Americana Subwatershed Monitoring Plan

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List of Abbreviations

ACHD	Ada County Highway District
CFR	Code of Federal Regulations
COC	chain of custody
EPA	Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
PMEP	Project Monitoring and Evaluation Plan
psi	pounds per square inch
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Program Plan
SWMM	Storm Water Management Model
SWOMP	Storm Water Outfall Monitoring Plan
WQL	Boise City Water Quality Laboratory
WY	water year

Executive Summary

The National Pollutant Discharge Elimination System (NPDES) Phase I Permit No. IDS-027561 (Permit) was issued effective February 1, 2013, to Ada County Highway District (ACHD), Boise State University, City of Boise, City of Garden City, Drainage District #3, and the Idaho Transportation Department District #3, referred to as the "Permittees." Under this permit, the Permittees are required to update the existing storm water permit monitoring plan to be consistent with the monitoring and evaluation program objectives as described in Permit Part IV.A.2.

The Stormwater Outfall Monitoring Plan (SWOMP) was developed in 2014 to meet Permit requirements for stormwater monitoring, along with two other documents, the Project Monitoring and Evaluation Plan (ACHD 2013) and the Quality Assurance Program Plan for NPDES Storm Water Permit Monitoring (QAPP) (ACHD 2014a). The SWOMP describes monitoring activities at the stormwater outfall monitoring stations operated by ACHD, including the Americana outfall monitoring station. The results of monitoring data collected at the Americana outfall monitoring station show consistent background flow from the 875-acre subwatershed.

Dry weather and wet weather flows have been reviewed and analyzed, showing a complex flow regime from this subwatershed. Recommendations from multiple studies that include the Americana subwatershed identify the need for a greater understanding of both wet weather and dry weather flow volumes, sources, and pollutant loads upstream in the subwatershed. These studies include the *Subwatershed Planning: Americana and Main Street Subwatersheds, Ada County, ID* developed by Ecosystem Sciences in 2016, the *Impervious Area Connectivity Evaluation* developed by Brown and Caldwell in 2015, and the *Dry Weather Data Summary and Analysis* developed by Brown and Caldwell in 2017.

This monitoring plan has been developed to guide data collection and analysis efforts required to meet the objectives of the Americana subwatershed monitoring plan, which include the following:

- Validate assumptions about stormwater flows from individual subcatchments and identify situations where monitoring data does not align with expectations based on the results of the Connectivity Evaluation (BC 2015) or the Subwatershed Planning document for the Americana and Main Street subwatersheds (Ecosystem Sciences 2016).
- Identify sources of wet weather flows as well as non-stormwater dry weather flows that contribute to the flows discharging from the Americana outfall.
- Identify specific areas of the subwatershed where additional controls or changes in management approach are needed.

This plan describes ACHD's approach to subwatershed monitoring and provides site selection parameters and site description documentation, guidance for data collection efforts, including descriptions of meteorological and hydrological data collection procedures and use, as well as analytical data collection and sample handling procedures. Certain quality assurance/quality control (QA/QC) procedures that have been identified using United States Environmental Protection Agency guidance for QAPPs are also included in this plan. The QA/QC procedures are designed to ensure data collected meet specific data quality objectives developed specifically for Permit-required monitoring activities. This plan documents QC procedures, data acceptance criteria, and data management details specific to the subwatershed monitoring plan.

The appendices of this plan include documentation tools to assist with site selection, data management record keeping, and decision making. These tools will provide ACHD with an organized approach for maintaining an up-to-date record of current monitoring activities and tracking information and conclusions from the monitoring effort. They will also provide the basis for program assessment activities to adjust the program approach and monitoring methods as needed.

Section 1

Introduction

The Americana subwatershed is one of the largest urban subwatersheds on the lower Boise River and drains a significant portion of downtown Boise and the North End and Foothills residential areas, which results in a complex drainage area. Connections with natural surface waters, irrigation canals, and dewatering activities further complicate the profile of stormwater runoff and background non-stormwater flows. Stormwater runoff and dry weather, non-stormwater monitoring (flow measurement and analytical sample collection) have been conducted at the Americana outfall since 2013.

In 2016, Ecosystem Sciences completed a subwatershed plan for the Americana drainage area. The goal of the subwatershed planning project relating to the Americana drainage area was to develop a strategic subwatershed-scale plan for the whole Americana subwatershed. The plan delineated subareas within the watershed which were used to support hydraulic, hydrologic, and water quality modeling for the Americana subwatershed. Results of the model, along with other pertinent information, were used to prioritize subareas for future green stormwater infrastructure implementation.

In 2017, Brown and Caldwell completed an analysis of dry weather flow data collected at all outfall monitoring locations, which included a summary of flow and analytical data, results and conclusions drawn from the analysis, and recommendations and considerations for future dry weather monitoring and subwatershed mapping efforts. Major conclusions for flow data measured at the Americana monitoring station are described below:

- Background, dry weather flows were consistently present at the monitoring station.
- Background flow has been attributed to multiple confirmed sources and several suspected, but not specifically verified, sources throughout the year. Whether these sources are intermittent, recurring, or continuous has not been confirmed.
  - Diversions from Boise City Canal (confirmed)
  - Discharges from groundwater dewatering activities (confirmed)
  - Discharges from the City of Boise geothermal system (confirmed)
  - Discharges from Boise Cold Storage Company (confirmed)
  - Surface water from Hulls Gulch (confirmed)
  - Groundwater infiltration into storm drain pipes (suspected)
- Several unexplained spikes in dry weather flows have been recorded at the Americana monitoring station over the period of record. Some of these events have resulted in water depth and velocities reaching dangerous levels for anyone working in the pipe at the time of the discharge, and the volumes are high enough that the discharge could carry a substantial pollutant load if it happened to be associated with an illicit discharge.

Conclusions from the dry weather analysis mostly point to the need for a better understanding of sources of dry weather flows discharging from the Americana outfall. These conclusions include the following:

- Irrigation water, as a significant factor in dry weather flow volume, should be better documented.
- Dewatering activities authorized through license agreements, the Construction General Permit, or Sediment and Erosion Control Permits should be better documented, especially in terms of expected flow rates and discharge times/durations.

- Large and unexpected spikes in background flow pose a health and safety risk for Ada County Highway District (ACHD) personnel and consultants performing confined space entry activities in the Americana subwatershed and may also be contributing significant pollutant loads to the Boise River.

During water year (WY) 2018 the Stilson monitoring station was removed from the stormwater outfall monitoring program. This action occurred ahead of planned construction on the State Street /Veteran's Memorial Parkway intersection that included major changes to the Stilson subwatershed and storm drain infrastructure. As an adaptive management strategy to maintain National Pollutant Discharge Elimination System (NPDES) Phase I Permit (Permit) compliance, ACHD proposed to implement an alternative monitoring approach as described in ACHD's permit reapplication submittal to the Environmental Protection Agency (EPA). WY 2019 was the first year of Americana subwatershed monitoring.

1.1 Basis for Monitoring Plan

Stormwater runoff monitoring (flow measurement and analytical sample collection) is currently conducted at the Americana monitoring station and identified in the Storm Water Outfall Monitoring Plan (SWOMP) (ACHD, 2014b). There are also two rain gauges collecting representative precipitation data for the subwatershed. While data collected at the outfall is important for understanding discharges to the lower Boise River, the dataset does not provide much information about the characteristics of stormwater or dry weather flows and the sources of pollutants and flow characteristics farther up the drainage area.

This monitoring plan details ACHD's approach to targeted systematic flow and water quality monitoring at major nodes within the Americana subwatershed storm drain system and serves as a complement to the SWOMP. Flow and water quality data collected in the Americana subwatershed will be integrated into the stormwater outfall monitoring program, providing more detailed information about the monitored subwatersheds. Through correspondence with the EPA during the permit reapplication process, ACHD confirmed that monitoring conducted according to this monitoring plan effectively replaces the monitoring that is no longer possible at the Stilson monitoring station due to construction in that area.

1.2 Subwatershed Monitoring Plan Objectives

Monitoring data collected under this monitoring plan are intended to support the objectives for the monitoring program described below. This approach to monitoring is new to ACHD, and there is no specific permit guidance. Therefore, reviews of the data collected and progress towards the overall goal of gaining a better understanding of the Americana subwatershed will be evaluated at recurring intervals throughout the monitoring program. The monitoring plan and data collection approaches may be modified to align with the objectives identified below.

- Validate assumptions about stormwater flows from individual subcatchments and identify situations where monitoring data does not align with expectations based on the results of the Connectivity Evaluation (BC 2015) or the Subwatershed Planning document for the Americana and Main Street subwatersheds (Ecosystem Sciences 2016).
- Identify sources of wet weather flows as well as non-stormwater dry weather flows that contribute to the flows discharging from the Americana outfall.
- Identify specific areas of the subwatershed where additional controls or changes in management approach are needed.

As a complement to the SWOMP, this plan was developed with the same structure as the SWOMP, and therefore, under the guidance of the Project Monitoring and Evaluation Plan (PMEP) (ACHD 2013) This subwatershed monitoring plan is designed to address the minimum permit requirements for stormwater outfall monitoring as listed in Permit Part IV.A, as well as meet the level of service goals identified in the PMEP. This monitoring plan serves as guidance for data acquisition, management, and reporting efforts undertaken by the permittees. The sections in this document include specific Quality Assurance Program Plan (QAPP) elements recommended by the EPA. EPA-recommended QAPP elements are addressed as either program elements or monitoring plan elements.

All Phase I monitoring activities are designed following EPA guidance documents described in the ACHD *Quality Assurance Program Plan for NPDES Storm Water Permit Monitoring* (ACHD 2014a). The Phase I monitoring program has divided specific plan elements identified in the EPA guidance into two groups: QAPP elements and monitoring plan elements. Monitoring plan elements are described in full in this document, while program elements are addressed in the QAPP. Monitoring plan elements are those components that contain details specific to each individual monitoring plan. Plan organization, responsibilities, and objectives are derived from the PMEP, which serves as guidance to standardize stormwater management under the Permit as a whole, including the approach to quality assurance and monitoring plan implementation. Program elements consist of the standardized monitoring components that all individual monitoring plans developed under the Permit reference. A list of program and monitoring plan elements is included in Table 1-1.

Table 1-1. QAPP Element Document Reference

EPA Recommended QAPP Elements	QAPP Element	Subwatershed Monitoring Plan Element; Section
Group A: Project Management		
A1 – Title and Approval Sheet	X	
A2 – Table of Contents	X	
A3 – Distribution List	X	
A4a – Project Organization	X	
A4b – Task Organization		X; 1.3
A5 – Problem Definition/Background	X	
A6 – Project/Task Description		X; 1.2
A7a – Quality Objectives and Criteria for Measurement Data	X	
A7b – Method Dependent Criteria for Measurement Data		X; 5
A8 – Special Training Needs/Certification	X	
A9 – Documents and Records	X	
Group B: Data Generation and Acquisition		
B1 – Sampling Process and Design		X; 2
B2 – Sampling Methods		X; 3, 4
B3 – Sample Handling and Custody		X; 4
B4 – Analytical Methods		X; 4
B5a – Quality Control	X	
B5b – QA/QC Sampling Schedule		X; 5
B6 – Instrument/Equipment Testing, Inspection, and Maintenance		X; 3
B7 – Instrument/Equipment Calibration and Frequency		X; 3

Table 1-1. QAPP Element Document Reference		
EPA Recommended QAPP Elements	QAPP Element	Subwatershed Monitoring Plan Element; Section
B8 – Inspection/Acceptance of Supplies and Consumables	X	
B9 – Non-direct Measurements	X	
B10 – Data Management	X	
Group C: Assessment and Oversight		
C1 – Assessments and Response Actions	X	
C2 – Reports to Management	X	
Group D: Data Validation and Usability		
D1 – Data Review, Verification, and Validation	X	
D2 – Verification and Validation Methods	X	
D3 – Reconciliation and User Requirements	X	

1.3 Task Organization

Key monitoring roles and job functions are described in the QAPP. The subwatershed monitoring program organization chart is included below.

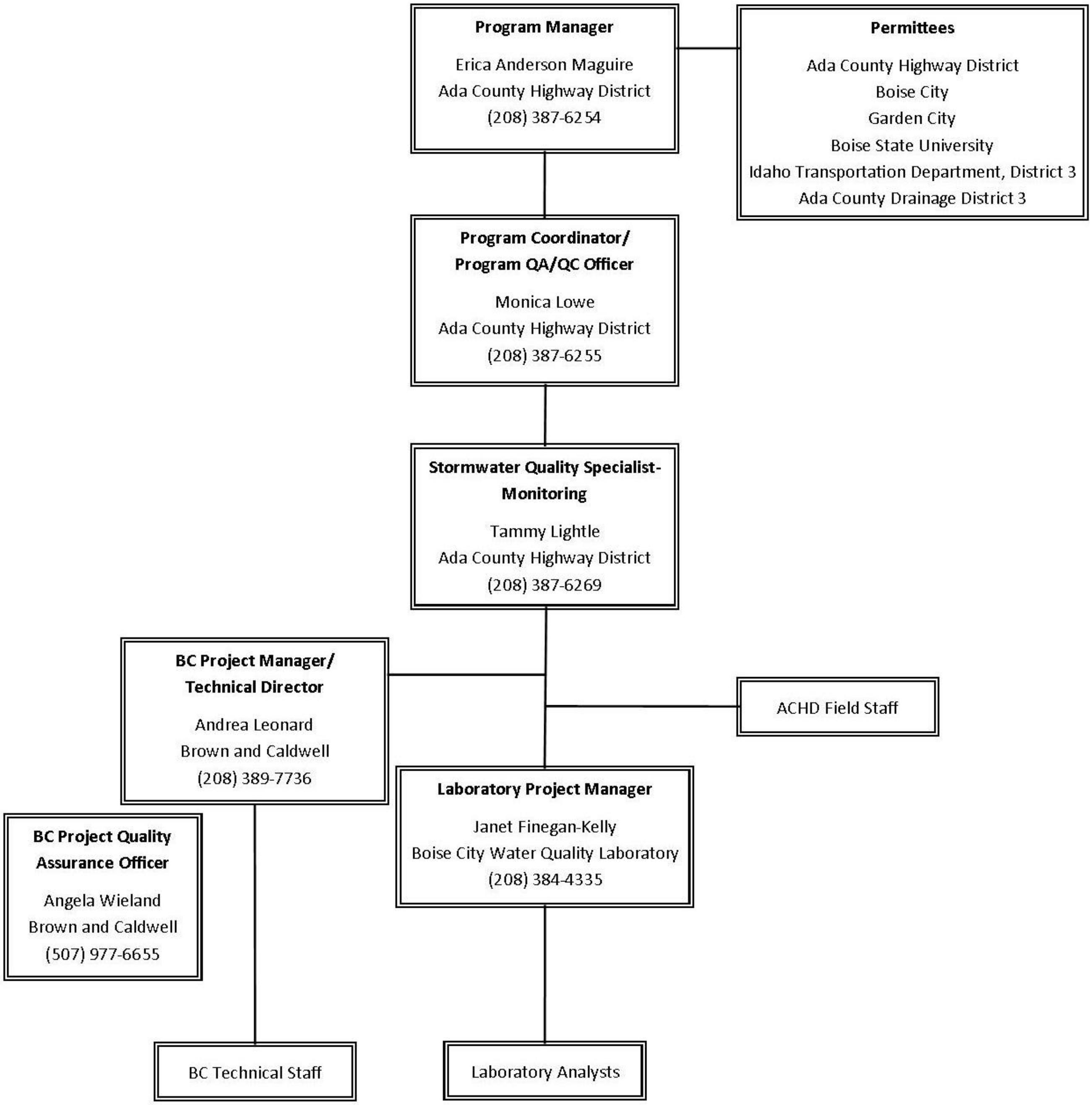


Figure 1-1. Subwatershed monitoring organization chart

Section 2

Sampling Process Design

The sampling process design consists of the collection of data at monitoring stations set up at various points in the Americana subwatershed storm drain system to present a picture of the amount, duration, and quality of wet weather and dry weather flows. An overview map of the Americana subwatershed is included as Figure 1. Data to be collected includes a combination of continuous flow data, continuous rainfall data, and water quality data. Section 2.1 provides an overview of the methods used to obtain this data, and more detail is provided in Sections 3 and 4.

The process for selecting monitoring sites and transitioning monitoring equipment from one site to the next is outlined below in Section 2.2. Detailed site description information is discussed in Section 2.3.

2.1 Data Collection Overview

Subwatershed data collection will be facilitated by a combination of temporary flow monitoring equipment, semi-permanent rain gauge locations established for the SWOMP, water quality samples, and instantaneous readings and measurements using handheld meters and measurement tools. Loggers deployed to collect in-pipe water level and temperature measurements are the primary data collection device used to collect flow data in the subwatershed monitoring program. The loggers measure pressure in pounds per square inch (psi) at 5-minute intervals. The measurements are downloaded from the logger instrument for further processing in proprietary software provided by the manufacturer. Additional information regarding equipment types and operation is included in Section 3.

Atmospheric barometric pressure measurements are also recorded in 5-minute intervals and are uploaded to the software. The pressure measured by the logger is compensated for barometric pressure and sensor depth (level) is calculated at the time of each measurement. Barometric pressure data is collected using another logger mounted in a protected open-air location at ACHD headquarters. Level data is then used, along with other site-specific information, to estimate flow volumes. Flow volume estimates derived from logger readings are described in detail in Section 6.

Flowmeters using level, area, and velocity sensors will also be deployed strategically throughout the course of the monitoring program to validate level measurements and flow estimates derived from logger data. Flowmeters are not as versatile as the loggers and can only be installed under specific conditions. Therefore, flowmeters will be used for specific purposes such as collecting higher resolution data, validating logger data measurements, and controlling automated sampling equipment.

Continuous rainfall data measurements will be recorded at the Front and East Rain Gauges (Figure 1). Rainfall data will assist with estimating runoff volumes and distinguishing between dry weather and wet weather flows through the storm drains.

Water quality data collection will be accomplished using manual and automated methods. Discrete grab samples will be collected for laboratory analysis and analysis of field parameters. Composite samples will be split at the laboratory for analysis. Analytical sample collection methods will follow outfall sampling protocols.

Monitoring equipment operation and maintenance descriptions are included in Section 3. Specific descriptions of sampling procedures are described in Section 4.

2.2 Site Selection

The intent of this monitoring program is to isolate sections of the Americana subwatershed to better understand flows and their associated water quality, which ultimately discharge to the Boise River through the Americana outfall. The first seven monitoring sites have been installed near major intersections within the storm drain system in the Americana subwatershed. The data collected at the two outfall monitoring site locations represent all flow in the subwatershed. Monitoring will progress up the system from the initial locations based on data collected at each monitoring site to isolate sources of dry weather flows, high pollutant loads, or stormwater runoff that does not match predicted runoff volumes. All potential monitoring locations in the Americana subwatershed are accessed through manholes, except for the southeast outfall monitoring site. There are 330 manholes providing access to the storm drain system in the Americana subwatershed. To prioritize monitoring sites for selection, each new potential monitoring location is ranked using the site selection matrix included as Table A-1 in Appendix A.

Site selection rankings are based on three key criteria: safety, data quality, and management. Each criterion has sub criteria to assist in ranking. The safety criteria evaluate access to the manhole and suitability of the vault as workspace for monitoring equipment installation. The data quality criteria evaluate the likelihood of obtaining representative measurements at the potential monitoring site. These sub criteria evaluate pipe conditions for turbulence and other factors that may degrade the quality of flow estimates and issues that may affect collecting representative water quality data. Managerial sub criteria are yes/no to document management conditions in the subcatchment area for consideration during data review and analysis. These conditions may include areas of known flooding issues or identify capital improvement projects and license agreements with dischargers.

Appendix B provides maps of all monitoring sites and the subcatchments they represent. Figure 3 is an overview map showing the outfall monitoring location (Site 14) and all other monitoring locations within the Americana subwatershed. Maps are added with progressively higher figure numbers for all other monitoring sites.

2.3 Site Descriptions

As part of the adaptive management approach to monitoring flows and water quality in the Americana subwatershed, monitoring sites are temporary locations. Loggers, flowmeters, and samplers will be installed for varying lengths of time at each monitoring location, depending on the results of data collected. A tracking table is provided as Table A-2 in Appendix A to document logger locations and pertinent monitoring information. The following information is recorded in the table:

- Site location information
  - Location name
  - Location ID specific to the Americana Subwatershed Study
  - Latitude and longitude
  - Manhole ID in Storm Water Management Model (SWMM) file
  - Manhole Object ID in geographical information system
- Storm drain characteristics
  - Pipe diameter
  - Pipe construction
  - Manning's coefficient
  - Pipe slope

- Subcatchment information
  - Subcatchment area
  - Subcatchment total impervious area
- Installation details
  - Identification number of equipment installed (serial number for loggers, ID number for flowmeters)
  - Installation notes
  - Depth of water during installation
  - Deployment start date
  - Deployment end date

Subcatchment water quality monitoring sites are identified in Table A-2. Each water quality monitoring location has a site information sheet inserted immediately following Table A-2 . Site information sheets describe sample collection methods, locations, and considerations. These sheets also include photographs of the sampling location and installed equipment.

Section 3

Monitoring Equipment

3.1 Pressure Transducer Water Level Data Loggers

Pressure Transducer Water Level Data Loggers (loggers) are the primary monitoring instrument used to gather flow data in the Americana subwatershed storm drain system. HOBO U20L-40 Water Level Loggers are used for in-pipe monitoring. The loggers record pressure (in psi) exerted on the sensor as well as temperature. The recorded pressure is compensated with barometric pressure data in the HOBOware Pro software and a corresponding water level reading is calculated for each pressure reading.

The loggers are installed in the storm drain pipes inside a 2-inch diameter steel-lined flexible conduit. The submerged end of the conduit is pinched to a narrow opening that holds the logger back from passing through the end of the conduit while still allowing free movement of water into the conduit for measurement. At each site the conduit is mounted with steel C-clips to pipe and vault walls, starting at the bottom of the manhole cover to the measured pipe floor. The logger is secured to a piece of flexible fiberglass rod that is the same length as the conduit. This configuration allows the logger to be removed from the conduit and reinserted without confined space entry and ensures that it is back in position at the bottom of the pipe. The picture below was taken at the 16th and Front monitoring site and provides an example of the installation.

Figure 3-1. 16th and Front monitoring site installation

Calibration and Maintenance

Loggers can be damaged by shock. If the logger is dropped or otherwise jarred, it should be recalibrated. The logger housing should be gently cleaned with a towel or brush as needed during data downloads to avoid buildup of biological growth. Batteries are expected to last about 5 years and may only be replaced by sending the unit to the manufacturer.

A water level measurement will be taken at the time of logger installation. If water in the pipe is not at a sufficient level to register correctly on the logger, a piece of material will be temporarily installed just downstream of the sensor to back up water and obtain a reference water level measurement. If there is no flow in the pipe at the time of installation, water will be added to the pipe from containers. When and if a flowmeter is installed in the same pipe as a logger, level measurements recorded on the flowmeter will be used to validate level readings from the logger.

3.2 Flowmeters

Hach and ISCO flowmeters are used at certain Americana subwatershed monitoring sites on a case-by-case basis. Each flowmeter is equipped with a probe, which is mounted on the invert of the pipe and measures level and velocity. To measure level, Hach instruments use a bubbler depth sensor while ISCO instruments use a pressure transducer. Both brands of instruments use acoustic Doppler technology to measure velocity. The flowmeter then uses the recorded level and velocity values along with pipe characteristics to estimate the flow of water through the pipe. The flowmeters store this flow data at programmable intervals. Hach or ISCO flowmeters may be used in conjunction with an automated sampler to collect composite samples by sending a signal to the sampler at specified time intervals or after a pre-programmed volume of runoff has passed through the pipe.

Calibration and Maintenance

Routine maintenance of flowmeters, including calibration, will be performed according to the procedures described in the SWOMP. More frequent maintenance or calibration will be performed as warranted by equipment performance.

Calibrating the level requires only offsetting the initial depth of water. Typically, no field calibration of the velocity sensor is required. Additional checks on the accuracy of the velocity meter can, however, be conducted using a manual current meter to measure velocity. Depth can be checked by comparing an in-pipe measurement to the recorded value. Readings showing deviations can be corrected using the flowmeter interface while in the field.

3.3 Rain Gauges

ACHD currently maintains two rain gauge sites representative of the Americana Subwatershed. The rain gauges are deployed to collect continuous precipitation data throughout the water year. The program uses tipping-bucket style rain gauges that measure rainfall depths in 0.01-inch increments. Both rain gauge sites are equipped with Hobo event loggers. Both a primary and a backup event logger are used to record tip measurements. Rain gauge locations are shown on the overview map included in the Figures section at the end of the document.

The data collected on the rain gauge data loggers will be downloaded to a portable laptop computer on a regular basis by ACHD personnel. The data will be compared to the National Weather Service rainfall data to identify geographic variations, revise estimates of runoff coefficients, and analyze and evaluate the stormwater quality data.

Calibration and Maintenance

ACHD will inspect, maintain, and download the rain gauges and data loggers on a regular basis. Calibration is not typically required for the tipping bucket rain gauges. If needed, calibration procedures are outlined in the rain gauge equipment manual. Inspection, maintenance, and downloading procedures are described in the SWOMP.

3.4 Handheld Field Parameter Instruments

Handheld field parameter instruments are available for collecting certain water quality parameters including pH, conductivity, dissolved oxygen content, and temperature. Field parameter instruments will be rinsed with distilled water between measurements.

Handheld field parameter instruments include the following:

- In-Situ Aqua TROLL 500 Multiparameter Sonde
- Horiba D-21 pH/temperature meter and Horiba D-51 pH/temperature meter
- Oakton 300 pH/dissolved oxygen/temperature meter
- YSI-85 dissolved oxygen/salinity/conductivity/temperature meter

Safety monitoring instruments include the following:

- Hazardous vapor monitors including Biosystems PHD6 and GasAlert Max XT II

Calibration and Maintenance

Maintenance will be conducted per the manufacturers' recommendations and the procedures described in the SWOMP, or more frequently as warranted by equipment performance. Instruments will be inspected and calibrated prior to each monitoring event. ACHD is responsible for calibration and maintenance and will keep a log in the monitoring shed for reference.

3.5 Automated Samplers

Sampling will be conducted using Hach 900Max and ISCO 6712 portable liquid samplers. Sample aliquots are pumped from the stormwater conveyance to a 15-liter low density polyethylene (LPDE) carboy by a peristaltic pump. The discharge tubing of the pump is routed into the sample container. The container is secured in the base of the sampler with ice to maintain target sample temperature.

Ahead of a sampling event the automatic sampler is programmed to collect samples based upon flow-paced signals received from the flowmeter via a control cable. A record of the sampler's operations (e.g., execution data and sample times) is stored on the hard drive of both the sampler and the flowmeter and may be downloaded to a portable computer at any time.

Calibration and Maintenance

Routine maintenance of the automatic samplers, including cleaning and calibration, is described in the SWOMP. The sampler is calibrated by comparing the collected sample volume (measured using a graduated cylinder) with the required volume that was programmed into the sampler program. The sampler microprocessor will adjust the pump run time to either increase or decrease the sample volume. This process is repeated until the sampler delivers a volume that is within ±10 percent of the requested sample volume.

Section 4

Sampling Procedures

4.1 Analytical Sample Collection Frequency

Sample collection for laboratory analysis will be conducted for a minimum of three wet weather events per year. When possible, subcatchment water quality sampling events will coincide with sampling events conducted at Site 14 under the stormwater outfall monitoring program. After three successful events have been completed, more sampling may be conducted with targeted analytical parameters reduced to a subset of the full list of constituents based on water quality concerns specific to the monitored subcatchment(s).

4.2 Stormwater Parameter Analysis

The analytical methods used in the SWOMP are presented in Table 4-1 below. Additional constituents may be added to this list. The NPDES Permit requires that “sample collection, preservation, and analysis must be conducted according to sufficiently sensitive methods/test procedures approved under 40 Code of Federal Regulations [CFR] Part 136, unless otherwise approved by EPA. Where an approved 40 CFR Part 136 method does not exist, and other test procedures have not been specified, any available method may be used after approval from EPA.” As such, the methods identified below are the selected and preferred options. However, sample, laboratory, or instrument conditions may require the substitution of an alternate Part 136 method.

Table 4-1. Analytical Methods for Water Quality Constituents of Concern

Constituent	Analytical Method
Ammonia (NH_3)	SM 4500 NH3-D
Total Kjeldahl nitrogen	Perstorp PAI-DK01
Nitrite plus nitrate	EPA 353.2
5-day biological oxygen demand	SM 5210 B
Chemical oxygen demand	Hach 8000
Total dissolved solids	SM 2540 C
Turbidity	EPA 180.1
Arsenic, total	EPA 200.7
Cadmium, total and dissolved	EPA 200.7
Copper, dissolved	EPA 200.7
Lead, total and dissolved	EPA 200.7
Mercury, total	EPA 245.2
Zinc, dissolved	EPA 200.7
Hardness (as calcium carbonate)	SM 2340 B
Total phosphorus	EPA 200.7
Dissolved orthophosphate	EPA 365.1
Total suspended solids	SM 2540 D
E. coli	IDEXX Colilert

Table 4-1. Analytical Methods for Water Quality Constituents of Concern

Constituent	Analytical Method
Conductivity	EPA 120.1
Dissolved oxygen	SM 4500 G
Temperature	EPA 170.1
pH	EPA 150.1
Flow/discharge volume	Non-specific

4.3 Monitoring Station Set-up

Flowmeters and automated sampling equipment will be programmed prior to the start of the sampling event based on forecast information and the set of analytical samples planned to be collected.

Typical monitoring station setup activities include the following:

- Flushing the sampler intake line and silicone discharge tubing with a dilute hydrochloric acid solution
- Checking the condition of sampler harness, platform (if applicable), and the sampler humidity indicator
- Inspecting electrical and tubing connections for tightness
- Installing recharged batteries
- Freeing sampler tubing of twists, pinches, or cracks and replacing if needed
- Loading bottles and ice into automatic samplers
- Programming the samplers and flowmeters
- Initiating the sampling program
- Recording setup information on field data sheets

4.3.1 Flowmeter Programming

When background flow is present at the time of setup, the flowmeter will be programmed with a velocity or level cutoff value to avoid triggering sample collection from background flows.

Runoff Coefficients and Trigger Volumes

In order to collect a flow-weighted composite sample throughout a storm, estimates will be calculated for the runoff volume expected at the monitoring site. The expected runoff volume will be divided by the planned number of sample aliquots, and the resulting value will be used as the trigger volume for programming the flowmeter. The trigger volume is the amount of flow that will be measured before the automatic sampler is triggered to collect a subsample. Therefore, the number of samples collected over the course of a storm is a result of the runoff volume expected for the total storm as forecasted at the time of station setup.

Calculating the total estimated runoff is a function of the rainfall amount expected and the site-specific runoff coefficient. The site-specific runoff coefficients are derived from the percentage of impervious ground cover in the subwatershed and empirical values from observed storm data.

Historical data suggests that variability in the size, duration, and intensity of a storm, along with variability within the drainage area including soil moisture, temperature, snow cover, and a multitude of other variables all contribute to the actual volume of runoff discharging at each monitoring station. Actual runoff volumes recorded during storms will be used to refine runoff coefficients and over the course of the program to more accurately predict runoff and produce trigger volumes that will most consistently result in composite samples of adequate volume and that are representative of the storm.

4.4 Sample Collection

One sampling team will be deployed to collect grab samples and monitor the composite sampler. A sampling team will consist of two people, a sample team leader and a sample technician. Sampling team assignments will be determined once the decision is made to target a storm for a sampling event. The sample team leader will also serve as the site safety officer during sampling events.

When storm event runoff begins, the consultant field coordinator will confer with the program coordinator and mobilize sampling teams. All sampling personnel will meet at the ACHD shed for a briefing on field conditions, quality assurance/quality control (QA/QC) samples to be targeted, and safety reminders and concerns.

Sample collection will be conducted by personnel trained in the sampling procedures covered by the stormwater outfall monitoring program. Sampling teams are responsible for the following:

- Collecting field measurements of temperature, pH, conductivity, and dissolved oxygen
- Collecting laboratory analytical grab samples
- Verifying operation of the automated sampling equipment
- Collecting sample duplicates and/or preparing field blanks, as required
- Making arrangements to transfer samples for submittal to Boise City Water Quality Laboratory (WQL)

4.4.1 Grab Sample Collection

Sample collection will be accomplished by filling grab sample bottles for each analyte from a point near the center of the flow at the monitoring site in accordance with the applicable procedures listed in Appendix B of the SWOMP. Depending on site configuration and flow volume, the grab samples will be collected using a swing sampler or by hand and safely positioning the sample bottle in the runoff stream. Immediately following sample collection, the sample collection date, time, and sample identification will be recorded on the sample containers and on a Grab Sample Data Log (SWOMP Appendix C – Form 1A-1B). Additional sampling information recorded on the Grab Sample Data Log includes sample collection equipment used, field parameter measurements, notes on the use of a transfer bottle, the time stormwater flow began at the site, and other comments and observations.

Field parameters including temperature, pH, conductivity, and dissolved oxygen will be measured in the field using handheld instruments to avoid changes that may occur between the time when the sample is collected and the time of the analysis. Measurements from these field tests will be recorded on the Grab Sample Data Log.

4.4.2 Composite Sample Collection

Collecting flow-weighted samples throughout a storm event is accomplished with automated sampling equipment installed at the monitoring site. During site setup, the sampler is programmed for a site and event-specific trigger volume. At each monitoring site, the automatic sampler is linked to a flowmeter. When the flowmeter records the trigger volume amount, the integrated peristaltic pump on the automatic sampler engages and draws a sample through the tubing installed in the invert of the storm drain pipe. The sample aliquot is pumped into the composite sample bottle secured in a cooler inside the enclosure or in the base of the automatic sampler. If automatic compositing of samples is not possible due to issues with equipment or other difficulties, manual composites may be collected. Procedures for manual composite sample collection are listed in Appendix B of the SWOMP.

The sampler program will end automatically after the last programmed subsample has been collected (typical target of 24 subsamples). Collection date, time, and sample identification will be recorded on sample containers immediately following collection of the sample container. Collection date, time, and other observations will be recorded on a Composite Sample Collection form (SWOMP Appendix C – Form 2B).

Variability between expected runoff amounts and measured runoff amounts are common. In order to increase the probability of collecting a representative sample, a conservative approach to programming composite sample trigger volumes is used. The minimum volume required by the WQL to run the analyses identified in Table 4-1 is 8 liters. In order to collect a representative composite sample, the sampler is programmed to collect 24 aliquots at 620 milliliters (mL) per aliquot. This program will provide a minimum of 17 subsamples with a conservative estimate of forecasted rainfall and will also provide additional capacity to collect up to 7 more aliquots in the event the intensity and duration of the storm is more than expected.

In this program, the composite sample will be considered valid and unqualified if aliquots were collected for greater than 75 percent of the total runoff volume from the storm event or a total of 6 hours of the storm.

4.5 Sample Handling Procedures

The required types of containers and holding times for subwatershed monitoring are dependent upon the components to be analyzed. Table 4-2 includes container types and holding times for each parameter group.

Preservation techniques in the field are limited to cooling samples to a target sample temperature of less than 6 degrees Celsius but above freezing. Five to ten pounds of food grade ice will be placed in the coolers of the automatic samplers during station setup. Sufficient ice will also be placed in coolers used for grab and composite sample transport to maintain the samples at a maximum temperature of 6 degrees Celsius. Composite samples will be collected for the majority of analytical parameters in stormwater samples. Composite samples will be collected in a 15-liter Nalgene low-density polyethylene carboy.

No chemical preservation measures are required in the sample collection process. The WQL will add chemical preservatives, as necessary, after the composite samples are split for analysis, i.e., metals analysis. In the 15-liter carboy, composite samples have a holding time of 48 hours. Analysis of composite samples will include the parameters listed in Table 4-2.

Parameters to be measured in the field include dissolved oxygen, conductivity, pH, and temperature. Parameters will be measured on-site using portable handheld meters immediately following sample collection. Field parameter samples will be collected and measured in a glass jar.

Special Handling Considerations

4.5.1 E. coli

Due to the variable nature of storm event timing, *E. coli* grab samples are sometimes analyzed outside of sample holding times required by the standard method (8 hours). The WQL has committed to providing *E. coli* analysis within the holding time for samples submitted during normal business hours (Monday–Friday), and within 12–16 hours if samples are submitted after hours. *E. coli* samples analyzed within the 8–16 hour timeframe will be qualified as estimated in the context of the program-established data quality objectives discussed in Section 5. In the event that analysis is not initiated within 16 hours of collection, results will be rejected.

4.5.2 Dissolved Metals

Current regulations under the EPA Method Rule Update issued on May 18, 2012, require that samples collected for the analysis of dissolved metals, including dissolved orthophosphate, be filtered within 15 minutes of collection of a grab sample or the last subsample of a composite sample. Dissolved metals will typically be a constituent of the composite sample for the Americana subwatershed monitoring program.

The WQL has committed to splitting composites and filtering dissolved metals samples at the time of submission to the laboratory when they are submitted during normal business hours and within 24 hours when samples are submitted after hours. Samples filtered within the 24 hour timeframe will be not be qualified as estimates in the context of the program-established data quality objectives discussed in Section 5. In the event that filtration is not accomplished within 24 hours of collection, results will be rejected.

Table 4-2. Sample Handling Requirements

Constituent	Container	Holding Time
Composite Samples		
Ammonia (NH_3) Total Kjeldahl nitrogen Nitrite plus nitrate 5-day biological oxygen demand Chemical oxygen demand Total dissolved solids Arsenic, total Cadmium, total and dissolved Copper, dissolved Lead, total and dissolved Mercury, total Zinc, dissolved Turbidity Hardness Total phosphorous Dissolved orthophosphate Total suspended solids	15-liter low-density polyethylene carboy	48 hours (in carboy)
Grab Samples		
E. coli	500 mL sterilized high-density polyethylene	8 hours
Field Parameters		
Dissolved oxygen	1-liter glass	Field analysis
Temperature		
pH		
Conductivity		

4.6 Chain-of-Custody Procedures

Standard chain of custody (COC) forms will be completed prior to submitting samples to the laboratory. Information recorded on the COC includes the following:

- Sample collection team member names
- Sample identification
- Sample type (grab or composite)
- Analyses requested
- Start and stop times
- Sample start and end date

A sample is considered to be “in custody” if it is either in actual physical possession of authorized personnel or in a secured area that is restricted to authorized personnel. Such areas include laboratory refrigerators, the monitoring lab at ACHD, ACHD office space, consultant office space, ACHD vehicles, and consultant vehicles. Automatic samplers at monitoring sites will be installed in locking enclosures or in manholes. Where samplers are installed in manholes, the sample container base will be locked to secure access to the sample. All transfers of custody will be recorded by signature, date, and time by both the individual relinquishing custody and the one receiving custody. This information is placed in the designated area on the bottom of standard COC forms.

Samples may be stored overnight (in coolers with ice) at the ACHD monitoring shed or offices while awaiting submittal to the laboratory. The COC forms must be reviewed and signed by at least one of the people who collected the samples listed on the COC form. The COC forms will be delivered to the laboratory with the samples.

If samples are submitted to the laboratory during business hours, samples are relinquished to laboratory personnel in person for immediate receipt with signature, date, and time. ACHD has after-hour access to the laboratory to accommodate sample submittal. When sample delivery occurs after hours, grab samples are placed in a locked refrigerator, and composite samples are stored in coolers or sample bases and packed with ice. The team delivering the samples will notify a laboratory representative that the samples have been dropped off and the time the earliest samples were collected. A signed COC form is left in the locked laboratory for morning receipt by laboratory personnel.

Section 5

Quality Assurance/Quality Control

QC checks will be conducted for hydrologic and water quality data throughout the duration of the subwatershed monitoring program. QA/QC measures mirror those described in the SWOMP, including data quality objectives, data quality indicators, and acceptance and performance criteria. Subwatershed monitoring sites will be added to the outfall monitoring program QC sample collection schedule each year.

Quality control checks for hydrologic data will be conducted during logger download site visits when water is present. During the site visit, field personnel will measure water depth with a handheld measuring device such as a tape measure or measuring stick. The result and time of the measurement will be recorded and compared to level data generated for that time from the logger pressure data log. If measurements do not match within 25 percent margin of error, remedial actions will be taken. Data collected from the date of any identified out-of-range measurement going back to the last documented data of acceptable quality will be flagged for further review and possible correction, qualification, or rejection.

Section 6

Data Management and Reporting

All flow, rain, and analytical data collected as part of the Americana subwatershed monitoring program will be stored in electronic format for secure storage and timely and accurate retrieval for data interpretation, graphing, reporting, and input into future data systems developed by the permittees. Data collected as part of the sampling program will include flow measurements, rainfall data, field analytical data, laboratory analytical data, QA/QC results, and some qualitative observations. All data will be formatted according to preset standards in order to interface with the developed database storage and parameter evaluation procedures. Specific reporting procedures are provided below.

6.1 Data Management System

ACHD uses the DataSight database software for managing data collected from stormwater monitoring programs. The intent of using this program to manage and store data is to provide ACHD a safe and secure platform for storing, validating, viewing, and analyzing data. Program data will be imported into the database according to established procedures identified in the SWOMP. ACHD will use the database to assist with implementing this monitoring plan.

The DataSight database is configured in four tiers or “levels” under which data is stored and related. The database structure and level dependencies for the Americana subwatershed monitoring program are illustrated in the figure below.

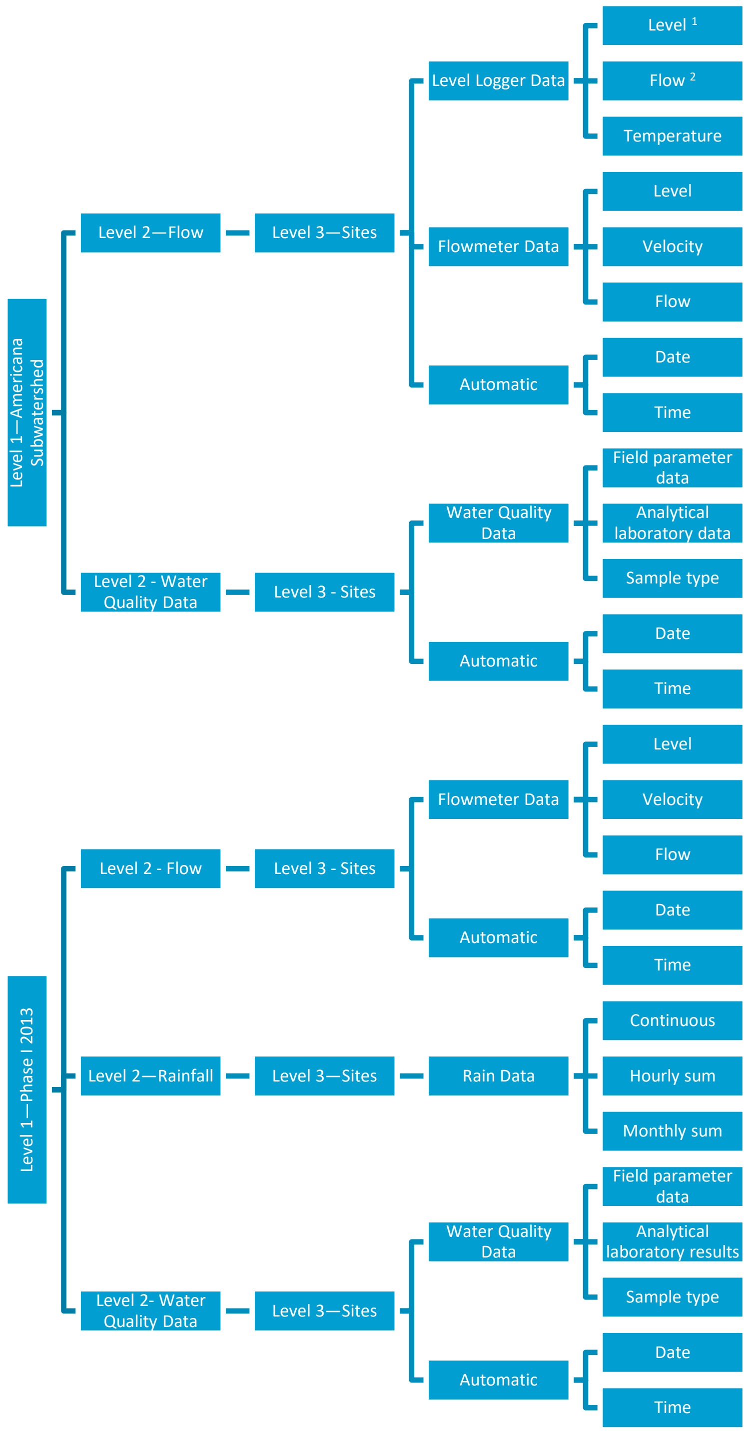


Figure 6-1. Database levels setup

[1] *Calculated in HOBOware*

[2] *Calculated in FlowLink or DataSight*

6.2 Data Analysis and Reporting

Once loggers are downloaded, the HOBOware Pro software converts pressure readings to depths using automatic calculations in the software. The software requires entering a reference water level and local barometric pressure data to produce level readings for each site. Calculated level results are then exported from the HOBOware Pro software and imported into DataSight.

Velocity data is calculated as the cross-sectional average velocity using the Manning formula. The Manning formula states:

$$V = \frac{1.49}{n} {R_h}^{2/3} \sqrt{S}$$

Where:

V is the cross-sectional average velocity

n is the Gauckler–Manning coefficient, selected based on the pipe construction material, which controls surface roughness.

R_h is the hydraulic radius defined as (R_h = A/P); these values are derived from the level readings and pipe diameter

A is the cross-sectional area of flow

P is the wetted perimeter

S is the slope of the pipe

Site-specific data required to complete Manning formula calculations is recorded in Table A-2.

Flow is then calculated as the product of the cross-sectional average velocity and the cross-sectional area of flow.

6.2.1 Quarterly Reporting

Data reviews will be conducted on a quarterly basis to evaluate the data collected from each monitoring site and determine whether each logger, flowmeter, or sampler should stay at its current location or be moved to a new monitoring site. Collected data will be input into PCSWMM, and the hydrologic/hydraulic model will be run to generate stormwater runoff estimates to be compared with measured data. The review will also seek to identify corrective actions as needed when monitoring data does not meet data quality objectives. Corrective actions may include troubleshooting logger settings, repositioning the logger in the storm drain pipe, and other adjustments and corrections.

6.2.2 Annual Reporting

At the end of each year of the program, an annual subwatershed monitoring report that summarizes the results of the program will be prepared. The report will be based upon the data collected at all monitoring sites throughout the year and will include a comprehensive evaluation of all the data collected. If data have been qualified as part of the QA/QC program, this will be noted in the appropriate table(s) and/or figures. The data evaluation will include the following:

- A summary of all sites monitored during the year including date ranges of each logger, flowmeter, and/or sampler deployment at each site
- A summary of the flow profile measured at each site
- A summary of water quality samples collected throughout the year
- A narrative discussion of implications of the results from each site regarding the associated monitored subcatchments area

- Recommendations for the upcoming year
- A statistical summary for analytical parameters with five or more data points
- A discussion of data quality including qualified data points and deviations from program plans
- A discussion and analysis of sampling analytical performance against data quality objectives including a discussion of any planned changes to the current plan based on QA/QC issues, site conditions, or program conditions

6.2.3 Evaluation and Assessment

The process of evaluating and assessing the subwatershed monitoring program will follow the general guidance identified in the PMEP. This monitoring program is data intensive, with continuous flow data, rain data, and water quality data collected from multiple sites. Observed flow data will be evaluated against predicted results based on outputs from the PCSWMM model previously developed for the subwatershed, as well as water balance calculations, strength of correlation, and between redundant equipment (i.e., comparing level logger data to flowmeter data at the same monitoring site).

Overall program effectiveness for meeting stated objectives will be assessed on a quarterly basis for hydrologic data and after five successful sampling events for water quality data. This assessment will follow a step-wise approach to determine whether monitoring efforts at each site should continue, based on the contribution to achieving monitoring program objectives. Assessment methods will be applied to hydrologic data and water quality data separately using the three questions below.

- Is the monitoring site producing representative data of good quality?
  - Do the site configuration and conditions allow for collecting data of sufficient quality to achieve monitoring program objectives?
- Does the data collected contribute to understanding of the hydrologic characteristics of the subcatchment area and/or the subwatershed as a whole?
  - Identifying sites that capture the right size of subcatchment and allow for collecting meaningful data can be difficult. If a given site does not provide useful insight into the impacts of land use and stormwater infrastructure on runoff and pollutant sources in its subcatchment, the monitoring location may need to be moved, or more information about the subcatchment may be required. Alternatively, if information collected has sufficiently answered questions about flow, runoff, etc., then monitoring can be discontinued and equipment may be moved to a different site, if no new questions are posed.
- Can the data be used to inform management decisions in the subcatchment and/or the subwatershed as a whole?
  - Flow and water quality data are evaluated to determine where additional controls or changes in management approach are needed. If the data collected at a given site is not contributing sufficiently to support decision-making, the monitoring location may need to be moved or more information about the subcatchment may be required. Alternatively, once management questions have been addressed, monitoring can be discontinued and equipment may be moved to a different site, if no new questions are posed.

Changes in monitoring sites and data collection approaches will be tracked using the tables in Appendix A and will be summarized in quarterly and annual reports.

Section 7

References

Ada County Highway District (ACHD), Project Monitoring and Evaluation Plan, 2013.

ACHD, Quality Assurance Program Plan for NPDES Storm Water Permit Monitoring Boise and Garden City, Idaho, 2014a.

ACHD, Stormwater Outfall Monitoring Plan, 2014b.

Brown and Caldwell (BC), Impervious Area Connectivity Evaluation, 2015.

BC, Technical Memorandum: Dry Weather Data Summary and Analysis, 2017.

Ecosystem Sciences, Subwatershed Planning: Americana and Main Street Subwatersheds Ada County, Idaho; June 29, 2016.

Appendix A: Subwatershed Monitoring Sites Information

Table A-1. Americana Subwatershed Monitoring Site Selection

	Crtieria	Result Type	Manhole/measuring point: Example Manhole	14th & Resseguie (AS_6) Manhole J16834	Fort & 15th Manhole 6484	Grove & 14th MH J27691	16th & Front St Manhole J87872	Americana & River St Manhole J69	Americana & River South Manhole J5567	Americana & River East Manhole J32000	15th & Resseguie Manhole J5577	Southeast Americana Outfall Manhole NA							
	Safety	Ranking [1]																	
S-1	Vault in acceptable condition for safe occupancy [2]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
S-2	Manhole located outside of major lanes of traffic	(Yes/No)	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes							
S-3	Reasonably accessible through ACHD right of way	(0,1,2,3)	3	3	3	3	3	3	3	3	3	2							
S-4	CSE not required for data download visits	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
	Data Quality																		
	Flow Measurement																		
Q-1	Non-turbulent pipe run	(0,1,2,3)	2	3	3	3	3	3	2	3	3	2							
Q-2	Not located near bends, falls, pileups, or non-uniform flow conditions	(0,1,2,3)	2	3	2	3	3	2	1	2	3	2							
Q-3	10x pipe diameter downstream from turbulence, 5 x pipe diameter upstream from turbulence	(0,1,2,3)	1	3	1	3	3	2	2	2	3	2							
Q-4	Suitable construction for placement of transducer, mounting conduit, and accessing transducer for download without CSE.	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Q-5	Pipe slope and conditions fit flow equation	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Q-6	Proper size for installation and maintenance	(0,1,2,3)	3	3	3	3	3	3	3	3	3	3							
	Water Quality Monitoring																		
Q-7	Absence of confounding variables (stagnant water upstream, major industrial discharge upstream, known issues)	(0,1,2,3)	3	3	3	1	NA	NA	NA	NA	NA	NA							
	BMPs upstream	(Yes/No)	No	No	Yes	Yes	NA	NA	NA	NA	NA	NA							
Q-8	No known issues with BMPs upstream	(0,1,2,3)	2	3	3	3	NA	NA	NA	NA	NA	NA							
Q-9	Access for grab sample collection	(0,1,2,3)	2	2	3	3	3	1	1	1	1	3							
Q-10	Ability to install sampler above ground	(0,1,2,3)	2	3	1	3	0	0	0	0	0	2							
	Managerial																		
	Areas of Interest Upstream																		
M-1	License agreements	(Yes/No)	Yes	No	No	Yes	NA	NA	NA	NA	NA	NA							
M-2	Industrial Discharges	(Yes/No)	No	No	No	Yes	NA	NA	NA	NA	NA	NA							
M-3	Irrigation	(Yes/No)	Yes	No	No	No	NA	NA	NA	NA	NA	NA							
	Capital Improvement Projects (CIPs)																		
M-5	Known flood problems	(Yes/No)	Yes	No	No	No	NA	NA	NA	NA	NA	NA							
M-6	Planned CIPs in need of sizing input	(Yes/No)	No				NA	NA	NA	NA	NA	NA							
M-7	High priority areas identified in subwatershed plan	(Yes/No)	Yes	No	No	Yes	NA	NA	NA	NA	NA	NA							
	Total Yes		8	4	5	8	4	3	3	3	3	4	0	0	0	0	0	0	0
	Total No		3	6	5	2	0	1	1	1	1	0	0	0	0	0	0	0	0
	Numeric Results Totals		20	26	22	25	18	14	12	14	16	16	0	0	0	0	0	0	0

Notes:

[1] Number rankings correspond to how well the potential monitoring site aligns with the monitoring objectives identified in the monitotring plan.

- 0 - Does not align with objectives.
- 1 - Aligns somewhat or only under certain conditions.
- 2 - Aligns well but may require minor qualification or special considerations.
- 3 - Aligns very well.

[2] A "No" answer to criteria S-1 removes the manhole from the list of potential monitoring sites

Table A-2. Monitoring Site Information

Location Name	Study ID	Latitude/ Longitude	Manhole ID (SWMM File)	Manhole ID (Americana Manholes files)	Subcatchment total area (acres)	Subcatchment impervious area (acres)	Pipe Diameter (in)	Pipe construction	Manning's coefficient (n value)	Pipe slope	Water level during installation (in)	Equipment ID	Equipment Deploy Start Date	Equipment Deploy End Date	Installation notes
Americana Monitoring Station	Site 14	Americana Monitoring Station	NA	NA	915	291	48	concrete	NA	NA	NA	Hach Flowmeter (FL-23)	2013	9/8/20	Hach flow meter installed; outfall monitoring site
												Hach Sampler (SA-17)	2013	9/8/20	
												ISCO Signature Flowmeter (FL-29)	9/8/20	NA	
												ISCO 6712 Sampler (SA-20)	9/8/20	NA	
16th & Front St	AS_1	43°37'7.57"N 116°12'52.66"W	J87872	33634	869	255	42	concrete	0.015	0.0001	4.13 NA	HOBO logger (SN:20029104)	8/10/18	NA	Logger installed downstream of manhole with conduit facing downstream
												ISCO 2150 Flowmeter (FL-21)	10/25/19	1/24/20	
Americana_River_South	AS_2	43°37'4.63"N 116°13'0.20"W	J5567	35568	39	28	42	concrete	0.015	0.0001	1.5	HOBO logger (SN:20029109)	8/10/18	4/28/20	Large pipe downstream of manhole (south) that leads to secondary outfall with conduit facing downstream flow
Americana_River_East	AS_3	43°37'4.63"N 116°13'0.20"W	J5567	35568	10	5	16	concrete	0.015	0.0001	2	HOBO logger (SN:20029106)	8/10/18	NA	Small pipe upstream of manhole (east) with conduit facing upstream
Americana_River St	AS_4	43°37'4.63"N 116°13'0.20"W	J5567	35568	29	23	42	concrete	0.015	0.0001	2	HOBO logger (SN:20029101)	8/10/18	NA	Large pipe upstream of manhole (north) with conduit perpendicular to flow
											1.7	ISCO 2150 Flowmeter (FL-21)	7/10/20	NA	Water level at installation: 2.7 inches
15th & Resseguie	AS_5	43°37'36.17"N 116°12'21.10"W	J5577	23810	289	49	30	concrete	0.015	0.0001	1.5	HOBO logger (SN:20029105)	8/10/18	NA	Logger installed downstream of manhole with conduit facing downstream
Resseguie & 14th	AS_6/	43°37'35.73"N 116°12'16.60"W	J16834	13187	206	23	22	corrugated metal	0.024	0.0001	NA	HOBO logger (SN:20029102)	8/17/18	NA	Installed downstream of vault
	Site 206				203	22	22	corrugated metal	0.024	0.0001	NA	Hach Flowmeter (FL-25)	1/23/20	NA	Installed upstream of vault, has smaller drainage area than HOBO logger
												Hach Sampler (SA-11)	1/23/20	10/9/20	Installed upstream of vault, has smaller drainage area than HOBO logger
												Hach Sampler (SA-13)	10/9/20	NA	
Southeast Americana Outfall	AS_7	43°36'57.66"N 116°13'17.75"W	NA	NA	40	30	42	concrete	0.015	0.0001	NA	ISCO 2150 Flowmeter (FL-20)	1/11/19	NA	Isco flowmeter installed

Appendix B: Subwatershed Monitoring Sites - Subcatchment Maps

Figure 3. Site 14 Map

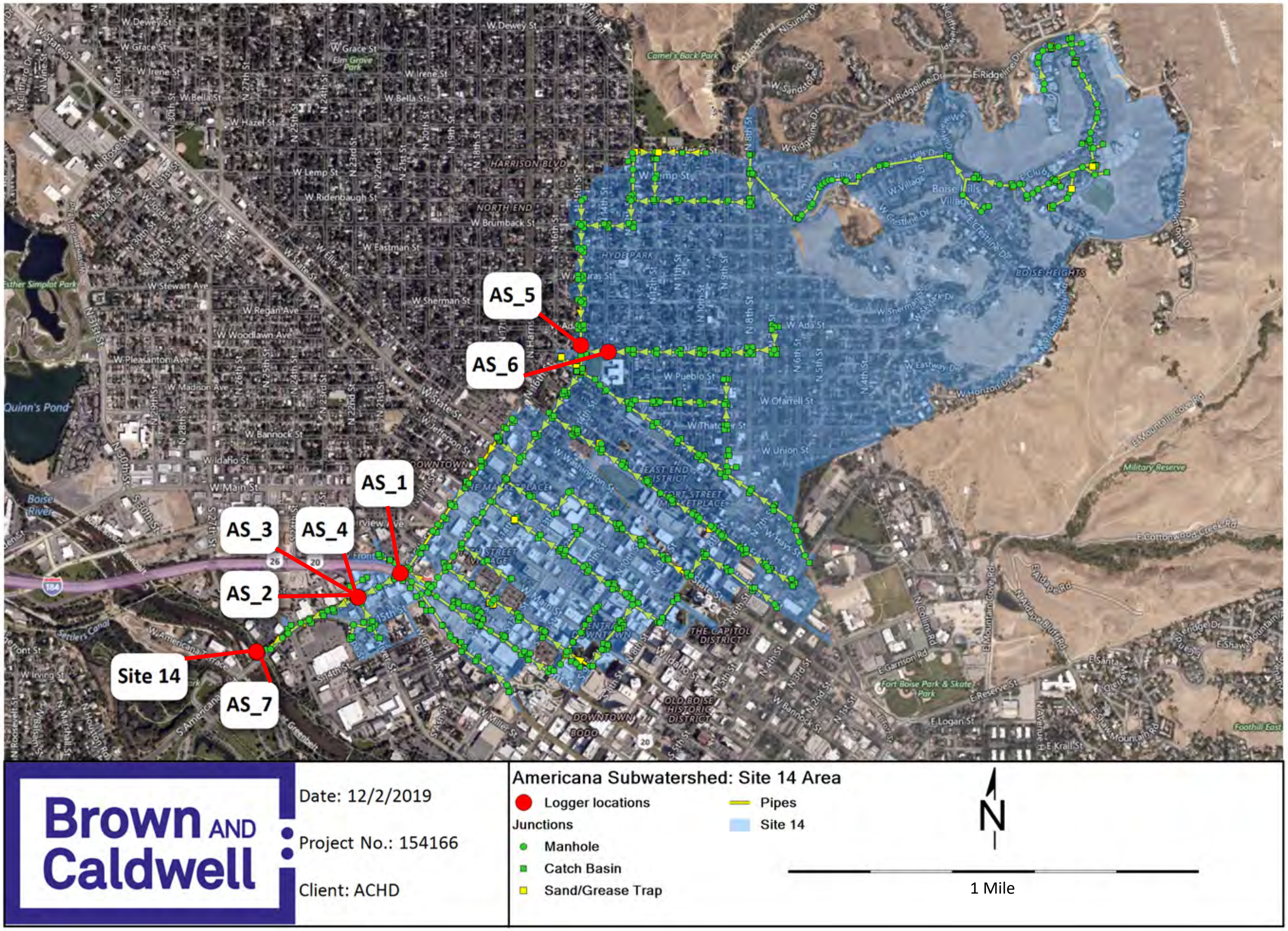
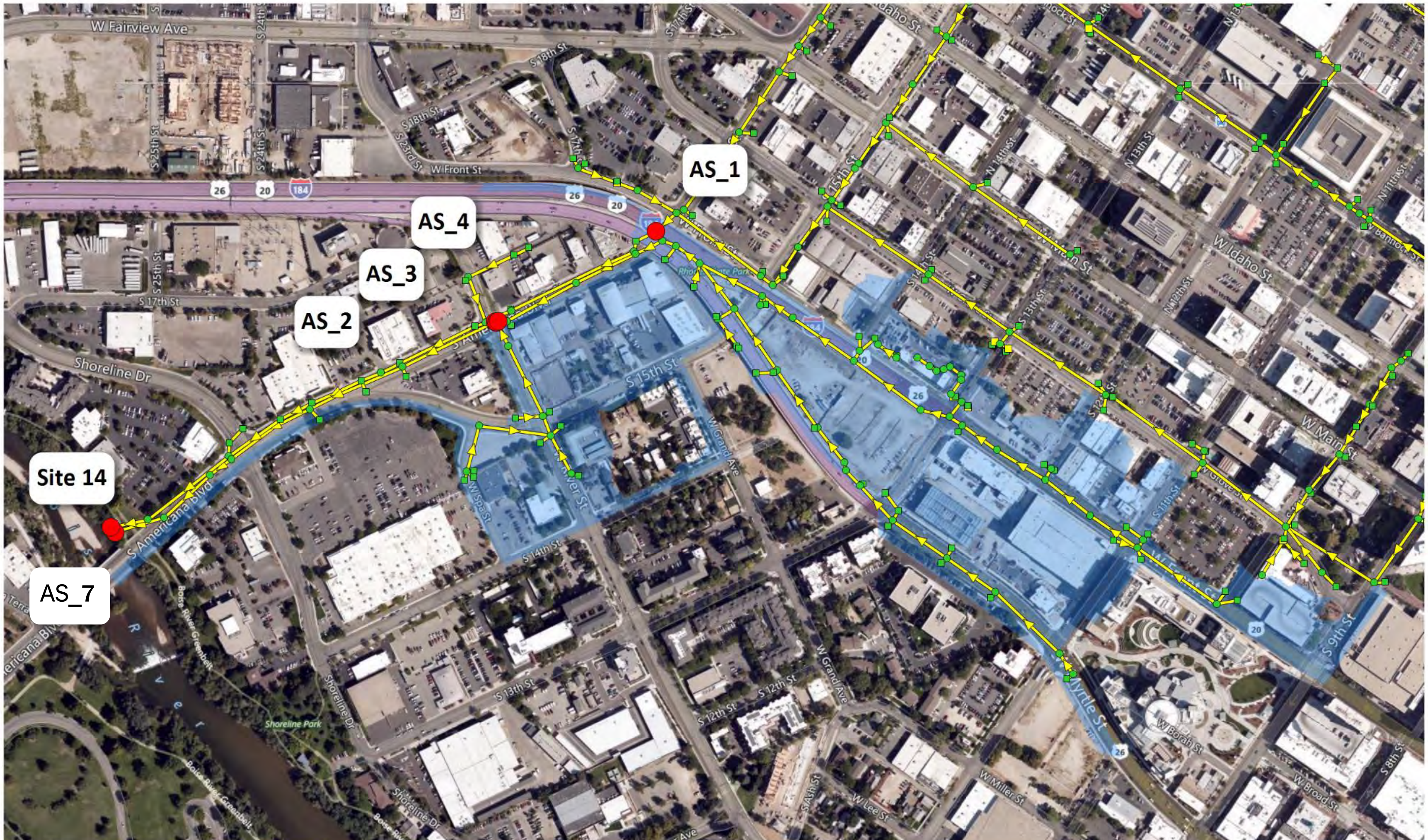


Figure 4. AS_7 Map



Brown AND Caldwell

Date: 12/2/2019

Project No.: 154166

Client: ACHD

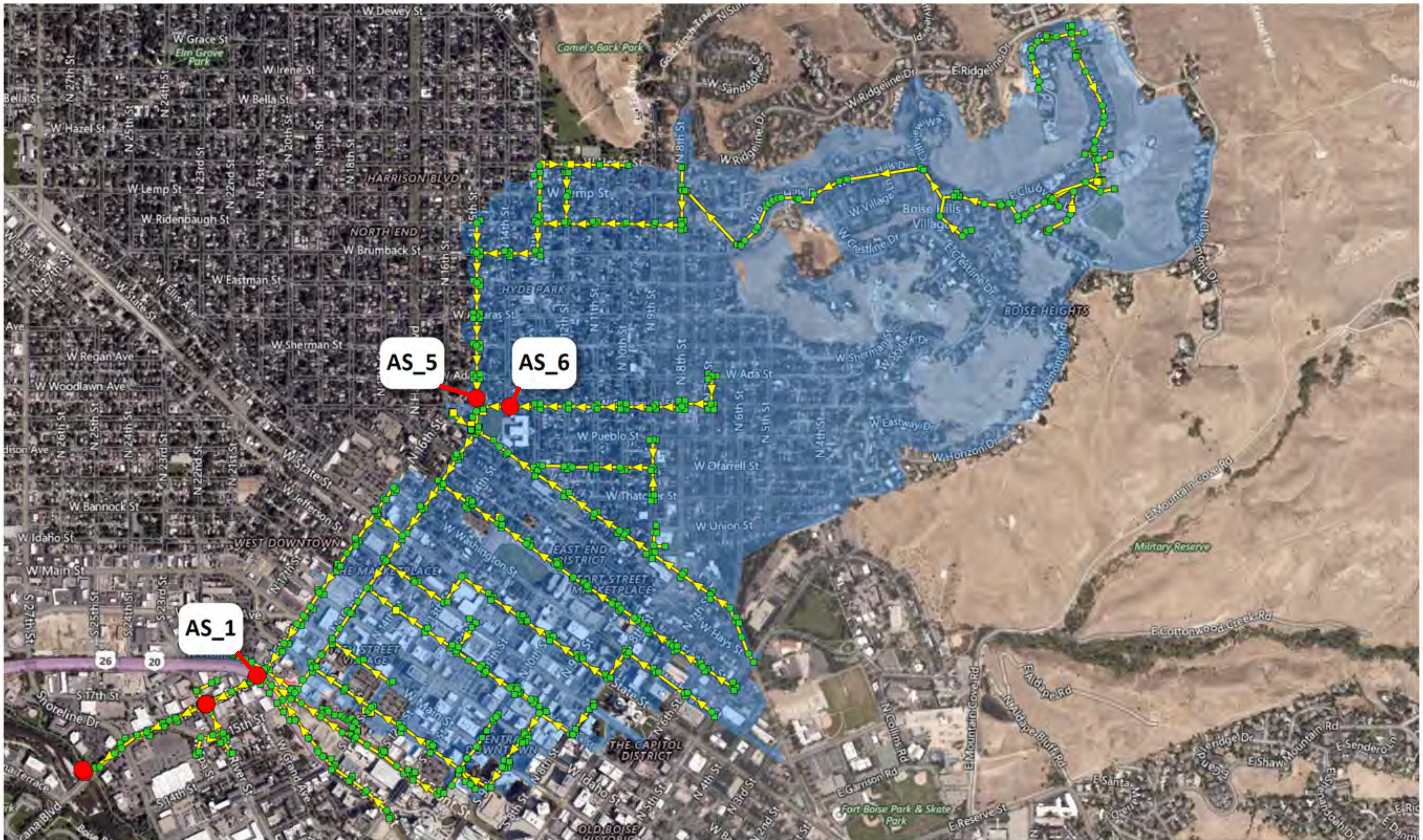
Americana Subwatershed: Site 7 Area

- Logger locations
- Junctions
  - Manhole
  - Catch Basin
  - Sand/Grease Trap
- Pipes
- Site 7 Area

N

500 yd

Figure 5. AS_1 Map



Brown AND Caldwell

Date: 12/2/2019

Project No.: 154166

Client: ACHD

Americana Subwatershed: AS_1 Area

- Logger locations
- Pipes
- AS_1 area

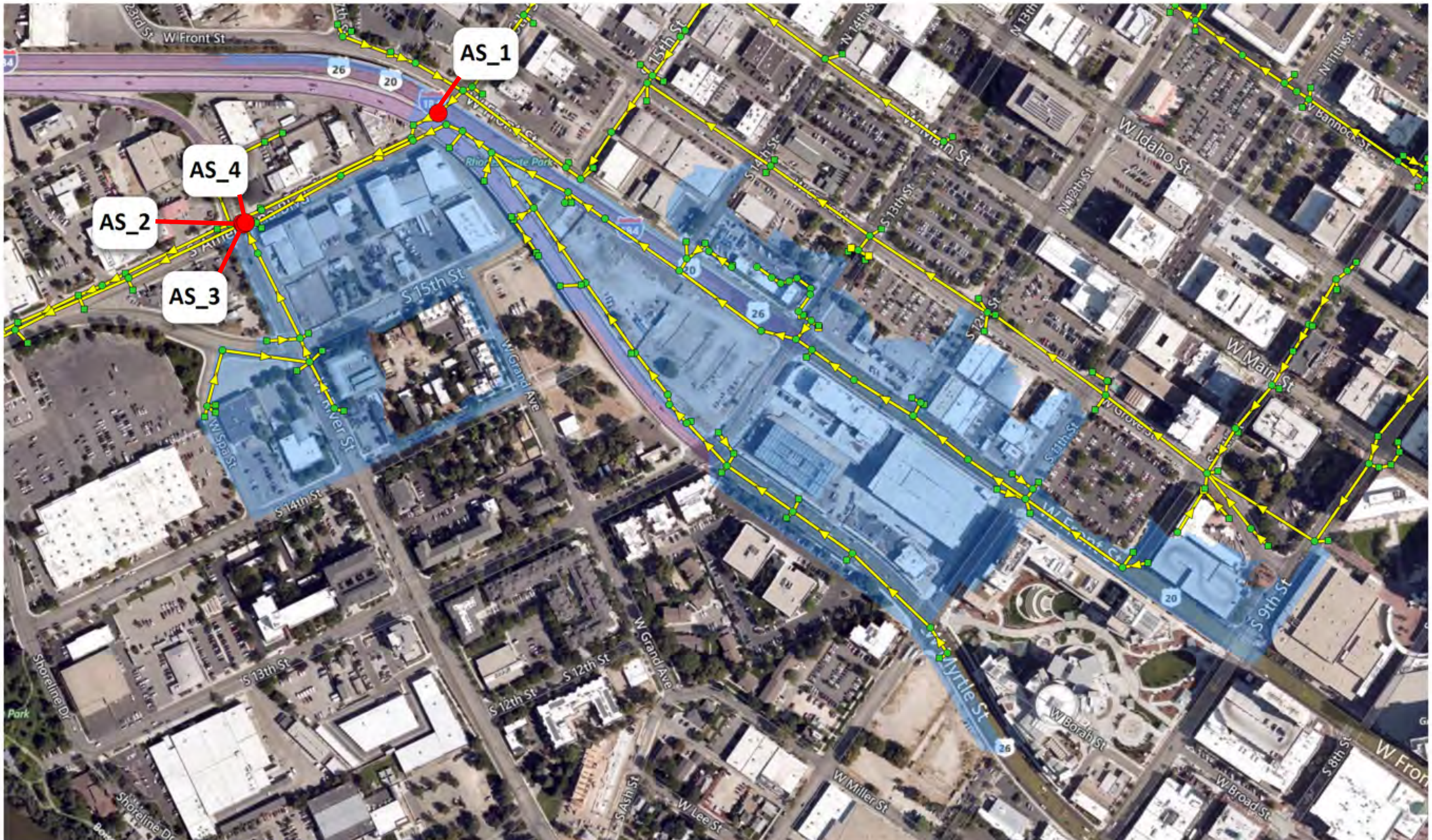
Junctions

- Manhole
- Catch Basin
- Sand/Grease Trap

N

1 Mile

Figure 6. AS_2 Map



Americana Subwatershed: AS_2 Area

- Logger locations
- Junctions
  - Manhole
  - Catch Basin
  - Sand/Grease Trap
- Pipes
- AS_2 area

N

500 yards

Brown AND Caldwell

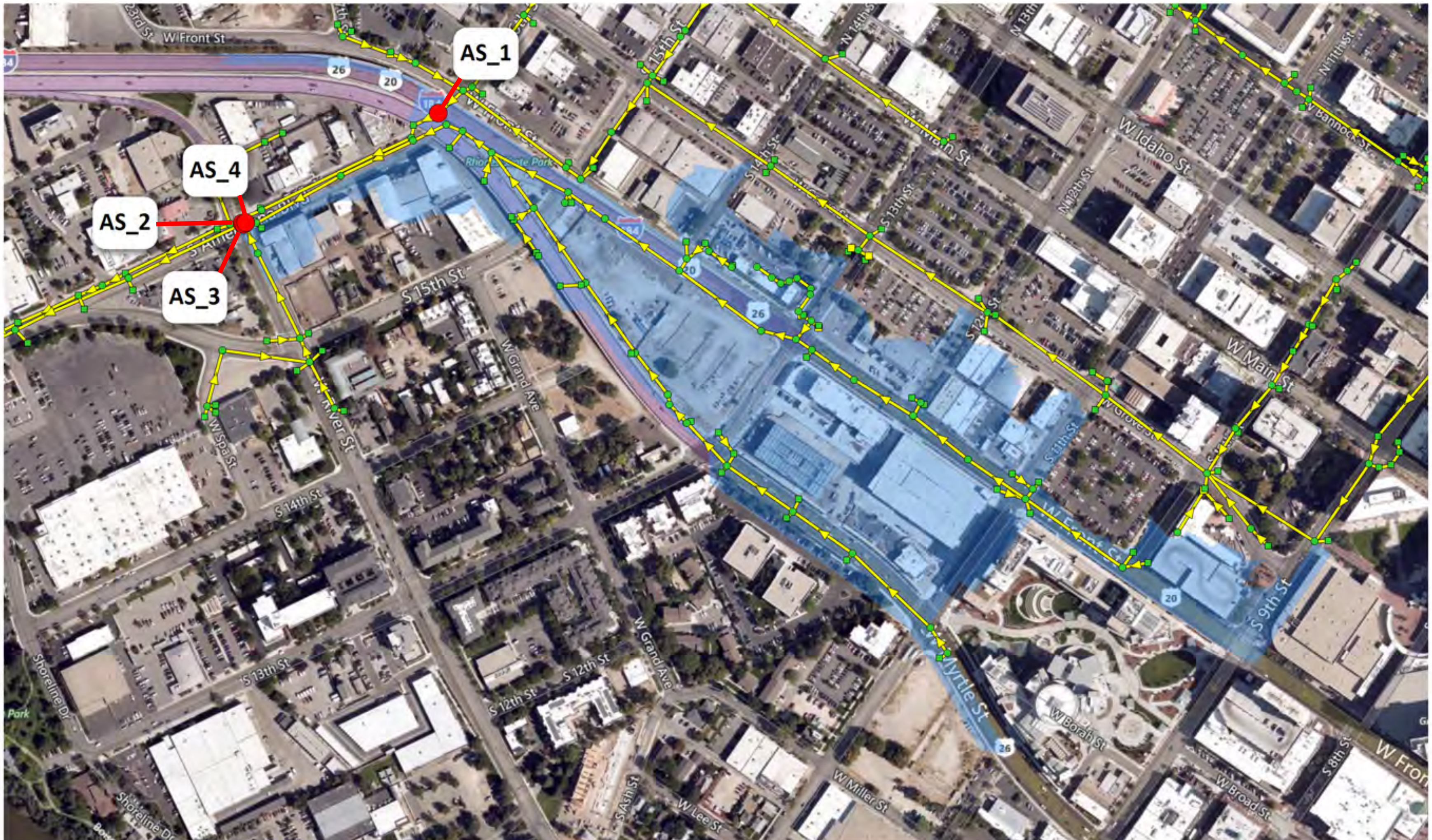
Date: 12/2/2019

Project No.: 154166

Client: ACHD

Figure 7. AS_3 Map

Figure 8. AS_4 Map



Brown AND Caldwell

Date: 12/2/2019

Project No.: 154166

Client: ACHD

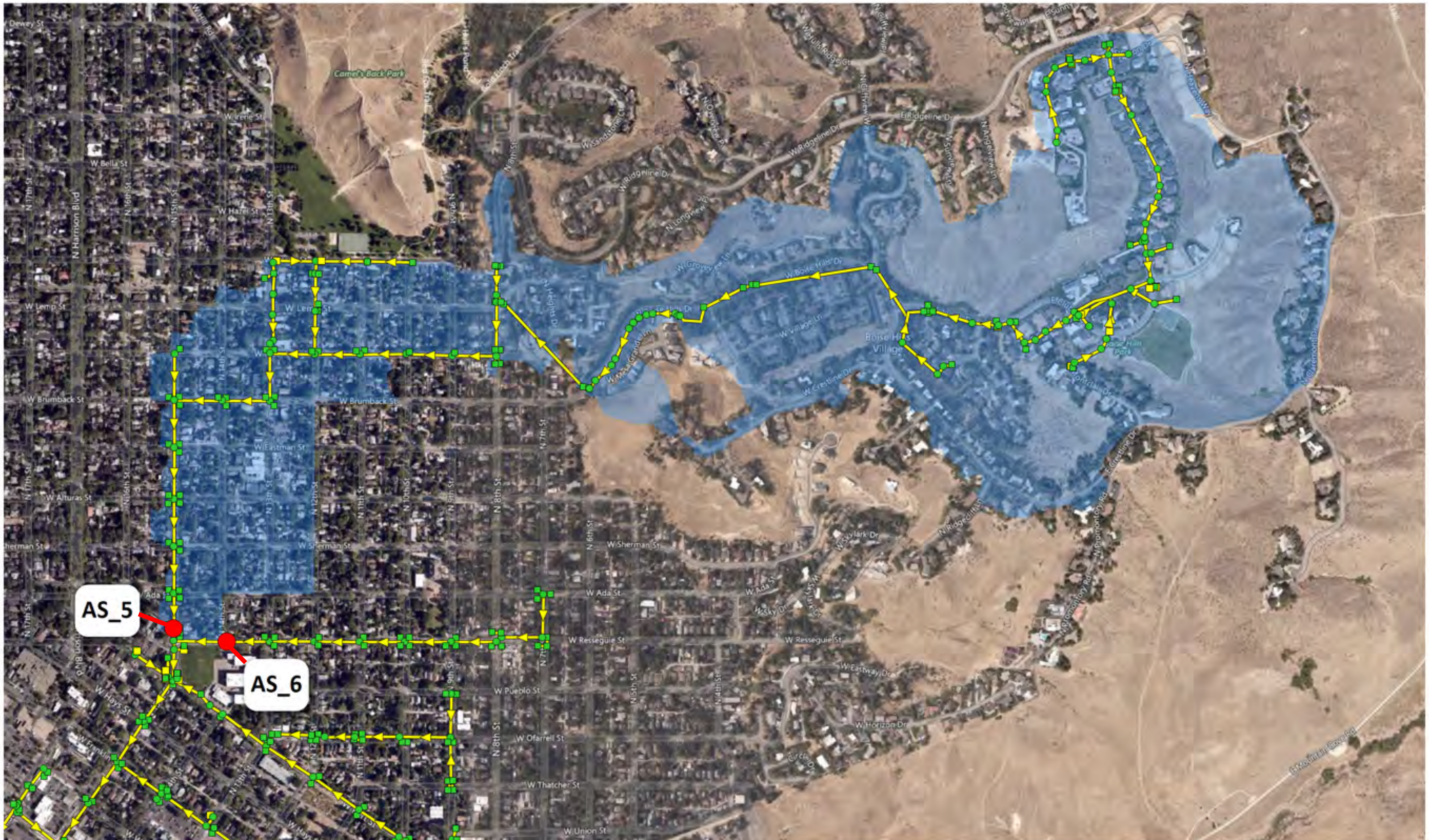
Americana Subwatershed: AS_4 Area

- Logger locations
- Junctions
  - Manhole
  - Catch Basin
  - Sand/Grease Trap
- Pipes
- AS_4 area

N

500 Yards

Figure 9. AS_5 Map



Date: 12/2/2019

Project No.: 154166

Client: ACHD

Americana Subwatershed: AS_5 Area

- Logger locations
- Pipes
- AS_5 area

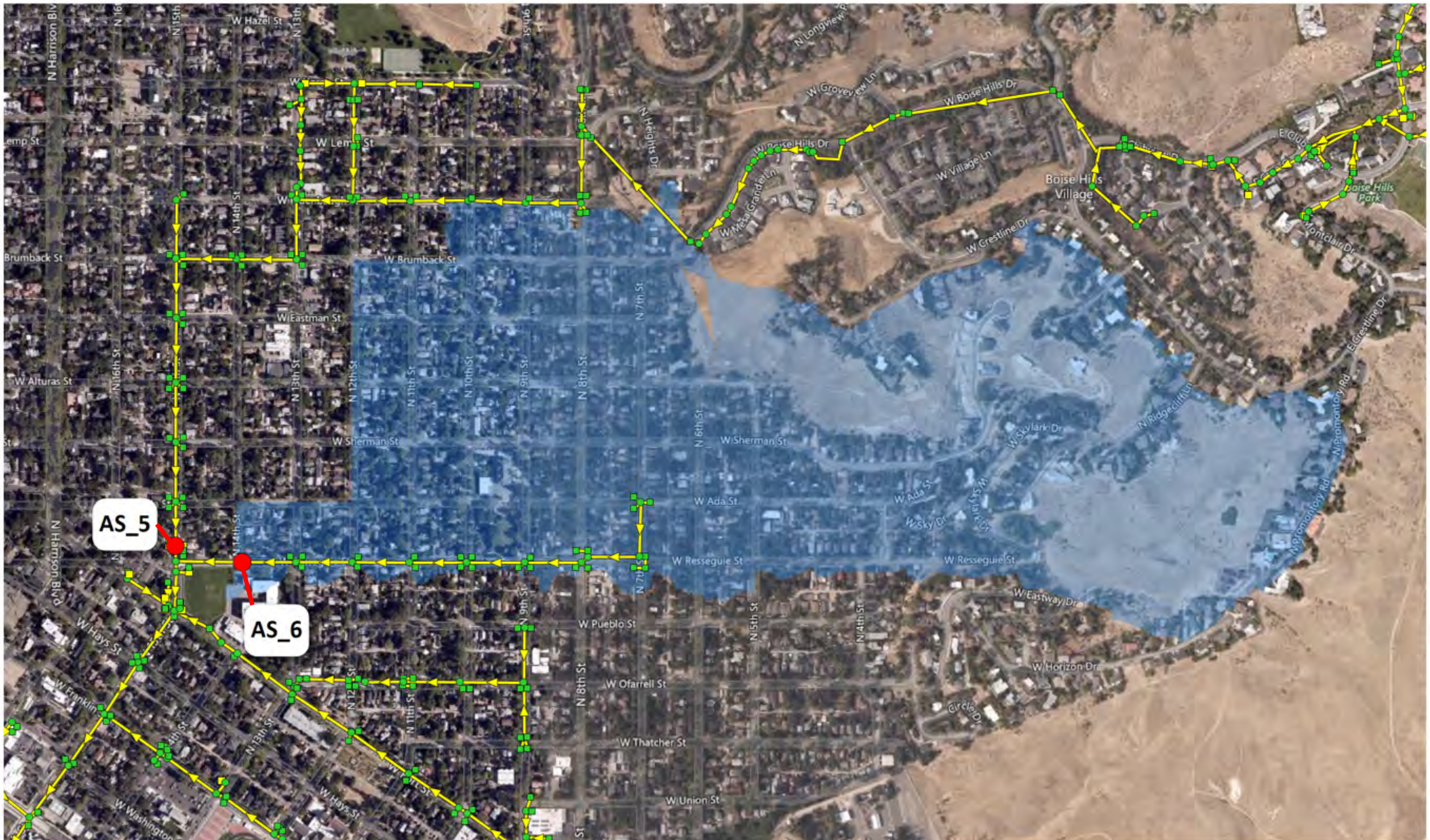
Junctions

- Manhole
- Catch Basin
- Sand/Grease Trap

N

1/2 Mile

Figure 10. AS_6 Map



Date: 12/2/2019

Project No.: 154166

Client: ACHD

Americana Subwatershed: AS_6 Area

- Logger locations
- Pipes
- AS_6 area

Junctions

- Manhole
- Catch Basin
- Sand/Grease Trap

N

200 Yards