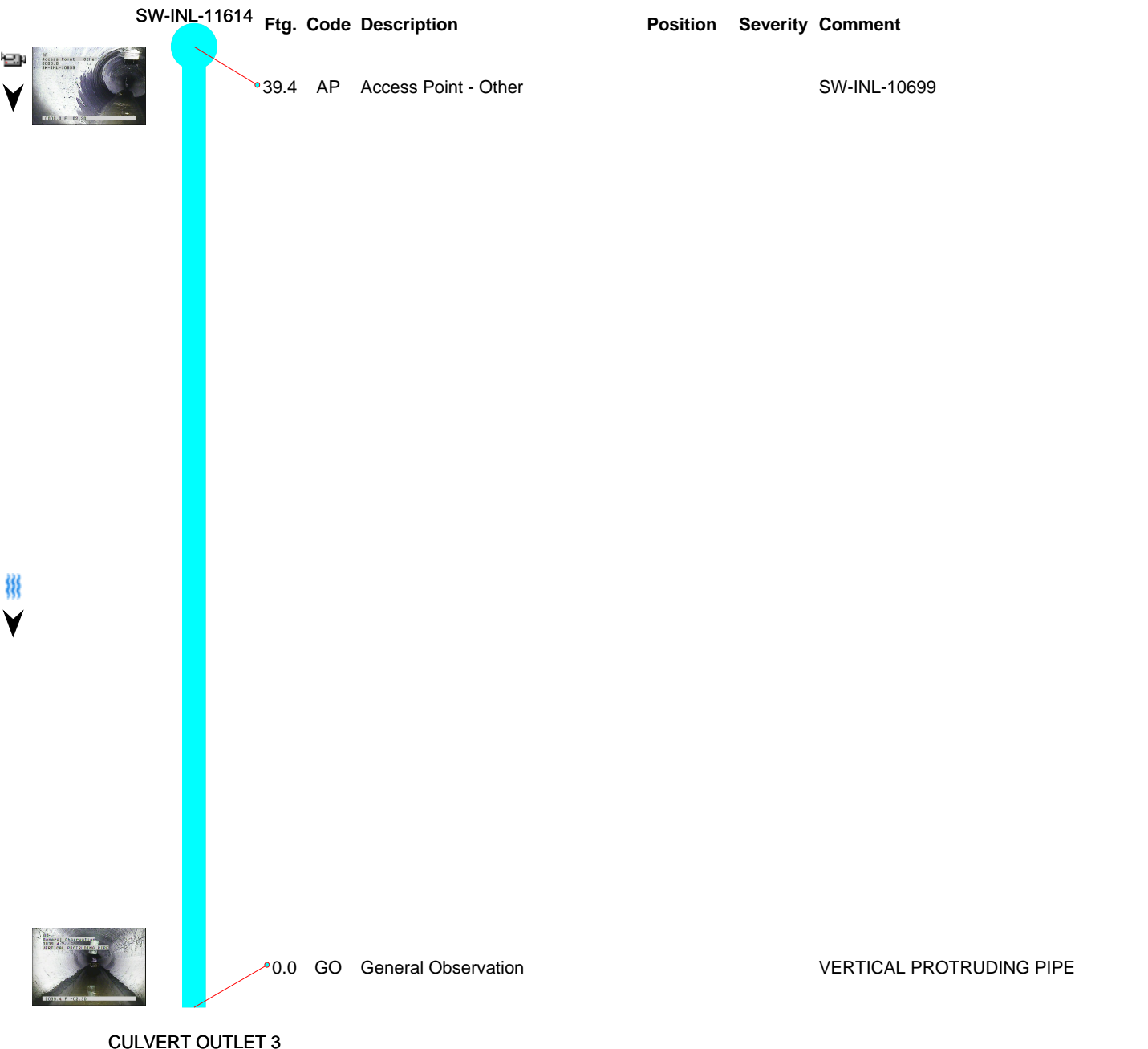
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH CULVERT OUTLET 3	Date 25-Oct-2023
Surveyor MIRANDA	Street MONTICELLO		City MISOULA	Weather Dry
Size 36	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments DOWNHILL STREAM			Pre-Cleaning 	TV Length 39.4



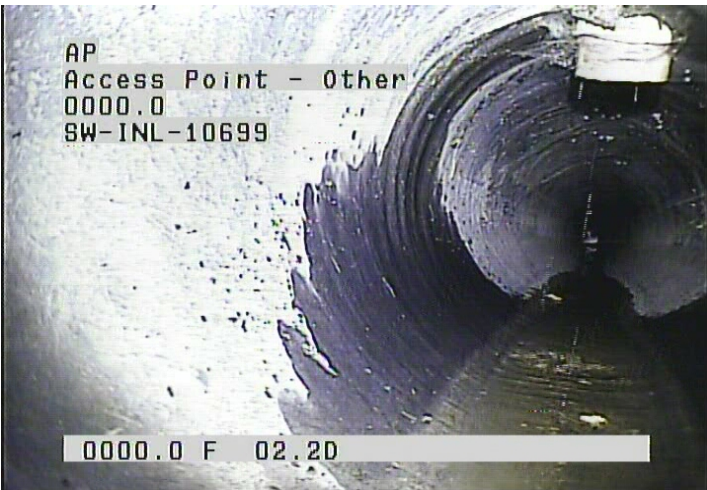


Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH CULVERT OUTLET 3	Date 25-Oct-2023
----------------------	----------------------------	------------------------------------	---	----------------------------

Surveyor MIRANDA	Street MONTICELLO	City MISOULA	Weather Dry
----------------------------	-----------------------------	------------------------	-----------------------

Size 36	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
-------------------	--	--------------------------------	--------------------------------------	---------------

Comments DOWNHILL STREAM	Pre-Cleaning	TV Length 39.4
------------------------------------	---------------------	--------------------------



AP - Access Point - Other @ 0.0 ft. SW-INL-10699



GO - General Observation @ 39.4 ft. VERTICAL PROTRUDING PIPE



^Note: Distances are indicated from the Downstream MH.

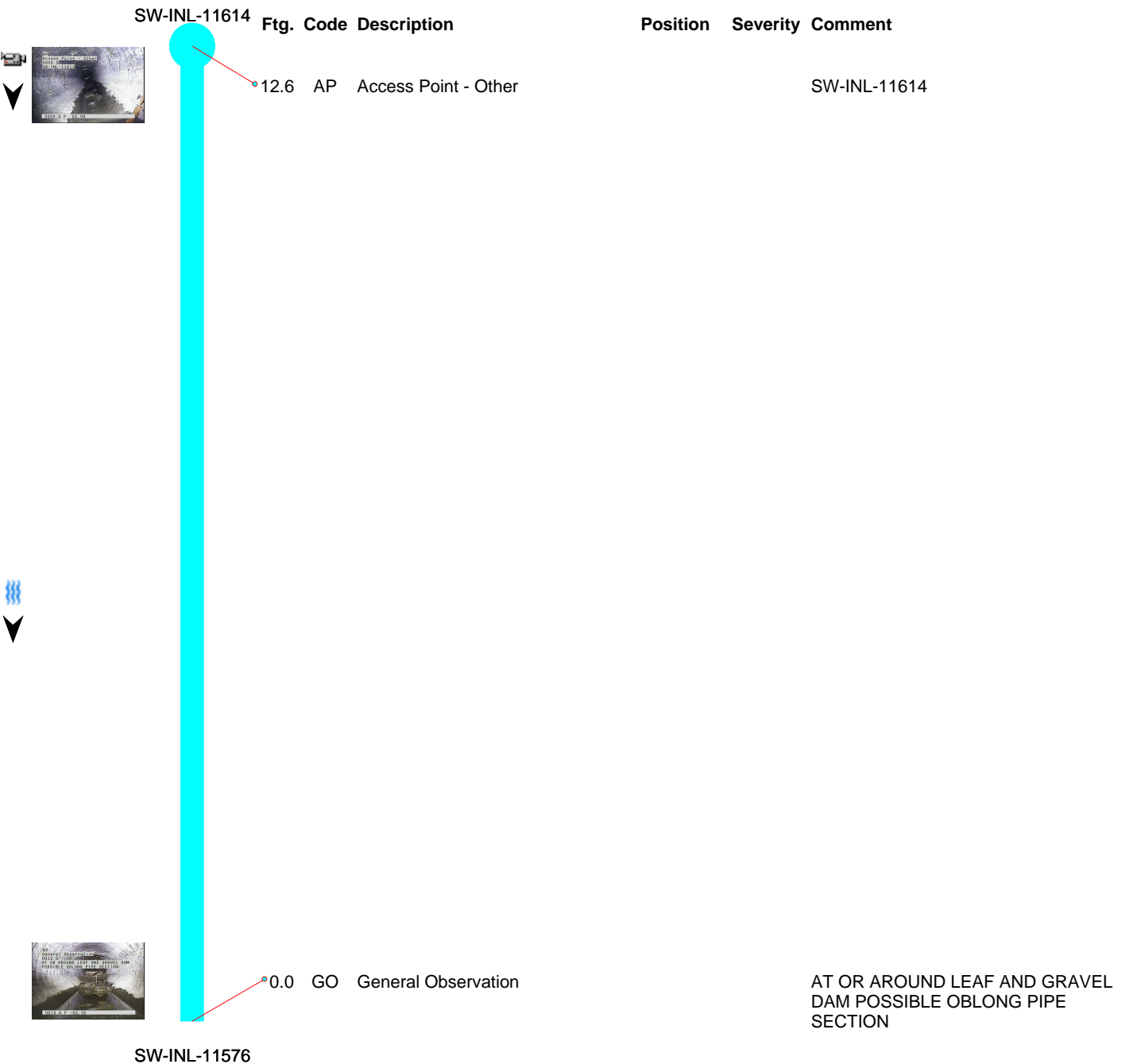
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH SW-INL-11576	Date 25-Oct-2023
Surveyor MIRANDA	Street MONTICELLO		City MISSOULA	Weather Dry
Size 12	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments GOING UPHILL UPON REQUEST			Pre-Cleaning 	TV Length 12.6

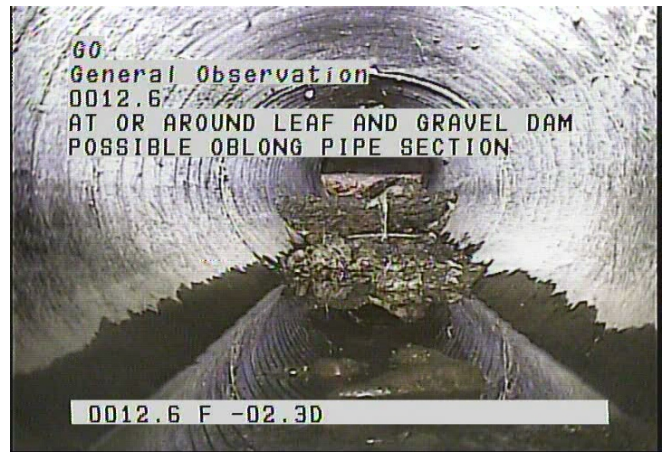




Owner NASH	Customer HERRARA	Upstream MH SW-INL-11614	Downstream MH SW-INL-11576	Date 25-Oct-2023
Surveyor MIRANDA	Street MONTICELLO	City MISSOULA	Weather Dry	
Size 12	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments GOING UPHILL UPON REQUEST			Pre-Cleaning 	TV Length 12.6



AP - Access Point - Other @ 0.0 ft. SW-INL-11614



GO - General Observation @ 12.6 ft. AT OR AROUND LEAF AND GRAVEL DAM POSSIBLE OBLONG PIPE SECTION



Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11616	Downstream MH SW-MH-107000	Date 24-Oct-2023
Surveyor 	Street CANYON CREEK	City MISSOULA	Weather Dry	
Size 48	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments 			Pre-Cleaning Jetting	TV Length 0



^Note: Distances are indicated from the Downstream MH.

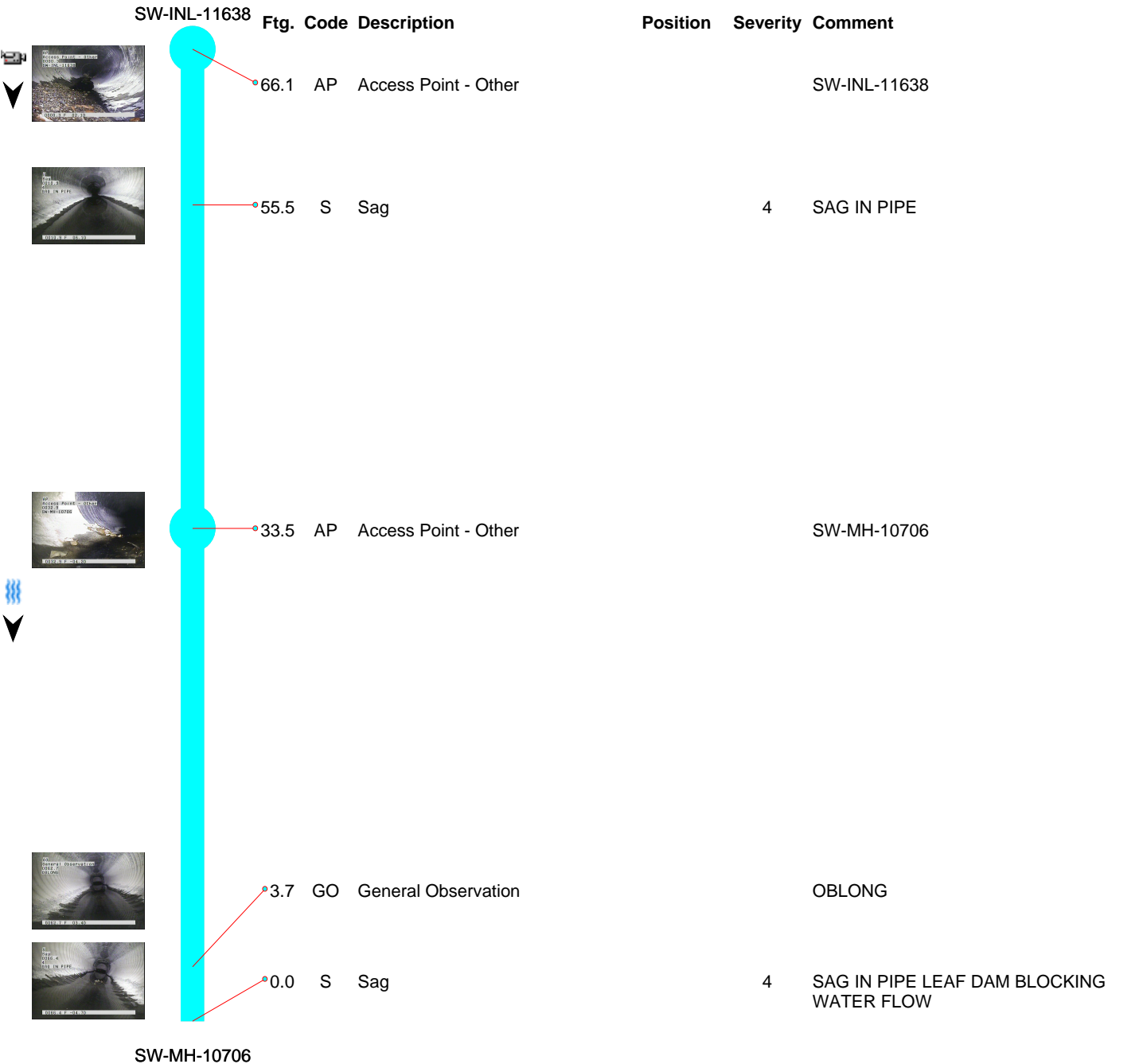
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11638	Downstream MH SW-MH-10706	Date 24-Oct-2023
Surveyor	Street CANYON CREEK	City MISSOULA	Weather Dry	
Size	Material	Sewer Use	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 66.4





Owner NASH	Customer HERRARA	Upstream MH SW-INL-11638	Downstream MH SW-MH-10706	Date 24-Oct-2023
Surveyor	Street CANYON CREEK	City MISSOULA	Weather Dry	
Size	Material	Sewer Use	Purpose Routine Assessment	Length
Comments				Pre-Cleaning
				TV Length 66.4



AP - Access Point - Other @ 0.3 ft. SW-INL-11638



S - Sag @ 10.9 ft. SAG IN PIPE



AP - Access Point - Other @ 32.9 ft. SW-MH-10706



GO - General Observation @ 62.7 ft. OBLONG



Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11638	Downstream MH SW-MH-10706	Date 24-Oct-2023
Surveyor	Street CANYON CREEK	City MISSOULA	Weather Dry	
Size	Material	Sewer Use	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 66.4



S - Sag @ 66.4 ft. SAG IN PIPE LEAF DAM BLOCKING WATER FLOW



^Note: Distances are indicated from the Downstream MH.

Peninsular Technologies

555 Ada Drive

Ada, MI 49301

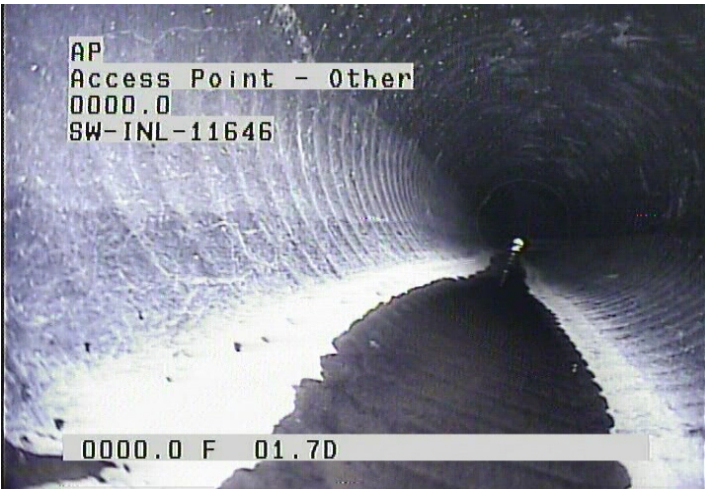
Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-INL-11646	Downstream MH SW-MH-10707	Date 24-Oct-2023
Surveyor MIRANDA	Street CANYON CREEK		City MISSOULA	Weather Dry
Size 24	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments CLEANED IN AUGUST NO JETTING REQUESTED			Pre-Cleaning No Pre-Cleaning	TV Length 94.4





Owner NASH	Customer HERRARA	Upstream MH SW-INL-11646	Downstream MH SW-MH-10707	Date 24-Oct-2023
Surveyor MIRANDA	Street CANYON CREEK	City MISSOULA	Weather Dry	
Size 24	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments CLEANED IN AUGUST NO JETTING REQUESTED			Pre-Cleaning No Pre-Cleaning	TV Length 94.4



AP - Access Point - Other @ 0.0 ft. SW-INL-11646



GO - General Observation @ 89.0 ft. LEAF DAMN & GRAVEL AT 89FT TO END OF PIPE



O - Obstruction @ 94.4 ft. CAN'T GET THROUGH MUD AND GRAVEL



^Note: Distances are indicated from the Downstream MH.

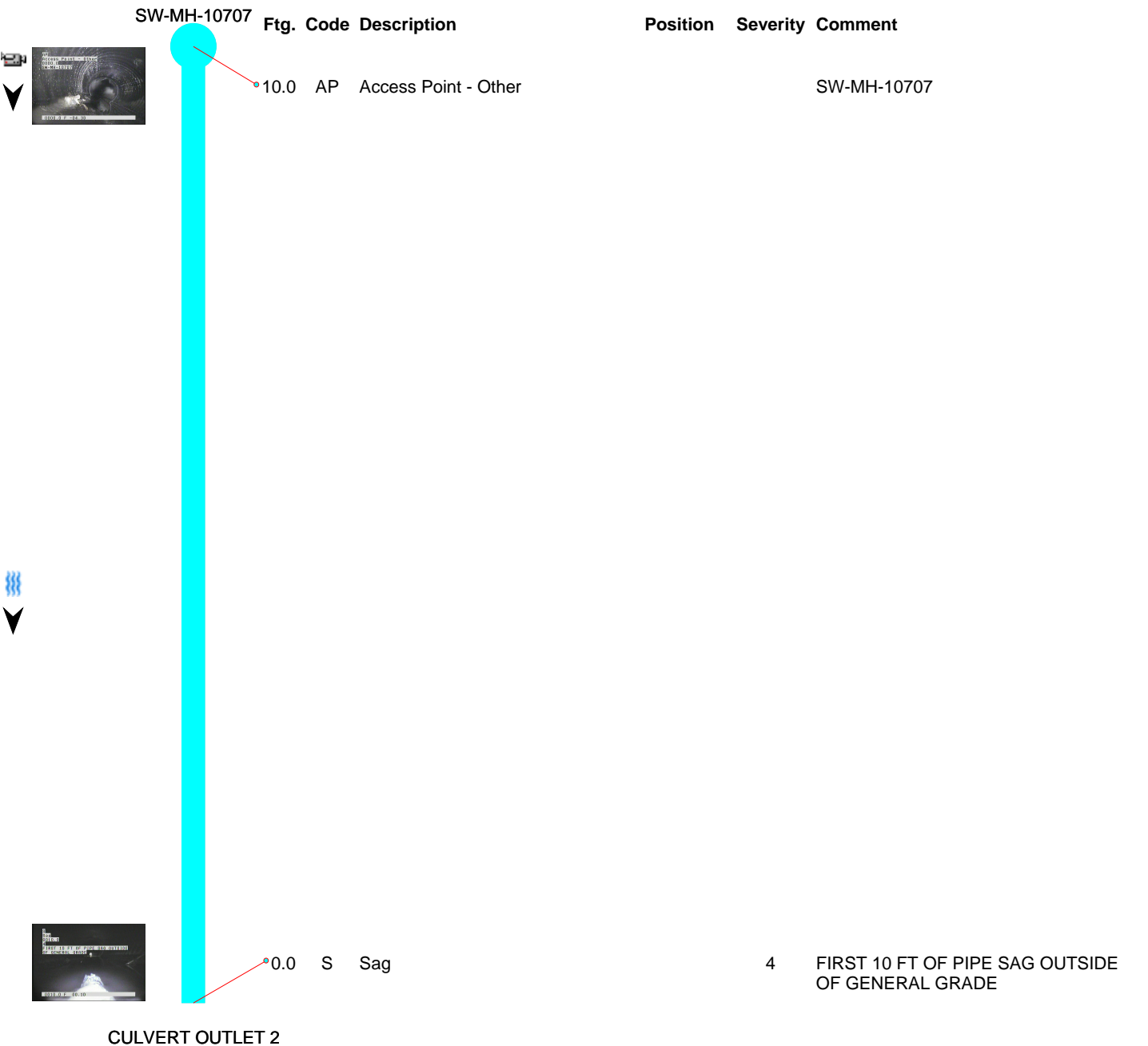
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10707	Downstream MH CULVERT OUTLET 2	Date 24-Oct-2023
Surveyor MIRANDA	Street CANYON CREEK		City MISSOULA	Weather Dry
Size	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 10

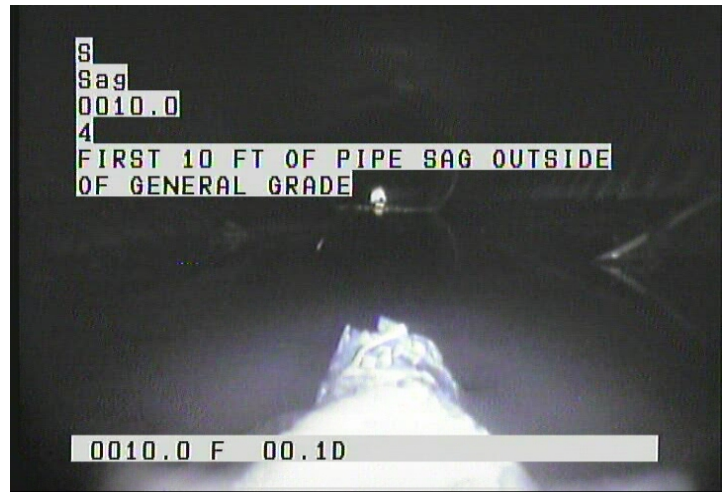




Owner NASH	Customer HERRARA	Upstream MH SW-MH-10707	Downstream MH CULVERT OUTLET 2	Date 24-Oct-2023
Surveyor MIRANDA	Street CANYON CREEK		City MISSOULA	Weather Dry
Size	Material Plastic/Steel Composite	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 10



AP - Access Point - Other @ 0.0 ft. SW-MH-10707



S - Sag @ 10.0 ft. FIRST 10 FT OF PIPE SAG OUTSIDE OF GENERAL GRADE



Owner NASH	Customer HERRARA	Upstream MH SW-MH-10707	Downstream MH SW-INL-11646	Date 24-Oct-2023
----------------------	----------------------------	-----------------------------------	--------------------------------------	----------------------------

Surveyor MIRANDA	Street CANYON CREEK	City MISSOULA	Weather Dry
----------------------------	-------------------------------	-------------------------	-----------------------

Size 24	Material Polyvinyl Chloride	Sewer Use Stormwater	Purpose Routine Assessment	Length
-------------------	---------------------------------------	--------------------------------	--------------------------------------	-------------------

Comments NEEDS MORE JETTING UPHILL GRADE	Pre-Cleaning 	TV Length 3.1
--	-------------------------	-------------------------



AP - Access Point - Other @ 3.1 ft. SW-MH-10707



^Note: Distances are indicated from the Downstream MH.

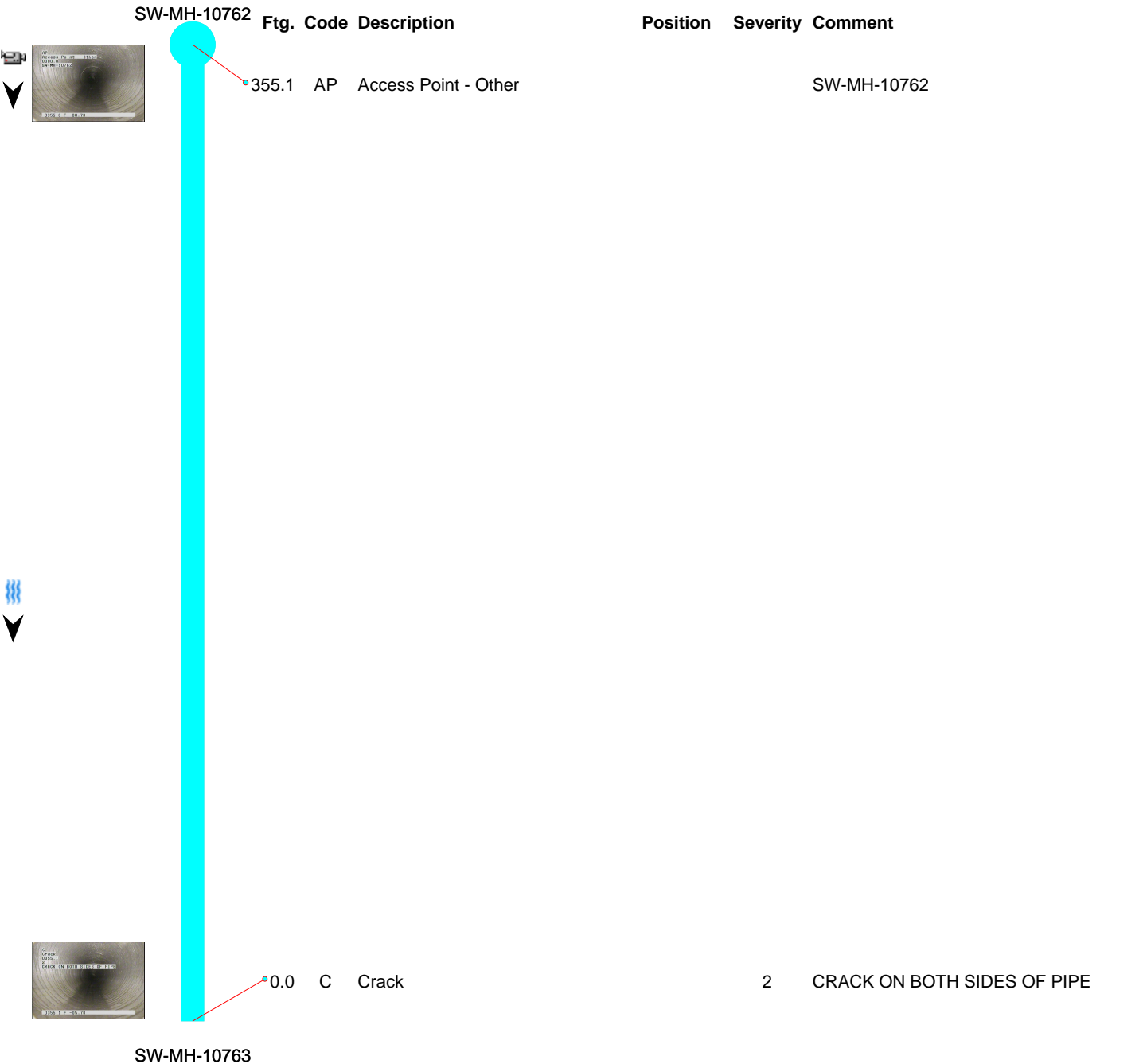
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10762	Downstream MH SW-MH-10763	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD		City MISSOULA	Weather Dry
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning No Pre-Cleaning	TV Length 355.1





Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10762	Downstream MH SW-MH-10763	Date 31-Oct-2023
----------------------	----------------------------	-----------------------------------	-------------------------------------	----------------------------

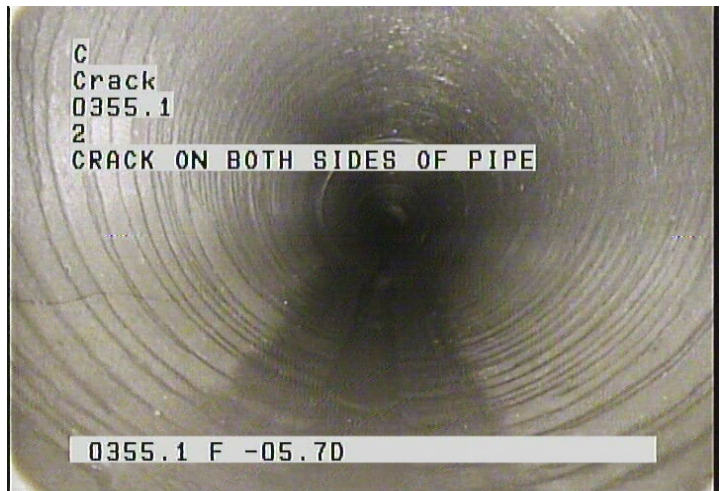
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry
----------------------------	------------------------------	-------------------------	-----------------------

Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
-------------------	---	--------------------------------	--------------------------------------	-------------------

Comments	Pre-Cleaning No Pre-Cleaning	TV Length 355.1
-----------------	--	---------------------------



AP - Access Point - Other @ 0.0 ft. SW-MH-10762



C - Crack @ 355.1 ft. CRACK ON BOTH SIDES OF PIPE



^Note: Distances are indicated from the Downstream MH.

Peninsular Technologies

555 Ada Drive
 Ada, MI 49301
 Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10762	Downstream MH SW-MH-10764	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry	
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 493.6





Owner NASH	Customer HERRARA	Upstream MH SW-MH-10762	Downstream MH SW-MH-10764	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry	
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 493.6



GO - General Observation @ 0.0 ft.
CANT GO ANYMORE



AP - Access Point - Other @ 493.6 ft. MH 10763



^Note: Distances are indicated from the Downstream MH.

Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10764	Downstream MH SW-MH-10763	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD		City MISSOULA	Weather Dry
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 154.7

SW-MH-10764	Ftg.	Code	Description	Position	Severity	Comment
						
						
	0.0	PR	Point Repair		3	YELLOW WIRE PERPENDICULAR TO MAIN W/ INTRUSION ON BOTH SIDES
SW-MH-10763						



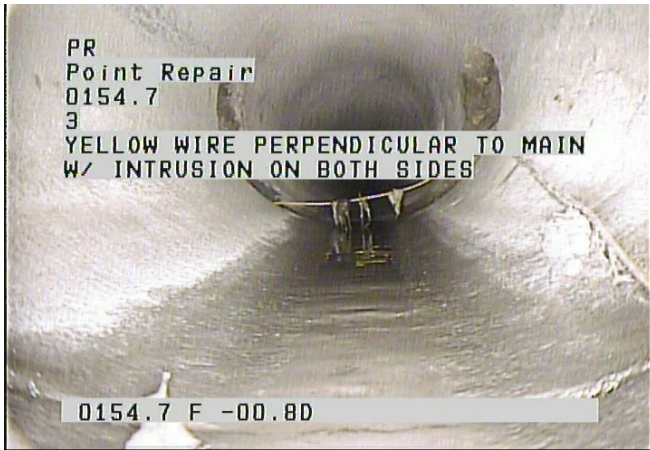
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10764	Downstream MH SW-MH-10763	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD		City MISSOULA	Weather Dry
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 154.7



PR - Point Repair @ 154.7 ft. YELLOW WIRE PERPENDICULAR TO MAIN W/ INTRUSION ON BOTH SIDES



^Note: Distances are indicated from the Downstream MH.

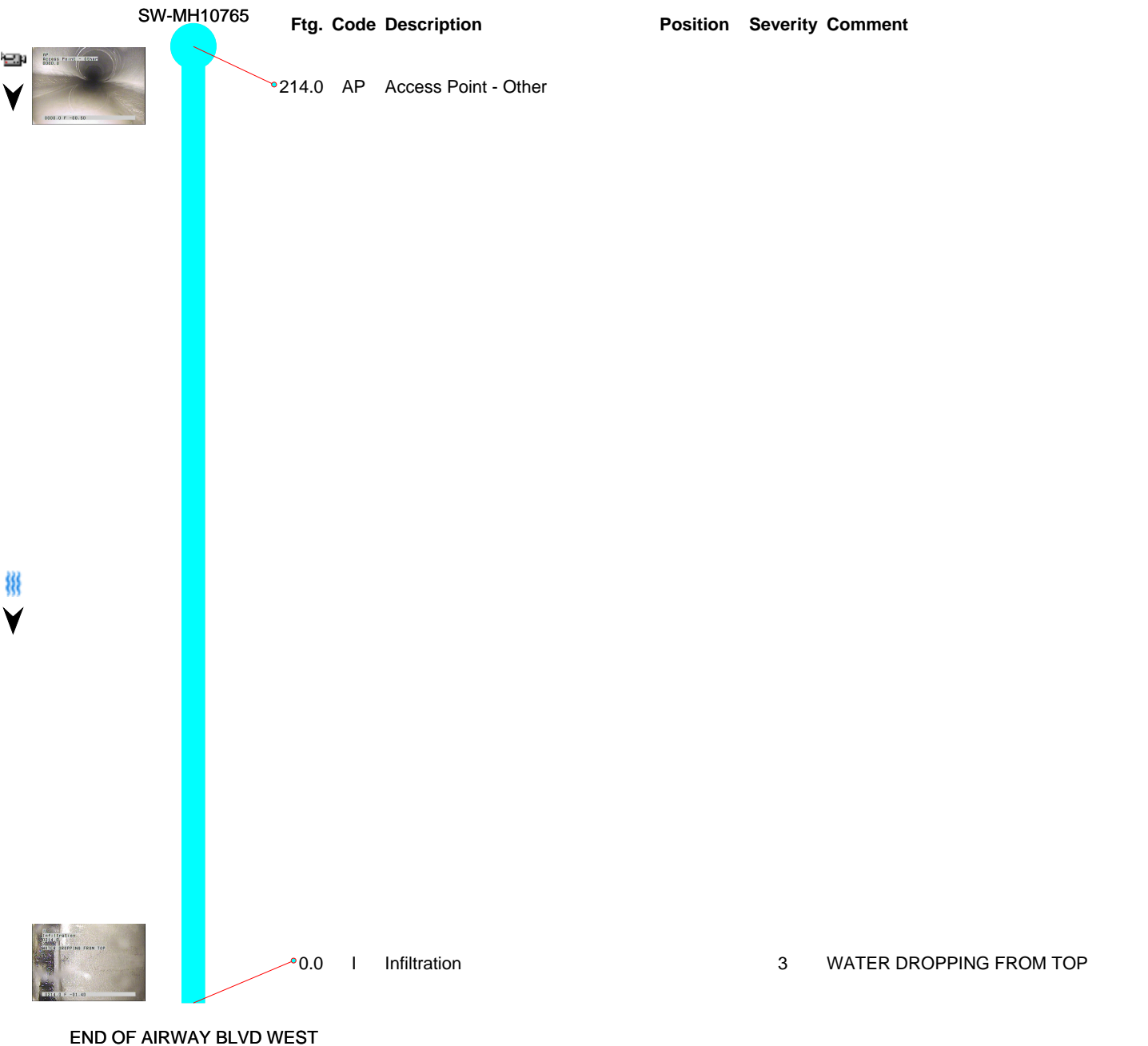
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH10765	Downstream MH END OF AIRWAY BLVD WEST	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD		City MISSOULA	Weather Dry
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 214



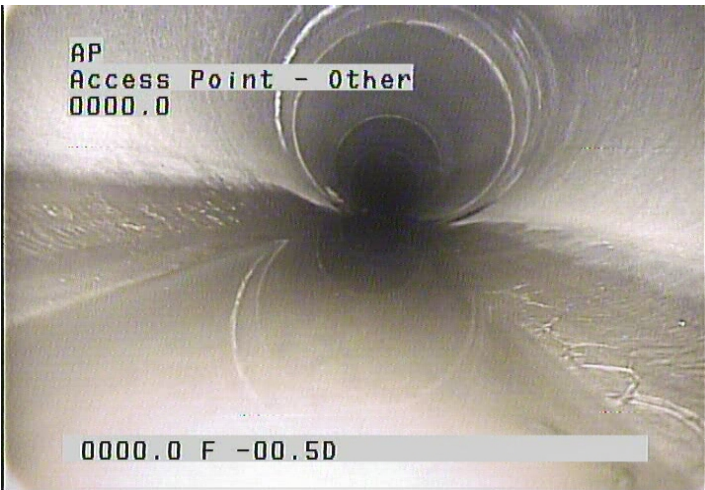


Owner NASH	Customer HERRARA	Upstream MH SW-MH10765	Downstream MH END OF AIRWAY BLVD WEST	Date 31-Oct-2023
----------------------	----------------------------	----------------------------------	--	----------------------------

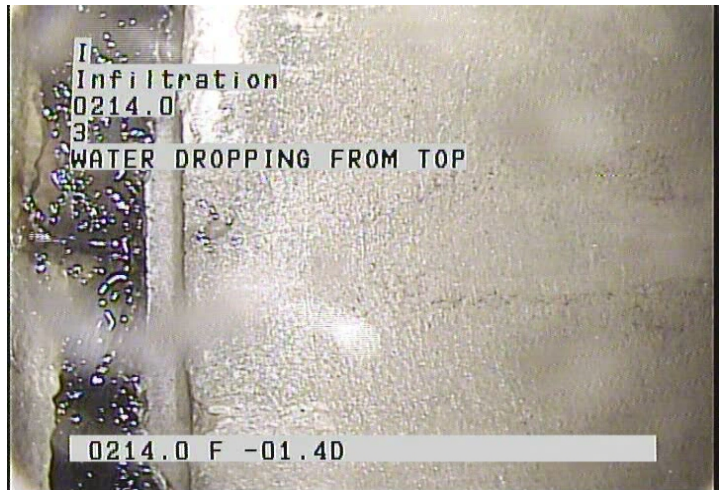
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry
----------------------------	------------------------------	-------------------------	-----------------------

Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
-------------------	---	--------------------------------	--------------------------------------	---------------

Comments	Pre-Cleaning	TV Length 214
-----------------	---------------------	-------------------------



AP - Access Point - Other @ 0.0 ft.



I - Infiltration @ 214.0 ft. WATER DROPPING FROM TOP



^Note: Distances are indicated from the Downstream MH.

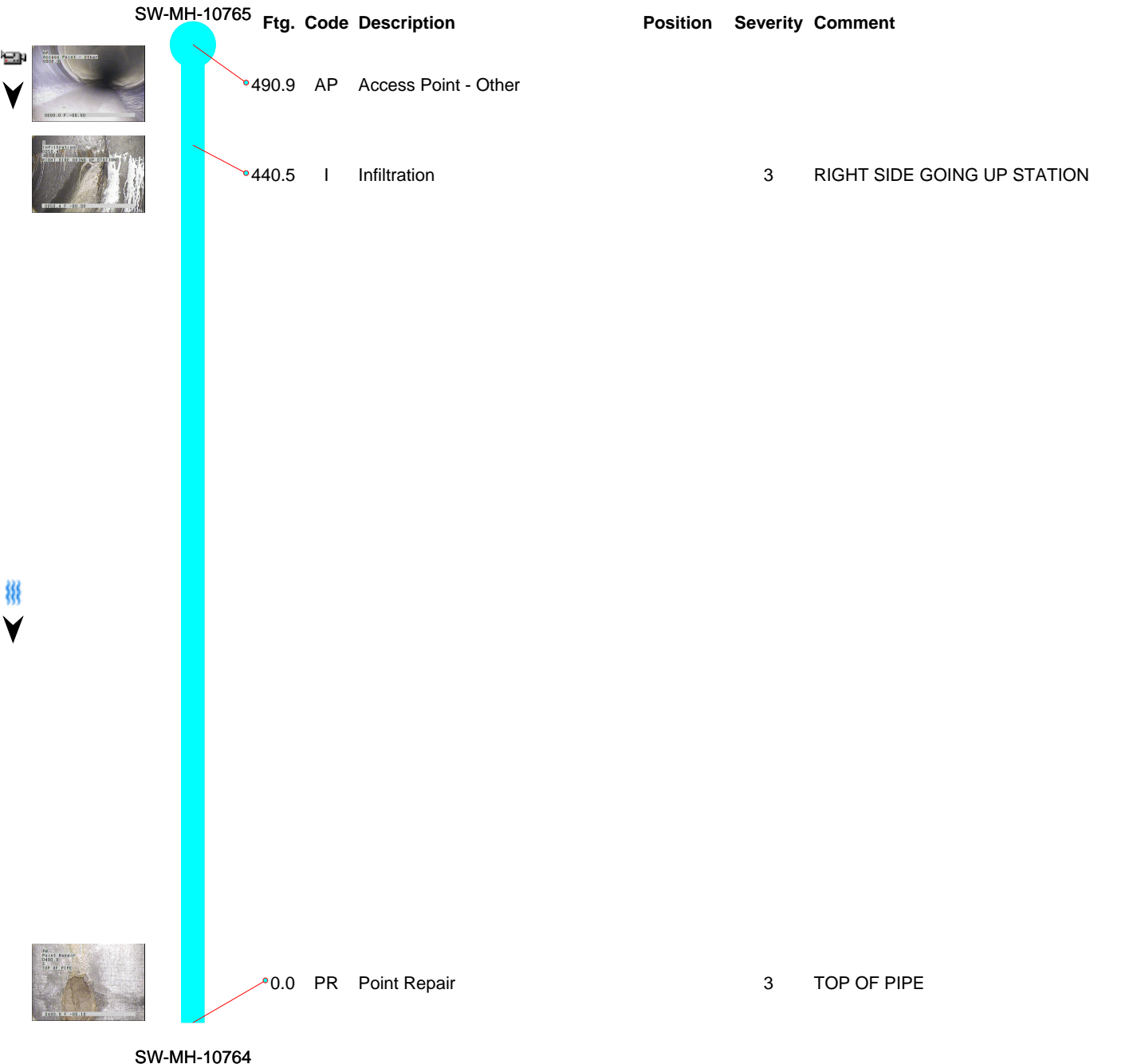
Peninsular Technologies

555 Ada Drive

Ada, MI 49301

Phone: (616) 676-9811

Owner NASH	Customer HERRARA	Upstream MH SW-MH-10765	Downstream MH SW-MH-10764	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry	
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 490.9

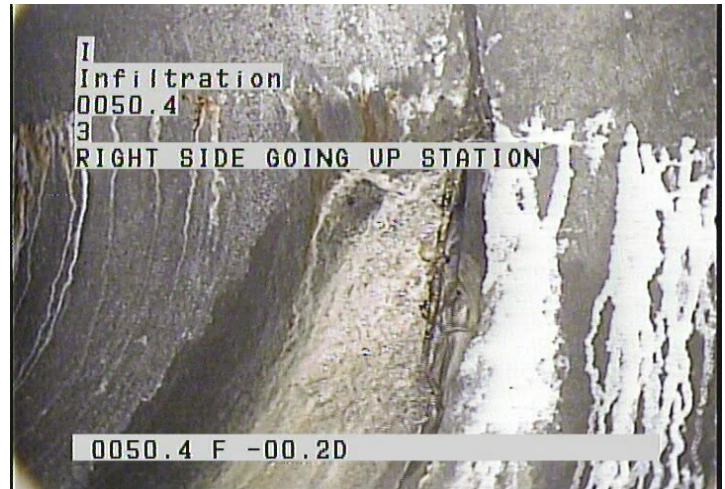




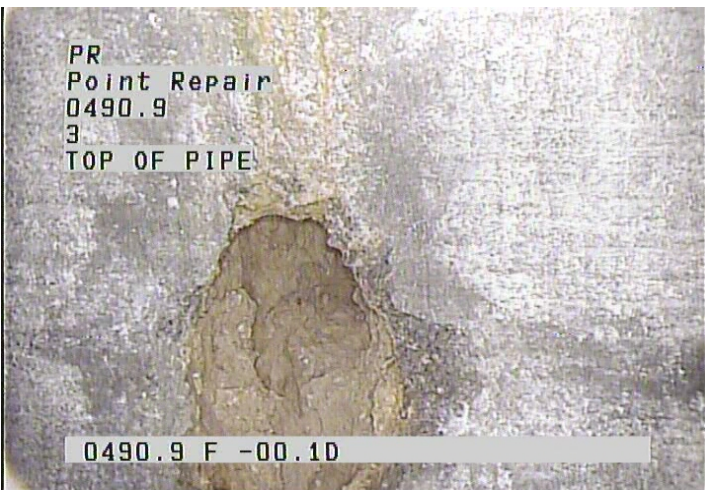
Owner NASH	Customer HERRARA	Upstream MH SW-MH-10765	Downstream MH SW-MH-10764	Date 31-Oct-2023
Surveyor MIRANDA	Street AIRWAY BLVD	City MISSOULA	Weather Dry	
Size 36	Material Concrete Pipe (non-reinforced)	Sewer Use Stormwater	Purpose Routine Assessment	Length
Comments			Pre-Cleaning	TV Length 490.9



AP - Access Point - Other @ 0.0 ft.



I - Infiltration @ 50.4 ft. RIGHT SIDE GOING UP STATION



PR - Point Repair @ 490.9 ft. TOP OF PIPE

Appendix E

Modeling Input File and Results

This page intentionally left blank

Table E.1. 5-year Storm Event Flooding Summary

Map ID	Location	Description	Overtop curb?	Maximum Street Spread Standard exceeded?	Risk to buildings?	Spread to Crown?	Duration (hrs)	Flooding Severity	Flooding Severity Comments
Area A									
A1	Butler Creek Road and Padre Lane	The ditch along the east side of Butler Creek Road overtops just north of the intersection of Butler Creek Road and Padre Lane. Flood waters drain to the roadway, appear to cross Padre Lane and drain south to DeSmet School field. A site visit confirmed that there is a low point near the northeast corner of the school building and that the most northern parking lot slopes towards the building, indicating that the building is at risk of stormwater reaching the ground line of the building. No ditch or conveyance was observed at this location along Padre Lane.	NA	No	Possible	Yes	0.6	Low	Maximum street spread standard met for collector and local roads but DeSmet School building at risk of inundation at the ground line.
A3	Butler Creek Road near CM Manufacturing	The ditch system appears to drain directly to Butler Creek Road (no culvert was found) from the northern end of the driveway at 6333 Butler Creek Road (CM Manufacturing property).	NA	No	No	Yes	12	Low	Standard met. Notable because ditch system drains to roadway.
A4	West side of intersection of Expressway and Butler Creek Road	This location floods on both sides of the road, exceeding the maximum street spread requirement for collector roads. The northern pipe entering the inlet structure was surveyed at a lower elevation than the pipe exiting the structure to the south, including a reverse slope on the pipe and contributing to flooding in the area. The most significant flooding is located on the northwest ditch along expressway.	NA	Yes	No	Yes	2	Moderate	Standard not met because flood waters extend to crown a collector roadways at intersection of Butler and Expressway.
Area B									

B2	Kestrel Drive at southern bend	Two catch basins flood on the east and west side (SW-INL-11951 and SW-INL-11950 respectively) at the southern bend of Kestrel Drive. These catch basins drain to west to a detention facility (SW-BSN-10127). The depth of water in the detention facility is creating a backwater condition that contributes to the flooding in the two catch basins. A field visit on April 9, 2024 was conducted to confirm model assumptions around the depth of the detention facility.	No	No	No	Yes	0.5	Low	Standard met.
Area C									
C2	Alloy South between Expressway and Industrial Road - 6200 Industrial Road Parcel	A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10325) inlet and enters the 6200 Industrial Road parcel (Bishops Storehouse). The hydraulic grade line (HGL) elevation for flooded node is approximately 4.4 inches greater than the estimated building floor elevation. The building is at risk if the drywell located in the parking lot becomes limited in capacity.	NA	No	Yes	No	<1	High	Maximum street spread standard met for local road but building at risk if catch basin capacity in parking lot becomes limited.

Table E.2. 100-Year Storm Event Flooding Summary

Map ID	Location	Description	Curb Present	Depth of Water Greater than 18 inches at curb?	Threatens building?	Flood waters extend beyond right of way?	Duration	Flooding Severity	Flooding Severity Comments	Note
Area A										
A1	Butler Creek Road and Padre Lane	The ditch along the east side of Butler Creek Road overtops just north of the intersection of Butler Creek Road and Padre Lane. Flood waters drain to the roadway, appear to cross Padre Lane and drain south to DeSmet School field. A site visit confirmed that there is a low point near the northeast corner of the school building and that the most northern parking lot slopes towards the building, indicating that the building is at risk of stormwater reaching the ground line of the building. No ditch or conveyance was observed at this location along Padre Lane.	No	NA	Yes	Yes	1.5	Moderate	Maximum street spread standard met for collector and local roads but DeSmet School building at risk of inundation at the ground line.	
A2	Butler Creek Rd adjacent to American Eagle Instruments	The ditch along with west side of the road overtops at the downstream culvert. Flood waters cross the southern driveway and extend outside of the right-of-way, before returning to the ditch system downstream. No flooding was observed at the parcel's second driveway to the north.	No	NA	No	Yes	1.5	Moderate	Standard not met because flood waters extend beyond the right of way.	
A3	Butler Creek Rd near CM Manufacturing	the ditch system appears to drain directly to Butler Creek Road (no culvert was found) from the northern end of the driveway at 6333 Butler Creek Road (CM Manufacturing property).	No	NA	No	No	13	Low	Standard met. Notable because ditch system drains to roadway.	
A4	West side of intersection of Expressway and Butler Creek Road	Flooding occurs at the northwest and southwest corners of the intersection. The northern pipe entering the inlet structure was surveyed at a lower elevation than the pipe exiting the structure to the south, including a reverse slope on the pipe and contributing to flooding in the area.	No	NA	No	No	2.5	Moderate	Standard met. Notable because flooding occurs on both sides of Expressway.	
A5	East side of intersection of Expressway and Butler Creek Road	The ditch culvert system appears to end at the downstream end of the culvert crossing the east side of Expressway. Water exiting the culvert appears to drain the parcels to the southeast until reaching a detention facility (SW-BSN-10127).	No	NA	No	Yes	See Note #1	Moderate	Standard not met because flood waters extend beyond the right of way.	

A6	Butler Creek Road north of railroad tracks and West Broadway	Butler Creek Road north of railroad tracks and West Broadway: A ditch from the west and north connect at a culvert on the west side of Butler Creek Road just north of the railroad tracks. Flooding was observed at the inlet of culvert (SW-CULV-10411). The flood waters appear to drain across the street but may reach the railroad tracks.	No	NA	No	No	1	Low	Standard met. Notable because flood waters may cross railroad tracks.	
Area B										
B1	Northwest corner of Kestrel Court and Expressway	Flows from the northwest ditch on Expressway overtop the sidewalk, enter a parcel (6401 Kestrel Court) with a baseball diamond and drain to the ditch on the west side of Kestrel Court. The model does not show flooding in the street at this location. The existing culvert is in poor condition (crushed and filled with sediment and vegetation).	NA	NA	NA	Yes	2	Moderate	Standard not met because flood waters extend beyond the right of way.	
B3	Intersection of Expressway and Sandpiper Drive North of Tanager Way/Kestrel	Flooding occurs on the northwest side of Sandpiper Drive and extends to both the roadway and to the parcel to the north with no indication of flood waters reaching the building. In addition, flooding at the culvert inlet on the northeast corner of the intersection occurs, overtops the sidewalk, and drains to an undeveloped parcel to the northeast. It is unknown if flood waters from the culvert inlet on the northeast corner of the intersection would extend past the undeveloped parcel to the developed parcel on 5975 Sandpiper Drive because the DEM does not reflect this developed parcel. The culvert that crosses Sandpiper Drive was surveyed as having a reverse slope.	Yes	No	Unknown	Yes	2.5	Moderate	Standard not met because flood waters extend beyond the right of way. Unknown if flood waters would extend to 5975 Sandpiper Drive because DEM does not reflect developed parcel.	Additional investigation recommended to evaluate risk to building.
Area C										
C1	Alloy South between Expressway and Industrial Road - 5550 Alloy South Parcel	A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10323) inlet and enters the 550 Alloy South (D&G Crane Services) parcel but does not reach building. Duration of flooding is less than 30 minutes.	No	NA	No	Yes	<1	Moderate	Standard not met because flood waters extend beyond the right of way.	

C2	Alloy South between Expressway and Industrial Road - 6200 Industrial Road Parcel	A ditch along the west side of the Alloy South floods at the culvert (SW-CULV-10325) inlet and enters the 6200 Industrial Road parcel (Bishops Storehouse). The hydraulic grade line (HGL) elevation for flooded node is approximately six inches greater than the estimated building floor elevation. The building is at risk if the drywell located in the parking lot becomes limited in capacity.	No	NA	Yes	Yes	<1	High	Standard not met because flood waters extend beyond the right of way and could reach building ground line.	
Area D										
D1	Trumpeter Way	A catch basin at the southeast end of the cul-de-sac floods as well as two structures immediately downstream. Flooding occurs in the cul-de-sac and parking lot to the west at (5102 Trumpeter Court).	Yes	No	No	Yes	<1	Moderate	Standard not met because flood waters extend beyond the right of way.	
D2	Grizzly Court	Grizzly Court: The model shows flooding at both ends of the culvert o then west side of the cul-de-sac. The model also shows flooding in a ditch at the south end of the cul-de-sac. Because the DEM does not reflect recent improvements to the ditch or development of parcel 5175 Grizzly Court, additional investigation is recommended to evaluate potential of flooding at this location	Yes	No	Unknown	Unknown	1	Unknown	Unknown if flood waters extend outside of of right-of-way.	Additional investigation recommended to evaluate risk to building.
Area E										
E1	Kendrick Place and Chesapeake Way	Catch basin SW-INL-11648 located on Chesapeake Way and Kendrick Place floods and likely drains south to a parcel (4852 Kendrick Place). There are two openings in the curb at this location that could allow flood waters to flow towards to the parcel that would otherwise drain down the gutter line. Flood waters likely drain down Cheshire Lane to a catch basin on Bordeaux Boulevard. Because the building may be in close proximity to flood waters, further investigation is recommended to confirm that the building will not be affected.	Yes	No	Possible	Yes	<1	Moderate	Standard not met.	Elevations of the catch basin were estimated because survey data was unavailable and only one of the two catch basins were modeled.
E2	Monticello Place - West Bend	The model shows flooding at the two catch basins located at a low point on Monticello Place (SW-INL-11576 and SW-INL-11614). Waters appear to pond in the roadway and eventually overtop the curb and drain southwest towards a detention facility (SW-BSN-10084).	Yes	No	No	Yes	0.75	Moderate	Standard not met because flood waters extend beyond the right of way.	While the model does not indicate waters extending to the ground line of any building, the HGL of SW-INL-11576 is only approximately 3 inches less than the ground elevation of the house at 4856 Monticello Place.

Appendix F

Recommendations Tables

This page intentionally left blank

Table F.1 Capacity Analysis Recommendations				
Map ID	Location*	Recommendation Type	Recommendation	Cost Estimate Line Items
Area A				
A1	Butler Creek Road and Padre Lane	Repair	Deepen ditch along Butler Creek Road and/or add conveyance along Padre Lane.	1.0, 7.0
A2	Butler Creek Rd adjacent to American Eagle Instruments	Repair	Deepen ditch.	1.0, 7.0
A3	Butler Creek Rd near CM Manufacturing	Repair	Add culvert at driveway.	1.0, 9.1
A4	West side of intersection of Expressway and Butler Creek Road	Repair	Deepen ditch along Expressway Boulevard. Fix reverse slope pipe. Remove wood pallet trash rack and add metal trash rack.	1.0, 7.0, 8.4, 9.4
A5	East side of intersection of Expressway and Butler Creek Road	Additional infrastructure	Add culvert to send flow to ditch along the north side of Expressway instead of south across Expressway. The size of the ditch along the north side of Expressway may need to be increased.	1.0, 9.2
A6	Butler Creek Road north of railroad tracks and West Broadway	None	Noted for informational purposes.	NA
Area B				
B1	Northwest corner of Kestrel Court and Expressway	Inspection and further evaluation	Inspect during storm event. Evaluate if ditch needs to be deepened if sending more flow from Butler Creek Road (see A5).	NA
B2	Kestrel Drive at southern bend	Inspection and further evaluation	Inspect during storm event.	NA
B3	Intersection of Expressway and Sandpiper Drive North of Tanager Way/Kestrel	Repair and further evaluation	Fix reverse slope of culvert crossing Sandpiper. Deepen ditch on north side of Expressway east of Sandpiper. After repairs, further evaluation of this area may be warranted to evaluate flooding extents.	1.0, 7.0, 8.4
Area C				
C1	Alloy South between Expressway and Industrial Road - 5550 Alloy South Parcel	Repair	Expose culvert ends under driveway and deepen ditch.	1.0, 7.0
C2	Alloy South between Expressway and Industrial Road - 6200 Industrial Road Parcel	Repair	Deepen ditch along west side of Alloy South. Culvert is shown in GIS as owned by 'other', so no recommendation to upsize or reset culverts.	1.0, 7.0
Area D				
D1	Trumpeter Way	Additional infrastructure	Add new pipe (18-inch CPP) from existing inlet to discharge to existing undeveloped field that drains to detention basin.	1.0, 8.6, 9.3, 9.5, 9.6, 9.7
D2	Grizzly Court	Inspection and further evaluation	Lidar data is outdated. Collect survey data on current, upgraded ditch/pond and further evaluate.	NA
Area E				
E1	Kendrick Place and Chesapeake Way	Deferred maintenance	Place sandbags along opening in curb cuts to force flow down curb line.	5.1
E2	Monticello Place - West Bend	Deferred maintenance and inspection	Clear vegetation from downstream detention basin. Inspect system at road curve (Monticello Place) during large storm event.	1.0, 3.0

*For further description of flooding conditions see **Table E.1** and **E.2**

Appendix G

Cost Estimates

This page intentionally left blank

Engineering Construction Cost Estimate for Missoula Development Park Stormwater Maintenance

Project Name: Missoula Development Park
 Project Number: 21-07621-003
 Client: City of Missoula Stormwater Division
 Submittal: Conceptual Level Costs



QA Review

Completed/Updated By: Kyle Johnson
 Last Updated On: 8/13/2024
 Approved By: HH
 Approved On: 8/13/2024

Item No.	Work Type	Item Description	Qty	Unit	Unit Cost	Total Cost
1.0	Support	General Requirements				
1.1		Mobilization (General)	1	L.S.	8%	\$ 21,390
1.2		Erosion/Water Pollution Control	1	L.S.	2%	\$ 5,348
1.3		Utility Protection and Relocation	1	L.S.	10%	\$ 26,738
1.4		Disposal	1	L.S.	0%	\$ -
1.5		Project Temporary Traffic Control	1	L.S.	\$ 40,000.00	\$ 40,000
2.0	Deferred Maintenance	Jetting and Vacuum				
2.1		Mainholes	30	Each	\$ 450.00	\$ 13,500
2.2		Inlets	42	Each	\$ 300.00	\$ 12,600
2.3		Pipe	6,924	L.F.	\$ 1.43	\$ 9,901
3.0		Vegetation Management				
3.1		Veg. Management	1	L.S.	\$ 48,000.00	\$ 48,000
3.2		Invasive Weed Management	1	L.S.	\$ 15,000.00	\$ 15,000
4.0		Swale/Channel Excavation				
4.1		Excavation/haul	45	C.Y.	\$ 200.00	\$ 9,000
4.2		Grading	32	S.Y.	\$ 100.00	\$ 3,200
4.3		Reveg	32	S.Y.	\$ 20.00	\$ 640
5.0		Other				
5.1		Place Sandbags (Area E1)	8	Each	\$ 50.00	\$ 400
6.0	Repair	Pipe/Culvert Ends				
6.1		10" CMP - 5' section with repair band	1	Each	\$ 400.00	\$ 400
6.2		18" CMP - 5' section with repair band	1	Each	\$ 473.00	\$ 473
6.3		20" CMP - 5' section with repair band	1	Each	\$ 625.00	\$ 625
6.4		42" CMP - 5' section with repair band	1	Each	\$ 1,625.00	\$ 1,625
6.5		12" CPP - 5' section with repair band	1	Each	\$ 352.00	\$ 352
6.6		15" CPP - 5' section with repair band	1	Each	\$ 400.00	\$ 400
7.0		Ditches				
7.1		Deepen Ditch (Areas A1, A2, A4, B3, C1, C2)	2,480	L.F.	\$ 6.60	\$ 16,368
7.2		Grade/topsoil (Areas A1, A2, A4, B3, C1, C2)	2,480	L.F.	\$ 6.40	\$ 15,872
7.3		Hydroseed/Hydromulch/Fertilizer/Tackifier (Areas A1, A2,	17,360	S.F.	\$ 1.00	\$ 17,360
8.0	Remove/Replace					
8.1		15" CMP	20	L.F.	\$ 126.00	\$ 2,520
8.2		18" RCP (in Airway Blvd.)	10	L.F.	\$ 1,500.00	\$ 15,000
8.3		Mid leg fix, surface restoration in asphalt or median	4	Each	\$ 7,500.00	\$ 30,000
8.4		Remove/Reset existing 15" CPP	107	L.F.	\$ 140.00	\$ 14,980
8.5		Remove/Reset existing 24" CPP	60	L.F.	\$ 165.00	\$ 9,900
8.6		Remove/Replace Sidewalk (Area D1)	50	S.F.	\$ 20.00	\$ 1,000
9.0	Additional Infrastructure					
9.1		15" CMP (Area A3)	60	L.F.	\$ 126.00	\$ 7,560
9.2		15" CPP (Area A5)	75	L.F.	\$ 166.00	\$ 12,450
9.3		18" CPP (Area D1)	30	L.F.	\$ 176.00	\$ 5,280
9.4		Trash rack (Area A4)	1	L.S.	\$ 1,750.00	\$ 1,750
9.5		Core Inlet (Area D1)	1	L.S.	\$ 500.00	\$ 500
9.6		Grade swale (Area D1)	45	L.F.	\$ 6.00	\$ 270
9.7		Hydroseed/Hydromulch/Fertilizer/Tackifier (Area D1)	450	S.F.	\$ 1.00	\$ 450
		Construction Subtotal				\$ 360,852
		Construction Contingency (See Note 1)	30%			\$ 108,255
		Subtotal (with +30% Contingency)				\$ 469,107
		Tax	0.0%			\$ -
		Construction Total (with Contingency and Tax)				\$ 469,200
		Further Evaluation Contingency	10%			\$ 46,920
		Engineering Design/Technical Support (See Note 2)	10%			\$ 36,100
		Construction Management	10%			\$ 36,100
		Total (Construction, Engineering, CM)				\$ 588,320

Notes:

- Costs include a 30% contingency on construction costs to account for changes in unit prices at the time of construction/maintenance, modifications to the preliminary alternatives, and other unforeseen price modifications.
- Costs include design and project management (10%) and construction administration (10%).