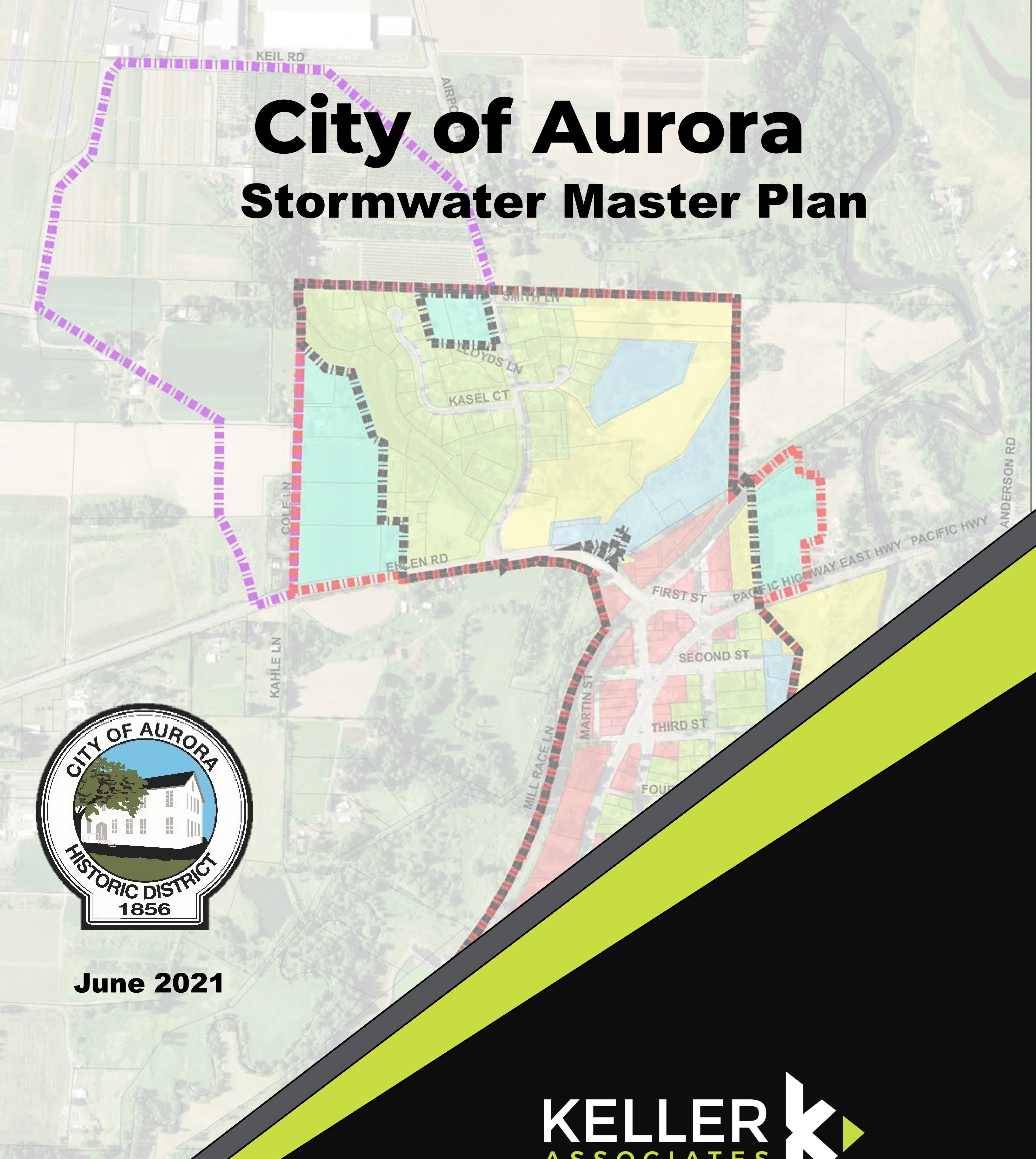
City of Aurora

Stormwater Master Plan



CITY OF AURORA
HISTORIC DISTRICT
1856

June 2021

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ASSOCIATES

CITY OF AURORA
STORMWATER MASTER PLAN

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NOV. 31, 2018
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EXPIRES: 12-31-2021

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JUNE 2021

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ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
BMP	Best Management Practice
CCTV	Closed-Circuit-Television
CFS	Cubic Feet per Second
CIP	Capital Improvement Plan
CMP	Corrugated Metal Pipe
DEQ	Department of Environmental Quality
d/D	Maximum depth divided by full depth
EPA	Environmental Protection Agency
HGL	Hydraulic grade line
MAO	Mutual Agreement and Order
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands
ROW	Right-of-Way
SBUH	Santa Barbara Unit Hydrograph Method
SCS	Soil Conservation Service
SDC	System Development Charge
SWMM	Stormwater Management Manual
SWMP	Stormwater Master Plan
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
WQMP	Water Quality Management Plan

SECTION 1 - EXECUTIVE SUMMARY

The City of Aurora contracted with both Ashley Engineering Design, P.C. and Keller Associates, Inc. to complete a stormwater master plan for the City's municipal stormwater system. This report was commissioned by the City in an effort to determine the current state of the stormwater system and plan for future needs. This report summarizes stormwater planning criteria, existing system capacities, recommended improvements, and a capital improvement plan.

1.1 PLANNING CRITERIA

Planning criteria were established with input from the City. Keller Associates recommends that stormwater conveyance components be capable of passing runoff from the 25-year storm event without flooding or surcharging to within 0.5 feet of the rim elevation. Detention ponds should be designed to limit the post-construction peak runoff to be equal to or less than the pre-construction peak runoff through the 50-year storm event. Additional planning criteria included minimum pipe diameters, freeboard in open channels, and safe overflow for detention ponds. Review and evaluation of water quality standards were not included in the scope of this study. However, water quality standards should be a consideration in any new stormwater facility. Best management practices (BMPs) should be followed as appropriate. It is recommended that the City review existing water quality standards and Stormwater Management Manuals (SWMM) of surrounding local jurisdictions and assess what resources may be best suited to guide the City's water quality criteria requirements for future developments and stormwater infrastructure.

1.2 MODEL DEVELOPMENT

The stormwater modeling software InfoSWMM (Suite 14.7, Update #2) was used to project stormwater runoff from the study area using the Natural Resources Conservation Service (NRCS) Unitless Hydrograph Method. Additionally, InfoSWMM was used to dynamically route the hydrologic model runoff through a hydraulic model representing the existing stormwater network. The computer model was calibrated by comparing historically known flooding areas with flooding areas projected in the model.

1.3 EXISTING SYSTEM EVALUATION

The City's existing stormwater system is illustrated in Figures 5A and 5B in Appendix A. The existing system is composed of approximately 4.5 miles of pipeline, 160 manholes, 170 catch basins, and 12 drywells/infiltration manholes. The storm drain system was delineated into 70 sub-basins as shown in Figure 6 (Appendix A). Figures 7A and 7B in Appendix A show the identified deficiencies throughout the stormwater system and at which storm event the deficiency first occurs.

1.4 RECOMMENDED IMPROVEMENTS AND CAPITAL IMPROVEMENT PLAN

The capital improvement plan was developed and prioritized based on factors such as flooding frequency and potential or recurring damage to property. Figure 8A and 8B in Appendix A illustrate the recommended improvements by prioritization. These improvements are summarized in Table 1-1. Section 7 discusses the capital improvement plan in more detail.

TABLE 1-1: CAPITAL IMPROVEMENT PLAN (CIP)

Project Identifier	Project Name	Estimated Cost (Rounded)
1A	Main Street and 1st Street	$405,000
1B	3rd Street and Main Street	$42,000
1C	Orchard Detention Pond Improvements	$45,000
1D	Highway 99 North of Ottaway Road	$533,000
1E	2nd Street (Church Parking Lot)	$90,000
1F	Liberty Street and Sayre Drive	$1,437,000
1G	Filbert Street and Walnut Street	$603,000
	Total Priority 1 Improvements (rounded):	**$3,155,000**
2A	Park Avenue and Cody Lane	$1,509,000
2B	Ottaway Road	$726,000
2C	Main Street North of Ottaway Road	$154,000
2D	Airport Road Ditch	$317,000
2E	Filbert Street North of Ottaway Road	$192,000
2F	Martin Street to 2nd Street	$290,000
	Total Priority 2 Improvements (rounded):	**$3,188,000**
3A	Highway 99 North of 2nd Street	$339,000
3B	Albers Way	$131,000
3C	3rd Street Outfall	$136,000
	Total Priority 3 Improvements (rounded):	**$606,000**
	Total Stormwater System Improvements:	**$6,949,000**

The cost estimate herein is concept level information only based on our perception of current conditions at the project location and its accuracy is subject to significant variation depending upon project definition and other factors. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. This cost opinion is in 2021 dollars and does not include escalation of time of actual construction. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented herein.

1.5 OPERATIONS AND MAINTENANCE

The annual operations and maintenance costs may increase with the addition of pipelines and additional catch basins. The improvements included in the CIP add a total of 8,400 LF of new pipeline, two new sedimentation manholes, and 54 new catch basins or catch manholes. Existing drywells are recommended to be cleaned annually, and one of the ten drywells in the Strawberry Meadows development is required to be sampled annually. Assuming a closed circuit-television (CCTV) and cleaning cycle of five years, the total additional operations and maintenance costs are summarized below in Table 1-2.

TABLE 1-2: ADDITIONAL ANNUAL OPERATIONS AND MAINTENANCE COSTS

Item	Unit Cost	Unit	Annual Quantity[1]	Annual Cost
Cleaning and CCTV of Storm Pipe	$3	LF	1,700	$5,100
Cleaning of Catch Basins	$60	EA	10	$600
Cleaning of Drywells[2]	$1,250	EA	12	$15,000
Drywell Monitoring[3]	$1,000	EA	1	$1,000
			Total Annual Cost	**$21,700**

1) Assumes 5-year annual cleaning cycle.

2) Assumes annual cleaning of all drywells.

3) MAO requires annual sampling of one of the ten drywells in Strawberry Meadows.

1.6 SYSTEM DEVELOPMENT CHARGES (SDC) AND FUNDING

The scope of this evaluation did not include evaluating the City's current system development charges (SDC). It is recommended that the City complete an SDC study to evaluate potential SDC impacts of the recommended capital improvement plan (CIP) and identify potential funding sources to offset impacts. As the City begins to prepare and proceed on CIP projects, it is recommended they set up a one-stop meeting with Business Oregon to identify and assess potential funding sources for the stormwater projects.

SECTION 2 - NEED AND PURPOSE

The City of Aurora commissioned the completion of a stormwater master plan (SWMP) to assess the current state of the stormwater system and plan for future needs. The primary objectives of the SWMP are to:

- Establish storm system design and planning criteria
- Evaluate the existing storm system capacity using computer hydraulic modeling
- Summarize existing system deficiencies and proposed improvements to enhance system serviceability
- Recommend improvements needed to service future growth
- Develop a capital improvement plan and an appropriate system implementation strategy.

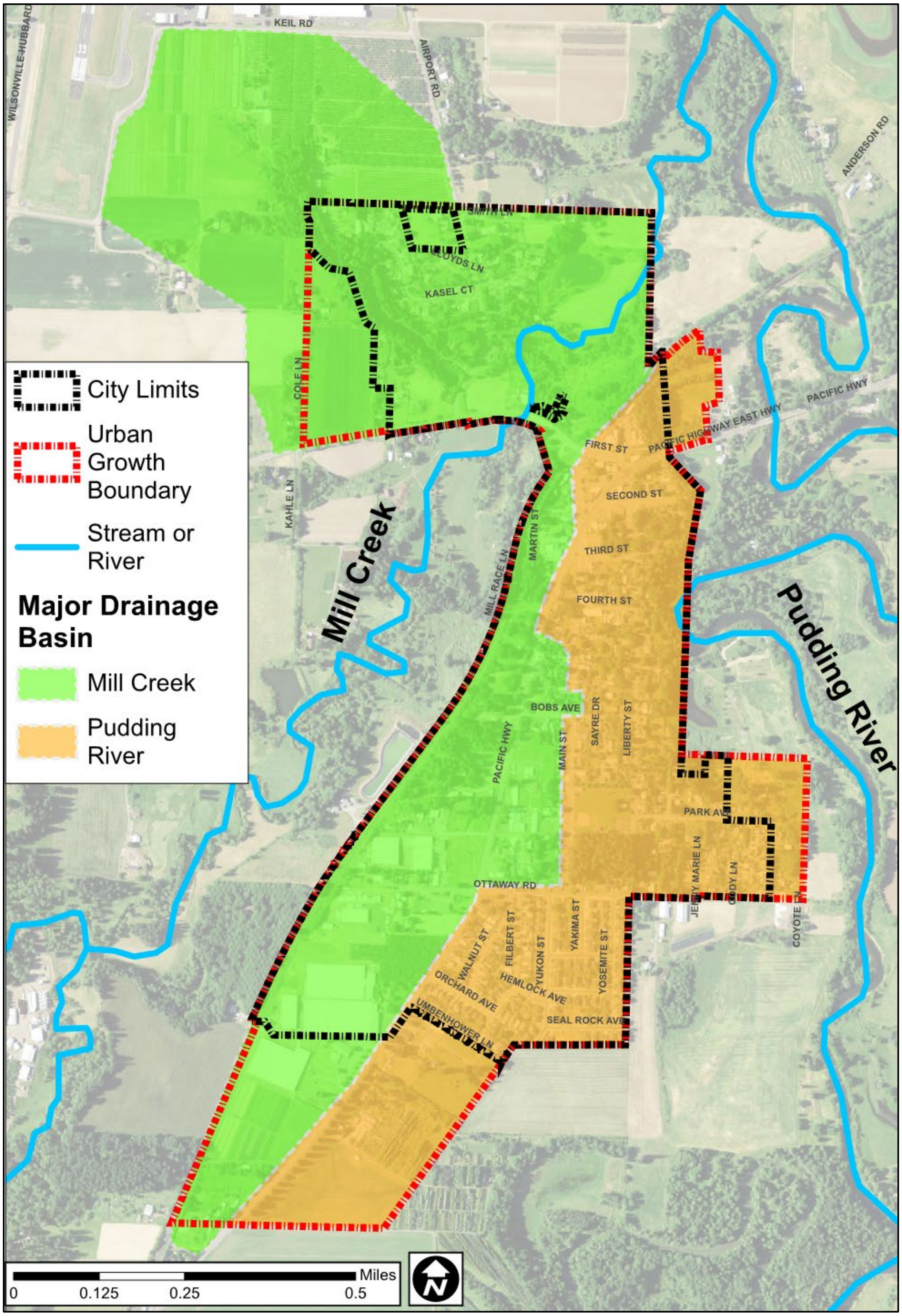
This study summarizes the evaluation completed, deficiencies identified, and recommended improvements to the City's stormwater system over the 20-year planning period.

SECTION 3 - STUDY AREA AND STORMWATER SYSTEM

The study area is comprised of the areas within the city limits, the urban growth boundary (UGB), and additional areas outside of these two boundaries where stormwater drains into the City's stormwater system. The city limits are approximately 630 acres in area and the UGB includes an additional 200 acres outside the city limits. The additional study area includes an additional 97 acres to the northwest of the city limits and UGB. Figure 1 in Appendix A shows the city limits, UGB, additional study area, and existing zoning.

The City of Aurora is generally bordered by the Pudding River to the east and Mill Creek to the west. Figure 3-1 shows the major drainage basins within the City's UGB and areas that drain to existing stormwater infrastructure. The City's topography is characterized as relatively flat, with the highest points running from the southern boundary to the confluence of Mill Creek and the Pudding River creating a natural drainage basin boundary. The 100-year flood plain of the Pudding River covers a small section of the eastern side of the City and the 100-year floodplain of Mill Creek goes through the northern part of the City through a low-lying, undeveloped area. Figure 2 in Appendix A shows the topography and flood plains.

FIGURE 3-1: MAJOR DRAINAGE BASINS



Mill Creek flows through the study area and outfalls into the Pudding River north of the City. The Pudding River runs along the east side of the City. As of the most recent listing in 2012, the Pudding River is 303(d) listed by the Oregon Department of Environmental Quality (DEQ) for biological criteria, dissolved oxygen, Guthion, and lead. The Pudding River is classified (OAR 690-502-0120) for domestic, livestock, irrigation, municipal, industrial, agricultural, commercial, power, mining, fish life, wildlife, recreation, pollution abatement, wetland enhancement, and public instream uses from October 1 through April 30 and only for domestic, commercial use for customarily domestic purposes not to exceed 0.01 cubic feet per second (cfs), livestock, and public instream uses from May 1 through September 30. In 2008, DEQ published a Total Maximum Daily Load (TMDL) Water Quality Management Plan (WQMP) for the Molalla-Pudding Subbasin (within the Willamette River Basin) to address temperature, bacteria, and toxins in the subbasin. There are no wild or scenic rivers in the study area. A full assessment of water quality criteria and requirements was not included in the scope of this study.

The NRCS categorizes soil types into hydrologic soil groups, which are used to estimate the amount of runoff a given soil group will produce. The hydrologic soil groups are categorized into groups A through D, with Group A soils being well-drained and producing less runoff, and Group D soils having poor drainage and producing significant runoff. The hydrologic soil groups within the study area are generally Group B and Group C, as seen in Figure 3 in Appendix A.

The Oregon Department of State Lands (ODSL) keeps an inventory of the local wetland areas in Oregon. Wetland delineation was not within the scope of this project, so the U.S. Fish and Wildlife National Wetlands Inventory was used to determine the wetland areas that could potentially be impacted. The map of delineated wetlands from the National Wetlands Inventory is shown in Figure 4 (Appendix A). The City has four sites delineated by the National Wetlands Inventory. Two on the north side of the City are designated as freshwater ponds. One on the northeast side of town along Highway 99E is designated as a freshwater forested/shrub wetland. The fourth is a freshwater emergent wetland on the eastern border of the city limits.

The Pacific Northwest Interagency Special Status/Sensitive Species Program lists the endangered, threatened, and sensitive species for the state and county by the Bureau of Land Management (BLM) district. The City of Aurora lies within the Salem BLM District. Endangered species in the district include the Fender's blue butterfly, Taylor's checkerspot, Bradshaw's desert parsley, and Willamette Valley daisy. The fish in the Salem district listed as federally threatened include the Coho salmon, Steelhead, Chinook salmon, and Pacific eulachon.

The City's existing stormwater system consists of approximately 24,000 feet of pipe ranging in diameter from 4-inch to 36-inch, approximately 330 catch basins, 160 manholes, 12 drywells, and 17 outfalls to Mill Creek or the Pudding River. Figures 5A and 5B (Appendix A) show the existing stormwater system.

SECTION 4 - PLANNING CRITERIA

4.1 GENERAL

Stormwater system planning criteria establishes fundamental principles and performance standards to evaluate the existing system and future improvements. The planning criteria include defining the design storm event(s), hydrologic methods, and hydraulic calculation methods. The planning criteria in this evaluation were chosen by reviewing neighboring communities, industry standards, and state and federal stormwater regulations to select the criteria that best fit the City of Aurora.

4.2 DESIGN STORM

The design storms were established to evaluate the existing stormwater system performance and to assist in the design of future improvements. Recurrence intervals, the total depth of rainfall, and duration of the storm event are important characteristics that define a design storm. Recurrence intervals are the average interval between successive storm events and can be expressed in annual probability of occurrence. For example, a 50-year storm has a 2 percent chance of occurring in any given year. The total depth of rainfall will vary depending on the recurrence interval and duration of the design storm. The specific recurrence intervals and total depth of rainfall used in the evaluation of the stormwater system are shown in Table 4-1; the storm event duration was assumed to be 24-hours, which is typical of the region. The total rainfall depth for each recurrence interval and duration was taken from the National Oceanic and Atmospheric Administration's (NOAA) isopluvial charts. These charts show the rainfall depths for each of the design storms used in this evaluation.

TABLE 4-1: DESIGN STORM DEPTHS (24-HOUR DURATION)

Design Storm	Cumulative Rainfall (in)
2-Year	2.5
5-Year	3.0
10-Year	3.5
25-Year	4.0
50-Year	4.5
100-Year	4.5

1) From NOAA Atlas 2, Volume 10

The temporal distribution of the design storm is an additional characteristic of the design storm that was considered. The temporal distribution is how the given amount of precipitation is distributed over the duration of the storm. The NRCS has developed synthetic hyetographs for regions across the United States, as shown in Figure 4-1. These hyetographs are based on historical data collection and extrapolation. The Type 1A theoretical rainfall distribution (Figure 4-2) is used to approximate storm events for the Aurora region. It should be noted that the hyetographs are appropriate for approximating the distribution of the design storm; however, because it is an approximation, a real storm may not have the same uniform distribution to the maximum intensity shown in Figure 4-2.

Selection of a design storm is a matter of balancing a level of service with economic feasibility. Keller Associates recommends the stormwater conveyance system be capable of passing runoff from the 25-year storm event without flooding or damage to existing infrastructure. For this evaluation, a system is considered flooded if the hydraulic grade line exceeds the ground elevation (rim elevation) at any point during the storm event. Detention facilities are recommended to be designed to store the runoff volume from a 50-year storm and provide safe overflow during a 100-year storm event. They should also be designed so that post-development maximum runoff from the design storm event does not exceed the pre-development runoff for any design storm through the 50-year storm event.

FIGURE 4-1: GEOGRAPHICAL BOUNDARIES FOR NRCS (SCS) RAINFALL DISTRIBUTION

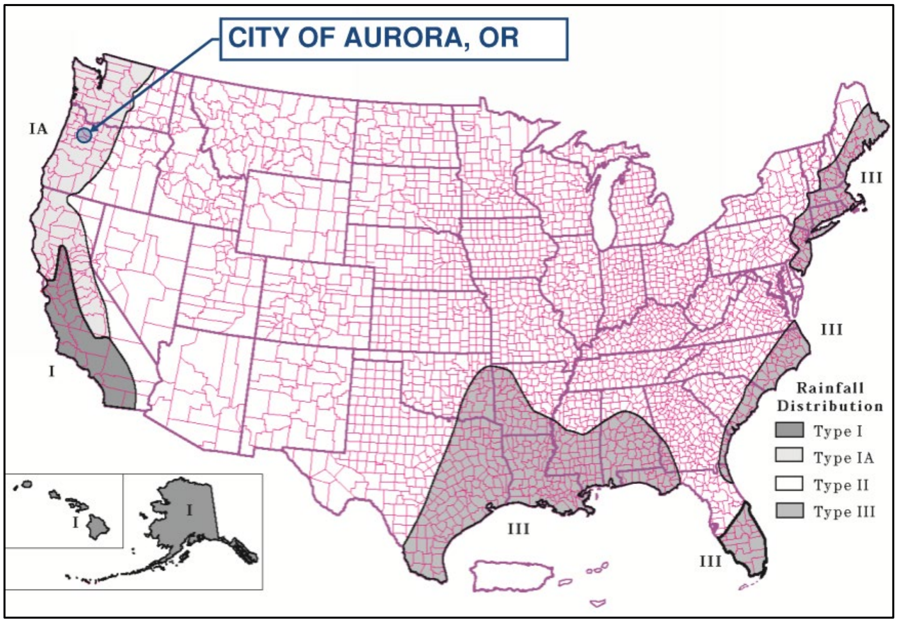
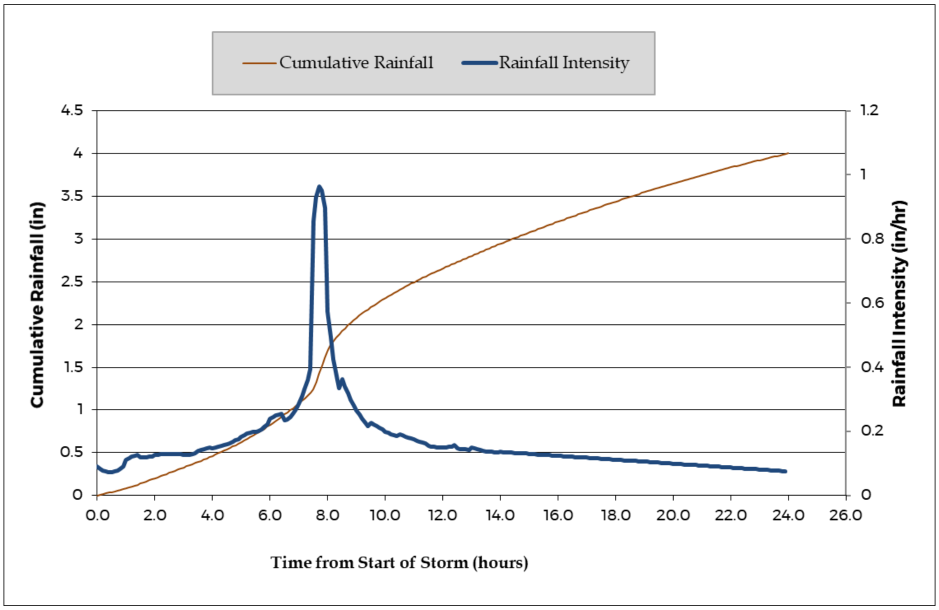


FIGURE 4-2: AURORA 25-YEAR STORM HYETOGRAPH



4.3 HYDROLOGIC AND HYDRAULIC METHODOLOGY

The hydrologic portion of the stormwater system involves how a given area or drainage basin will react to the design storm event. Hydrologic parameters are analyzed in each basin and are used to estimate how much rainfall from the design storm event is converted to runoff, where the runoff drains, and how long it takes the runoff to drain to inlets in the drainage conveyance system. The hydrologic calculations are then used to put "loads" or "demands" into the hydraulic portion of the stormwater system model.

Several hydrologic methods exist for defining basin characteristics and there is no single methodology or procedure that is universally accepted. The selection of which methodology to use in the evaluation depends on several factors, including geography, project area (size), and the overall purpose of the evaluation. Some of the most common methods used in this region include the following:

- Natural Resources Conservation Service (NRCS) TR-20
- Hydrologic Modeling System (HEC-HMS)
- NRCS Urban Hydrograph Method (TR-55)
- Santa Barbara Urban Hydrograph Method (SBUH)
- Rational Method
- Environmental Protection Agency (EPA) Storm Water Management Model

These methods have their own varying applications. NRCS TR-20 is an older methodology to the NRCS TR-55. The SBUH method is similar to the NRCS method but uses a different process to develop the hydrograph. The rational method is appropriate for smaller urban watersheds less than 200 acres in area. The HEC-HMS and EPA SWMM methodologies are not as widely used as the NRCS TR-55 method for assigning basin characteristics. It should be noted that the list of methods provided above are not independent of each other. For example, the EPA Stormwater Management Model methodology used the same NRCS hyetographs as used in the NRCS TR-55 method to assign rainfall distribution throughout the design storm event.

Keller Associates recommends using the NRCS TR-55 methodology in the characterization of the basins because this method is commonly used in the region, and the characteristics of the study area fit within the limitations of the method. The NRCS TR-55 method is used in defining hydrologic characteristics of the basins. The parameters calculated using the NRCS TR-55 method will be input into the computer modeling software, InfoSWMM. InfoSWMM uses the calculated parameters of the hydrologic basins to evaluate runoff or "loads" to the hydraulic portion of the model. The InfoSWMM hydraulic model is a fully dynamic model which allows for evaluation of complex hydraulic flow patterns.

4.4 PLANNING CRITERIA AND STANDARDS

The planning criteria and standards established in this study will serve as the basis for evaluation of the existing system, as well as for construction standards of future storm drainage systems. It will provide guidance to developers building within Aurora's urban growth boundary. It is imperative for these documents to be consistent with the City's goals for effective stormwater management. The City's existing stormwater policies pertaining to hydraulic modeling and capacity were reviewed as part of the master plan effort. A full evaluation of the City's stormwater policies and design standards was not within the scope of this study.

Planning criteria and standards were reviewed for neighboring communities to provide additional validation of the recommended criteria and standards, as shown in Table 4-2. The following summary of recommended planning criteria and design standards have been developed to meet the City's goal of being prepared to meet future stormwater regulatory requirements and target the specific needs of the City based on its geographic location and hydrologic conditions. It should be noted that any stormwater infrastructure in the County or Oregon Department of Transportation (ODOT) will need to be designed and constructed to the respective agency's standards.

TABLE 4-2: SUMMARY OF LOCAL PLANNING CRITERIA

Planning Criteria						
Design Storm	**ODOT[1] (2012)**	**Marion Co.[3] (1990)**	**Wilsonville (2015)**	**Stayton[4] (2015)**	**Canby (2012)**	**Aurora Recommended**
Conveyance System	10-year	25-year	25-year	25-year	25-year	25-year
Culverts	50-year	25-year	100-year	25-year	25-year	25-year
Open Channels	10-year	10-year	25-year	25-year	25-year	25-year
Detention Facilities Design Storm	50-year	10-year	10-year	50-year	25-year	50-Year
Detention Facility Safe Overflow Design Storm	100-Year	50-Year	100-Year	100-Year	100-Year	100-Year
Surcharging Allowed	Yes[2]	No	Yes	Yes[6]	Yes[5]	Yes[2]
Minimum Pipe Main Size (in)	12	10	12	12	12	12
Detention Facilities and Open Channel Minimum Freeboard (ft) [7]	1	0.5	1	1	NS	1
Detention Facility Peak Discharge	NS	Limit to 5-Year, pre-development	Equal to pre-development for any design storm event	Equal to pre-development for 2-, 5-, 10-, and 50-year storm. 25-year post-development equal to 10-year pre-development	Equal to pre-development for any design storm event less than the 25-year storm	Equal to pre-development for design storm event through the 50-year storm

1) Design storms for ODOT are based on an ADT > 750.

2) Surcharging allowed as long as hydraulic grade line (HGL) is 0.5 feet below rim elevation of any drainage structure that may be affected

3) Pipes and culverts based on criteria for trunklines 24" and larger. Open channels and detention facilities based on commercial and high value districts criteria.

4) Values based on local and collector streets. Arterial streets require 50-year storm for conveyance system, culverts, and open channels.

5) Surcharging allowed as long as HGL is below the manhole lid.

6) Surcharging allowed as long as HGL is below the road subgrade.

7) Distance measured from bottom of containing structure to design storm water surface level

An evaluation of water quality standards was not included in the scope of this study. However, water quality standards should be a consideration in any new stormwater facility. Best management practices (BMPs) should be followed as appropriate. It is recommended that the City review existing water quality standards and Stormwater Management Manuals (SWMM) of surrounding local jurisdictions and assess what resources may be best suited to guide the City's water quality criteria requirements for future developments and stormwater infrastructure.

SECTION 5 - MODEL DEVELOPMENT

5.1 INTRODUCTION

An accurate computer model of the stormwater system serves as a planning tool and provides the basis for a solid stormwater master plan. The model also provides insight into potential improvements to address existing deficiencies and can be used to effectively plan for future development within the study area. A stormwater model correlates interactions of natural events with natural and artificial systems. Because there are countless variables with broad ranges of reasonable values in each system, a well-coordinated and strategic data collection effort is required, along with practical assumptions and good judgment of data that cannot be feasibly obtained. This section outlines the model construction process, beginning with data collection to how key assumptions were incorporated to construct the model of the Aurora existing stormwater system.

The stormwater model consists of two components: a hydrologic model and a hydraulic model. The hydrologic model consists of drainage basins, or geographic areas that drain to a specific point, and temporal distribution of storm events (hyetograph, as discussed in Section 4). Input parameters such as area, surface slope, soil infiltration, and percent impervious surface define each of these minor basins. Input parameters determine how much rainfall is converted to runoff and when the runoff reaches the outlet point. The hydraulic model routes the hydrologic model's runoff through the storm drain network of open channels, detention ponds, pipelines, drywells, and outfalls.

Each component of the stormwater model requires numerous input parameters to adequately simulate the actual rainfall events and the resulting effects on the storm drain network. The parameters and input assumptions are explained and summarized in this section.

InfoSWMM is the software modeling package utilized for modeling the City's stormwater collection system. InfoSWMM was also used for the wastewater collection system model for the Wastewater Facilities Planning Study (May 2019).

The area within Aurora's urban growth boundary was delineated into 67 sub-drainage basins. Sub-basins not draining to existing stormwater infrastructure were not included in the existing system hydraulic evaluation because there is no existing stormwater infrastructure to route the flow through. However, future improvements were evaluated and recommended on a case-by-case basis depending on if the City had seen drainage issues in the past. The delineated basins can be seen in Figure 6 in Appendix A.

5.2 KEY ASSUMPTIONS

Modeling stormwater systems to reflect actual conditions is a more difficult task than water and wastewater models due to the nature and uncertainty of stormwater. Hundreds of assumptions and "what if" scenarios go into the creation of a stormwater model. The goal is to capture a storm significant enough to simulate flooding in the majority of situations. Although the model is considered an appropriate method to evaluate a stormwater system, it is entirely possible that an actual 10-year storm event could flood the City, even though improvements are recommended for the textbook 25-year event.

The following assumptions were made for basins and boundary conditions:

- Pudding River and Mill Creek have sufficient capacity to handle flows discharged from pipe system outfalls and flooding of these features was not evaluated.
- Drywells are in good working repair and have exfiltration rates as defined by the NRCS soil data of the area. An in-depth evaluation of drywell capacity was not included in the scope of this study. No infiltration testing was completed as part of this master plan.
- All pipes are in good repair and free of debris.

- All channels and ditches have been dredged on a regular schedule to maintain the size documents in the site survey and photos.
- Natural channels have been mowed to remove excess vegetation, with only the plants intended to be used as water quality features remaining.

5.3 CALIBRATION

Typical calibration processes for stormwater models involve installing temporary flow monitors to capture the amount of water draining to the pipe networks during actual storm events. Since this system is relatively small, and the City staff is familiar with where the system has capacity issues, this model was calibrated using input from the City staff and by using engineering judgment to make reasonable assumptions.

A 2-year and 10-year storm event were used as the baseline to calibrate the model because the City staff has likely experienced both a 2-year and 10-year event. The pipe networks were analyzed, and capacity issues in the model were compared with actual known capacity issues. Where the model showed problems (in a known problem area), the model was assumed to be calibrated to complete an evaluation of the pipe network.

SECTION 6 - EXISTING SYSTEM EVALUATION

This section discusses the general capacity evaluation of the existing stormwater system within the study area. These assessments are based on input from City staff and computer modeling results of the design storms. Specific problem areas have been identified by the City where flooding has historically occurred. These problem areas consist of flooding from undersized pipes and ditches, and areas where ponding occurs from lack of stormwater infrastructure.

Four design storm events were simulated in the model and included the 2-year, 10-year, 25-year, and 100-year storms. The following sections identify the specific areas where flooding or surcharging to within one-half foot of the rim elevation of any modeled drainage structure in the given storm event. The areas with deficiencies are given a unique identifier which is shown in Table 6-1. Additional model results showing which storm event first causes flooding in the system is shown in Figure 7A and 7B in Appendix A.

6.1 EXISTING STORMWATER SYSTEM CONDITIONS

The design storm events were simulated, and the existing stormwater system components were evaluated against the planning criteria established in previous sections. The deficiencies summarized below included identifying stormwater structures, which flooded or surcharged to within 0.5 feet of the structure rim elevation during the design storm event. Flooding was defined as more than 100 gallons of water lost through the rim of a structure. Table 6-1 summarizes the deficiencies identified by the model for each of the design storm events. Note, the table includes areas, which flood during the 100-year storm event. However, the design storm for the conveyance system is the 25-year storm. For this reason, alternatives and descriptions are not included in this study for areas that only flood during the 100-year storm.

TABLE 6-1: SUMMARY OF EXISTING STORMWATER DEFICIENCIES

Problem Area ID	Location Description	First Storm Event with Surcharging[1]	First Storm Event with Flooding
PA-1	Airport Road Ditch	-	2-Year
PA-2	Main Street and 1st Street	-	10-Year
PA-3	2nd Street (Church Parking Lot)	10-Year	100-Year
PA-4	3rd Street and Main Street	-	2-Year
PA-5	Highway 99 North of 2nd Street	-	10-Year
PA-6	Main Street and Ottaway Road	-	2-Year
PA-7	Main Street North of Ottaway Road	2-Year	10-Year
PA-8	Cody Lane	-	2-Year
PA-9	Highway 99 and Ottaway Road	2-Year	10-Year
PA-10	Ehlen Road	-	25-Year
PA-11	Culvert under HWY 99 between Bobs and Ottaway	-	10-Year
PA-12	Liberty St.	-	25-Year
PA-13	Albers Way	25-Year	100-Year
PA-14	3rd Street Outfall	25-Year	100-Year
PA-15	Orchard Avenue	-	100-Year
PA-16	Kasel Court	-	100-Year

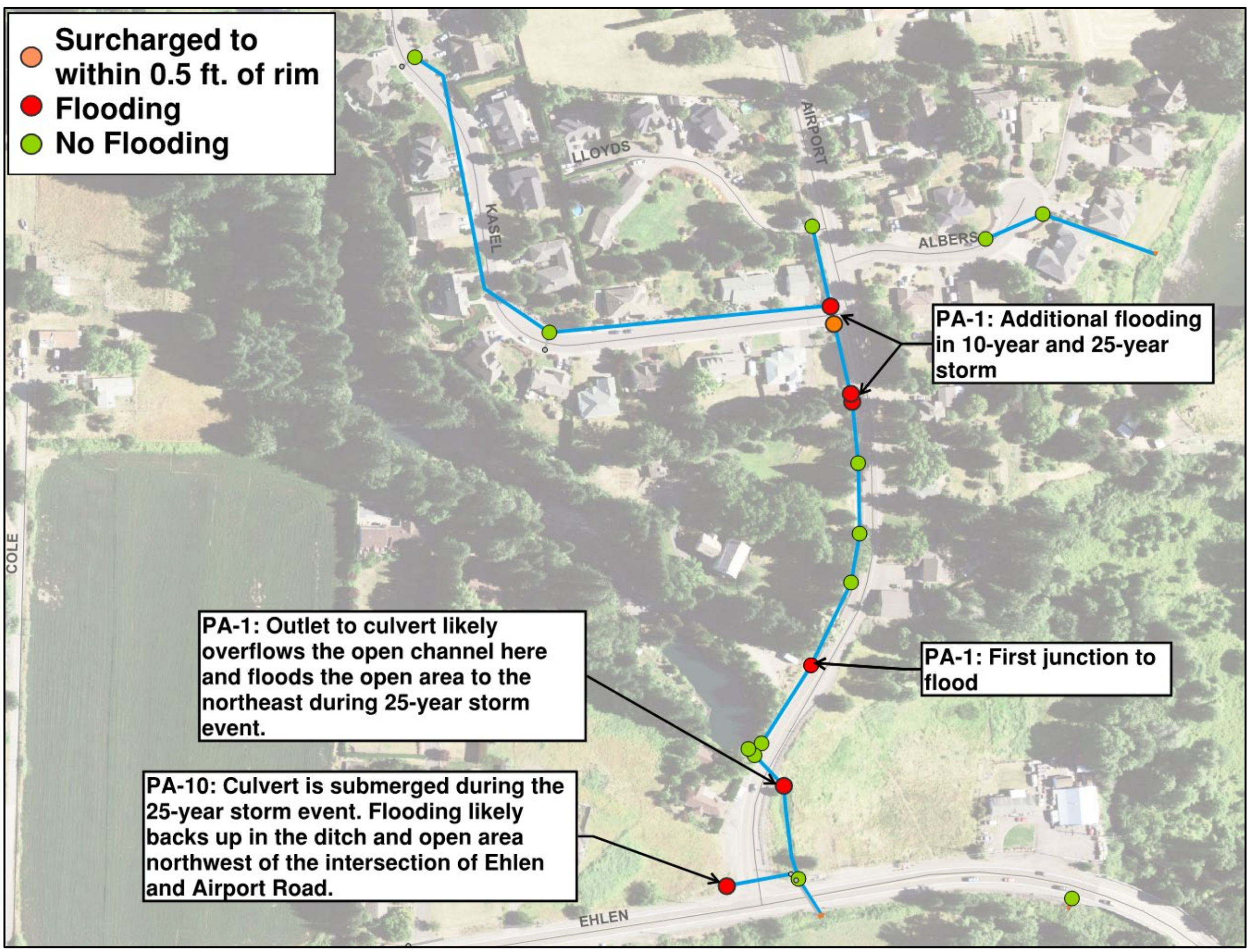
1) Junctions are considered surcharged when the HGL is within 0.5 feet of the rim elevation

Problem Area 1 and 10 – Airport Road Ditch and Ehlen Road

Stormwater drains down Airport Road from the north and from the existing piping along Kasel Court. Stormwater is discharged just south of the intersection of Kasel Court and Airport Road into a ditch that flows south through a series of 12-inch and 18-inch culverts. Airport Road is a Marion County road, while Kasel Court is a City road. The junction where flooding first occurs is where the ditch enters a 12-inch culvert that is undersized for the 2-year event peak flows. It should be noted that the rim elevation at culvert junctions is set equal to the top of the pipe elevation. Therefore, flooding occurring at pipe inlets may not be equivalent to flooding onto the road. However, it does indicate that the pipe is undersized for peak flows. Additional flooding and surcharging occur upstream during larger storm events. There is some flooding at the outlet of the 36-inch culvert during the 25-year storm event peak flows, which likely drains to the undeveloped, open area in the northeast before it makes its way to Mill Creek.

The 18-inch inlet culvert under Airport Road (the ditch drains on the north side of Ehlen Road) floods during the 25-year peak flows. Again, this represents the culvert being undersized for peak flows, so the inlet is submerged, and water backs up in the upstream ditch. Ehlen Road is within Marion County right-of-way (ROW). Figure 6-1 shows the deficiencies along Airport Road and Ehlen Road.

FIGURE 6-1: AIRPORT ROAD DEFICIENCIES



Problem Area 2 – Main Street and 1st Street

An 8-inch bottleneck was recorded in the City's stormwater survey (2017) between two 12-inch pipes. Flooding occurs at a manhole along Main Street because of the 8-inch bottleneck and the outlet pipe elevation is approximately one foot higher than the inlet pipe elevation. Figure 6-2 illustrates the flooding along Main Street. Note, if the 8-inch bottleneck was surveyed incorrectly and does not exist, there is still flooding in the area. There is flooding at downstream manholes near the intersection of Main Street and First Street. The 12-inch pipes draining to the outfall are undersized for conveying runoff from the 25-year storm event. Figure 6-3 shows the profile with the surveyed 8-inch bottleneck.

FIGURE 6-2: MAIN STREET TO 1ST STREET DEFICIENCIES

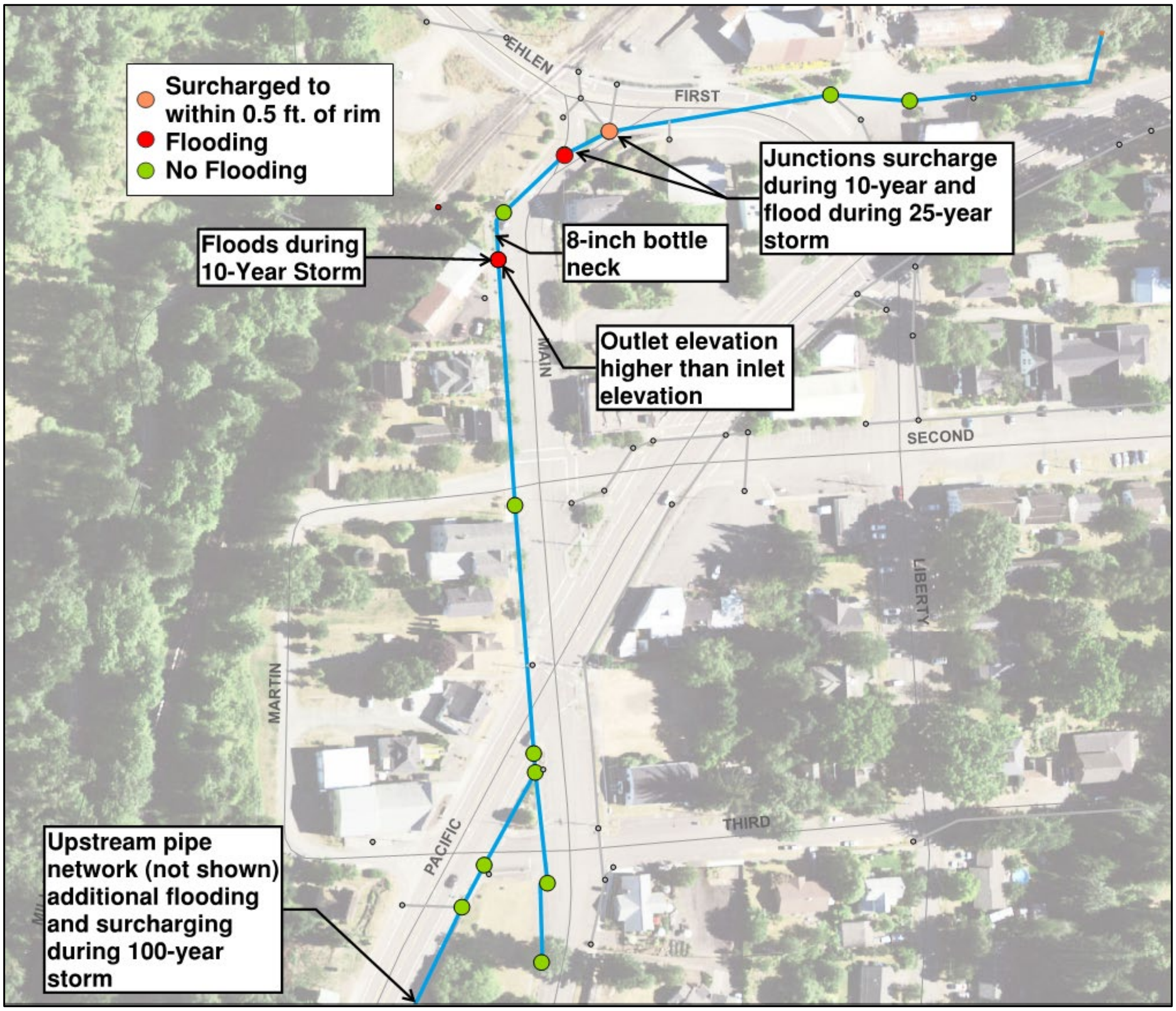
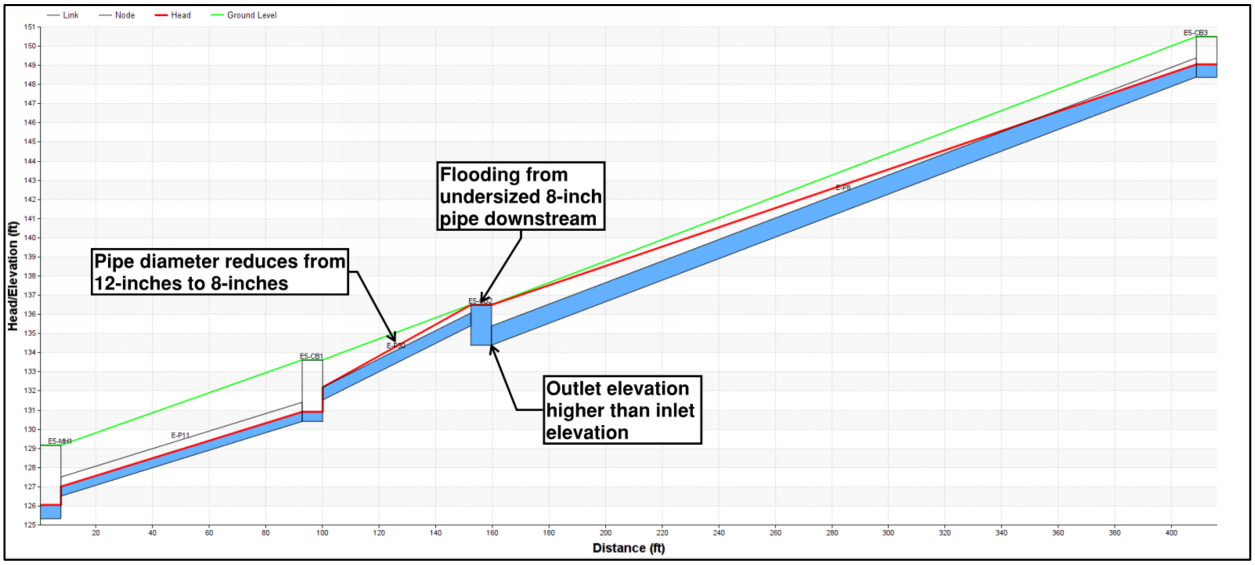


FIGURE 6-3: PROFILE OF BOTTLENECK AND RAISED OUTLET ALONG 1ST STREET



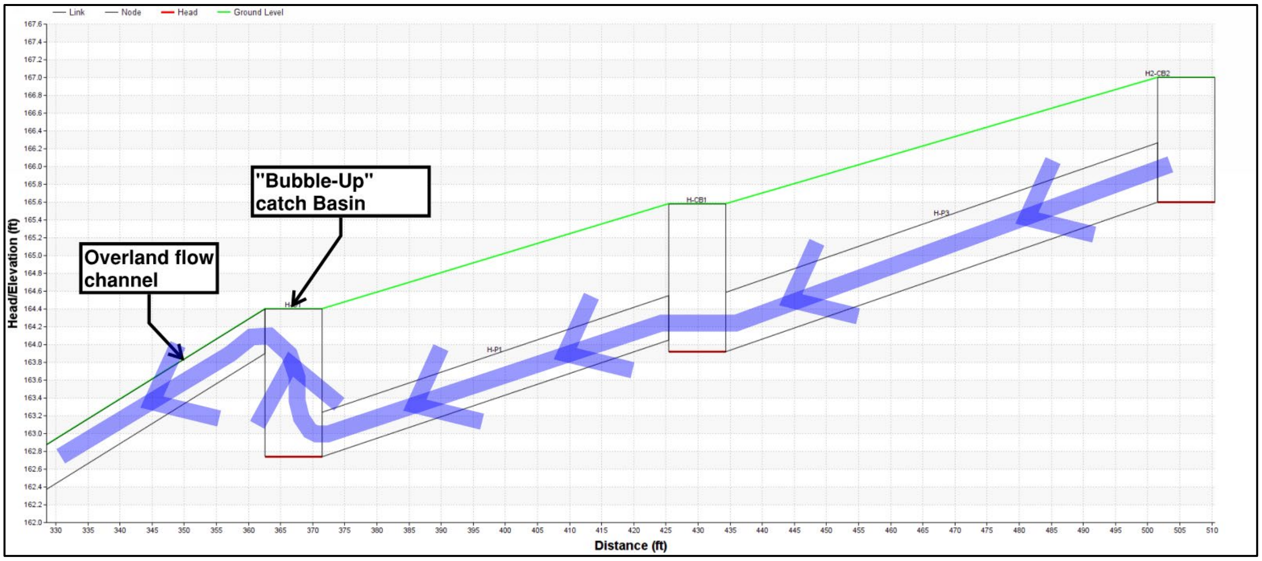
Problem Area 3 – 2nd Street (Church Parking Lot)

Localized ponding occurs along 2nd Street, where there is no inlet to the stormwater pipeline. Water pools here at a low point and has no place to drain. The ponding area is illustrated in Figure 6-6. The 8-inch pipe also surcharges in the 25-year storm and floods in the 100-year storm. The 8-inch pipe slope is less than the recommended minimum pipe slope.

Problem Area 4 – 3rd Street and Main Street

Stormwater drains down a perforated pipeline until it crosses to the north side of 3rd Street, where water "bubbles" up and out of the pipe network. The water flows north along the curb and gutter until it enters the pipeline on the south side of 2nd Street through a catch basin. This pipeline that captures the existing overland flow is within ODOT ROW. Figure 6-4 illustrates the profile view of this pipe configuration and how water flows through the system. The area can also be seen in Figure 6-6.

FIGURE 6-4: PROFILE OF BUBBLE-UP PIPE CONFIGURATION



Problem Area 5 – Highway 99 North of 2nd Street

Surcharging is seen in a catch basin along Highway 99 during the 10-year storm and flooding is seen during the 25-year storm. The pipe second to last to the outfall appears to be undersized and is causing flooding upstream. This infrastructure is within ODOT ROW. Figure 6-5 shows the profile view and the hydraulic grade line in red. The problem area is also shown in Figure 6-6.

FIGURE 6-5: PROFILE OF FLOODING ALONG HIGHWAY 99 DURING 25-YEAR STORM

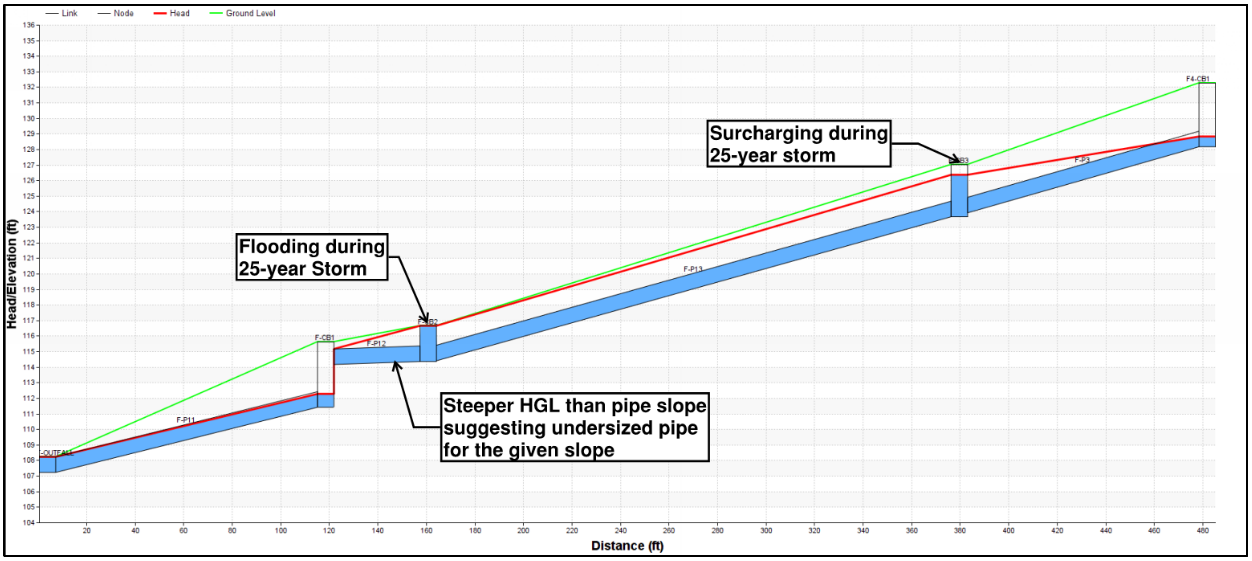
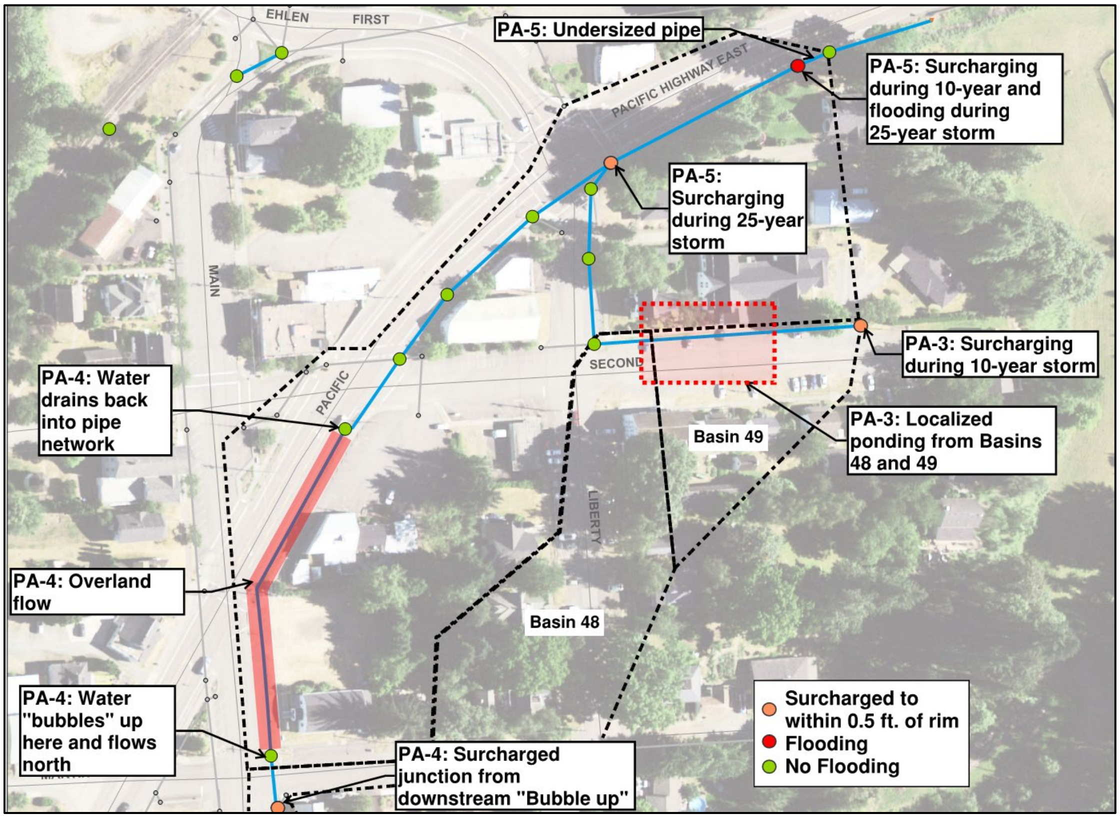


FIGURE 6-6: PROBLEM AREAS 3, 4, AND 5 LOCATIONS



Problem Area 6 – Main Street and Ottaway Road

Stormwater enters the pipe network south of Bobs Street and flows south toward a manhole/drywell. The manhole has an open bottom over what appears to be a cut corrugated metal pipe (CMP). There are no known outlets of the CMP. This junction was modeled as a drywell with infiltration and no outlet. The NRCS soil data infiltration and hydraulic properties were used to characterize the exfiltration at the drywell. An infiltration rate of 1.3 in/hr for the hydrologic soil type C in the area was used in the model parameters. The drywell does not have the capacity to drain the stormwater and backs up, which causes flooding in the catch basin to the south of the drywell. The flooded catch basin also has an outlet to the south, but it is unknown where it goes. The problem area can be seen in Figure 6-7.

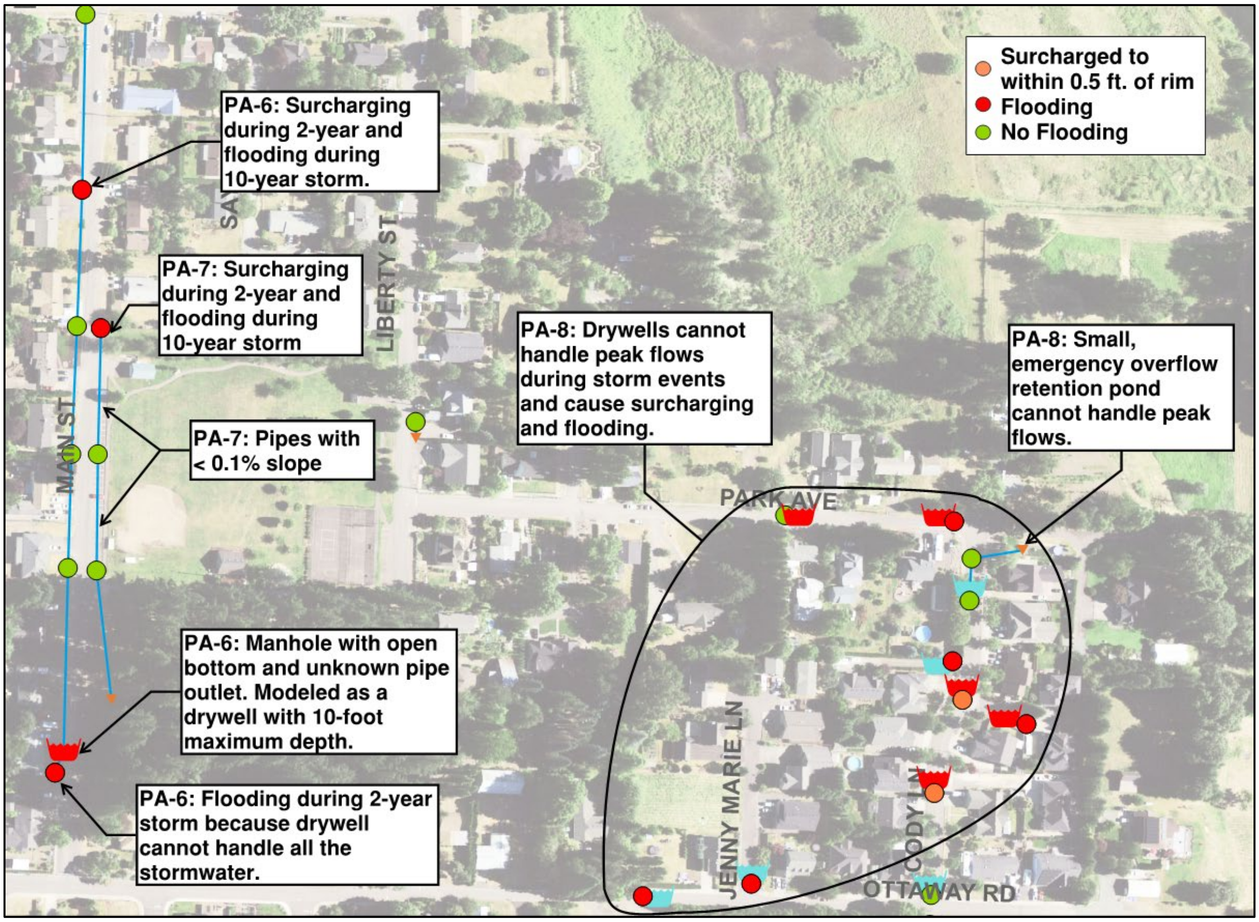
Problem Area 7 – Main Street North of Ottaway

This area is a pipe network consisting of three main pipes that flow to an outfall, as shown in Figure 6‑7. The two most upstream pipes have slopes less than 0.1% and water is backing up and flooding out of the upstream catch basin.

Problem Area 8 – Cody Lane and Park Avenue Drywells

There are ten drywells in the Strawberry Meadows Development. The drywells were modeled with infiltration parameters defined by the NRCS soil data for the area. An infiltration rate of 1.3 in/hr for the hydrologic soil group C in the area was used in the model parameters. The drywells do not have adequate capacity to handle the 2-year design storm. Some of the drywells flood at the rim and others cause flooding at upstream catch basins or manholes with backwater effects from the drywell. The drywell just south of the intersection of Park Avenue and Cody Lane has an emergency overflow pipe that drains to a small retention basin to the east, as seen in Figure 6-7. The model indicates a large volume of water overflows to the retention pond during the 25-year design storm, which would cause the pond to overflow. The City reported historical flooding in this area intermittently. The drywells have been reported to flood if not cleaned and maintained regularly. DEQ issued a Mutual Agreement and Order (MAO) to the City in July 2012. The MAO recognizes the ten drywells in Strawberry Meadows development and outlines general conditions and monitoring requirements for the drywells. A copy of the MAO is provided in Appendix E.

FIGURE 6-7: PROBLEM AREAS 6, 7, AND 8 LOCATIONS



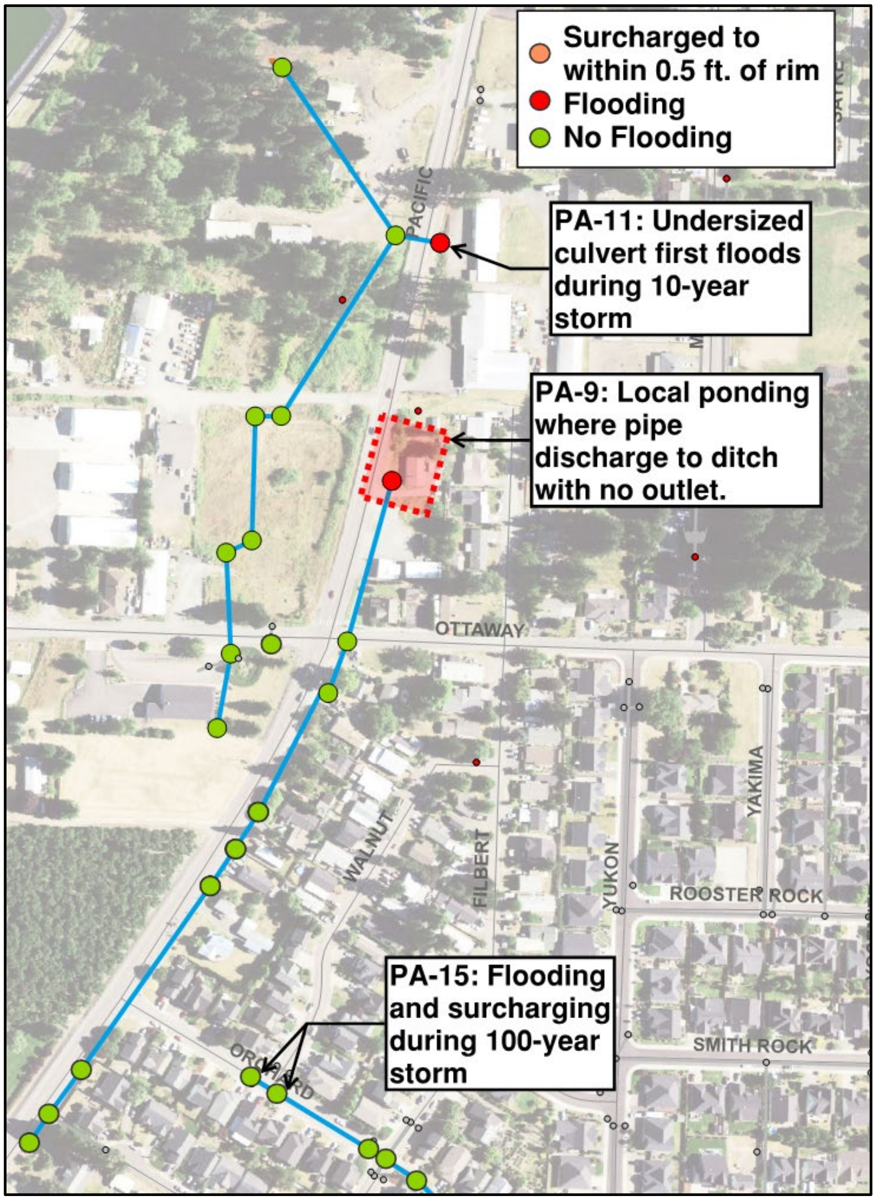
Problem Area 9 – Ottaway Road and Highway 99

This pipe discharges into a ditch north of Ottaway; however, the ditch does not have any outlet and causes localized ponding at the end of the ditch (Figure 6-8). The pipeline is within ODOT ROW.

Problem Area 11 – Culvert under Highway 99 between Bobs and Ottaway

A 12-inch culvert drains runoff from the east side of Highway 99 under the road and connects to a private storm system. This culvert is within ODOT ROW. This 12-inch culvert backs up during the 25-year storm, and likely backs up in the ditch on the east side of the highway (Figure 6-8).

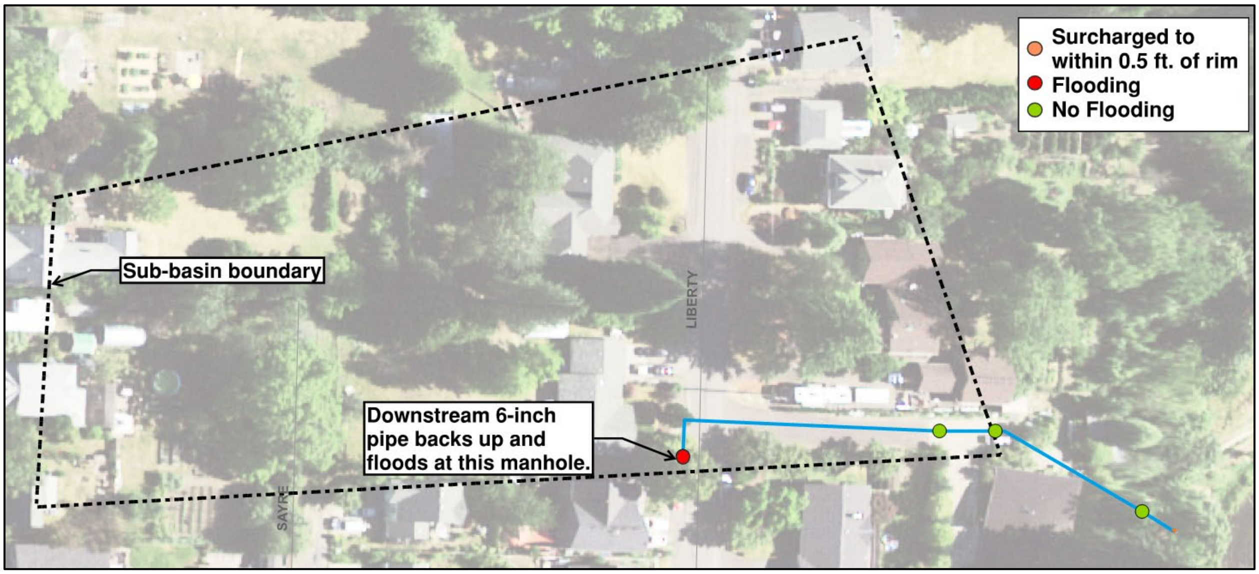
FIGURE 6-8: PROBLEM AREAS 9 AND 11 LOCATIONS



Problem Area 12 – Liberty Street

The pipe network draining to the outfall does not have the capacity to drain the 25-year storm event (Figure 6-9). Note, the pipes draining to this outfall are privately owned.

FIGURE 6-9: FLOODING AT LIBERTY STREET DURING 100-YEAR STORM



Problem Area 13 – Albers Way

The first segment of pipe along Albers Way is undersized. The 8-inch pipe surcharges to within 0.5 feet of the rim elevation in the 25-year storm event and floods during the 100-year storm event.

Problem Area 14 – 3rd Street Outfall

The existing 6-inch pipe causes surcharging to within 0.5 feet of the rim elevation at the most upstream catch basin along 3rd Street. The 6-inch pipe does not have the capacity to convey the 25-year storm event without surcharging. The same catch basin floods during the 100-year storm.

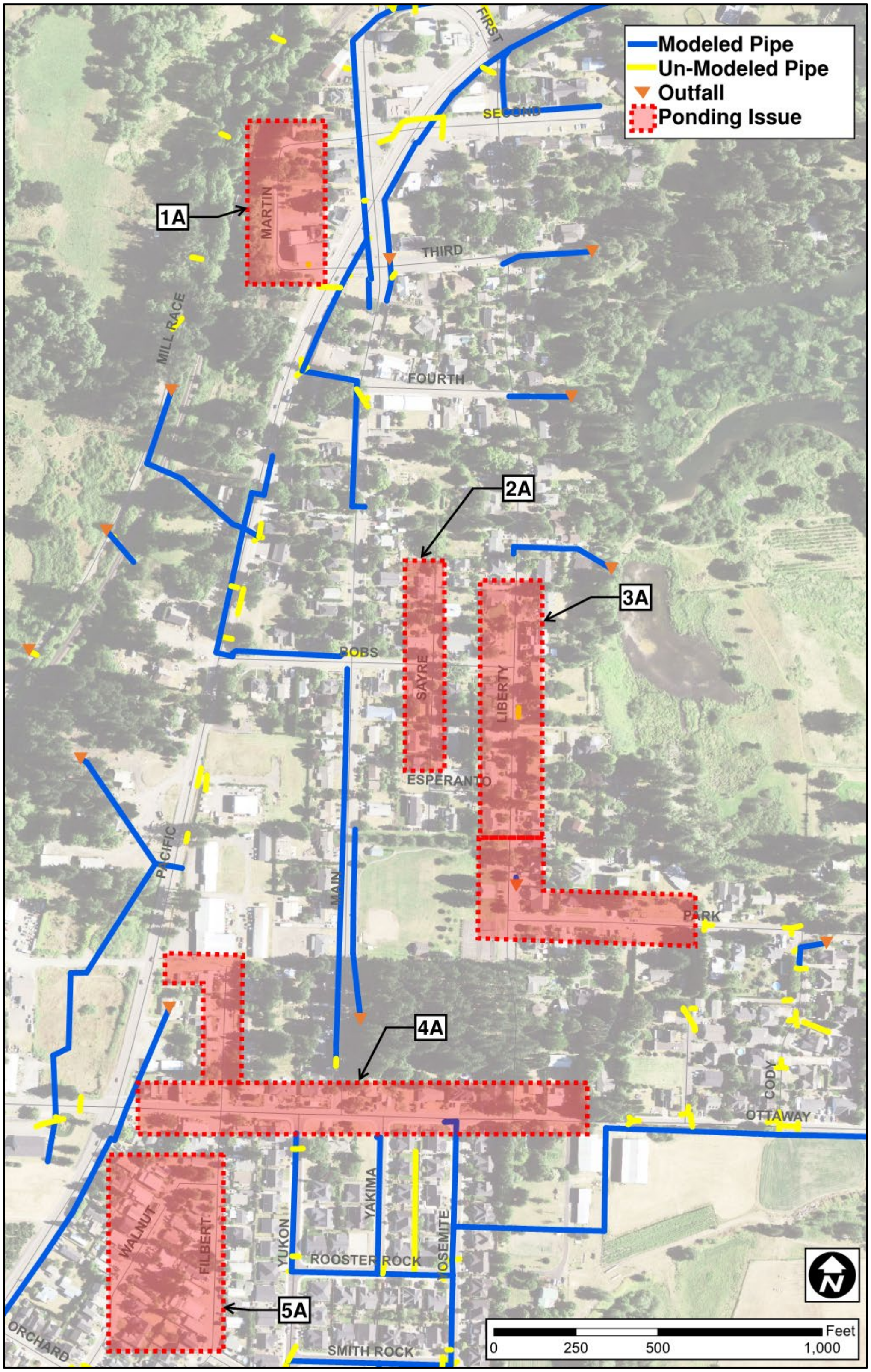
6.2 ADDITIONAL STORMWATER CONDITIONS

In addition to the flooding and surcharging of the existing stormwater components, the City has also reported areas with ponding due to the absence of stormwater infrastructure within these areas. Table 6-2 and Figure 6-10 summarize these areas.

TABLE 6-2: LOCAL PONDING ISSUES FROM LACK OF STORMWATER INFRASTRUCTURE

Problem Areas Without Existing Infrastructure	
PA-1A	Martin Street to 2nd Street
PA-2A	Sayre Drive
PA-3A	Liberty Street and Park Avenue
PA-4A	Ottaway Road
PA-5A	Filbert and Walnut Street

FIGURE 6-10: PROBLEM AREAS 1A-5A LOCATIONS



6.3 ORCHARD DETENTION POND EVALUATION

There is a detention pond in the existing stormwater system located toward the southern boundary of the City. The pond drains water from the pipe network along Orchard Avenue. The pond has a buried 4-inch perforated pipe, which discharges directly into the outlet structure and then drains through existing stormwater pipes to the outfall at the end of Ottaway Road. An open ditch drains flow east from the outfall to the Pudding River.

The City would like to evaluate removing this detention pond in the future and installing pipe in place of the pond to drain directly to the outfall. Model scenarios with the 25-year, 24-hour storm event were simulated with the detention pond in place and with the detention pond removed and piping installed in its place. The peak discharge rate and the total volume at the outfall were compared for both scenarios and are summarized in Table 6-3.

TABLE 6-3: EVALUATION OF REMOVAL OF ORCHARD DETENTION POND

	With Pond	Without Pond	Difference
Peak Flow at outfall (cfs)	27.1	29.3	2.2
Total Volume at outfall (MG)	2.36	2.44	0.08

The table above shows approximately 1.6 cfs difference in peak flows and approximately 80,000 gallons volume difference during a simulated 25-year, 24-hour storm event. This difference does not appear to create any capacity problems downstream of the pond if it were to be removed. Figure 6-11 and Figure 6-12 show the effect the removal of the detention pond will have on the downstream pipe network. The pipes are symbolized by the maximum depth divided by the full depth (d/D). The d/D impact on the pipes downstream of the pond location is minimal and most of the main trunkline is flowing at 60% depth or less. Additionally, water quality at the Ottaway Road outfall should be evaluated following regional industry stormwater quality standards and any TMDL requirements before additional conveyance systems are connected to this trunkline.

FIGURE 6-11: MAX DEPTH / FULL DEPTH WITH ORCHARD POND

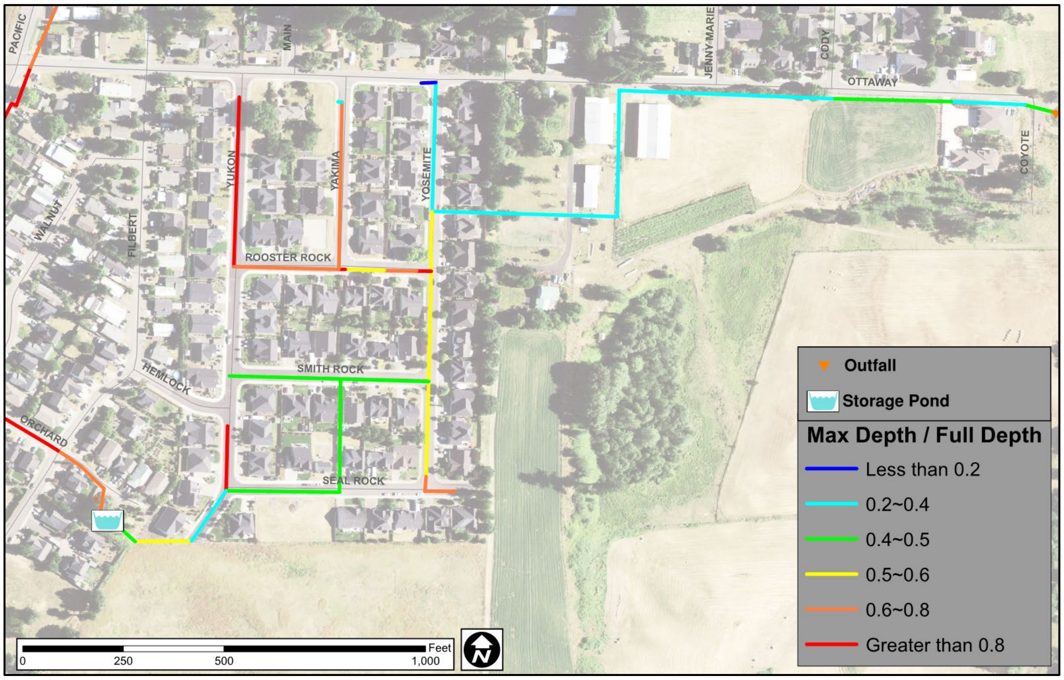
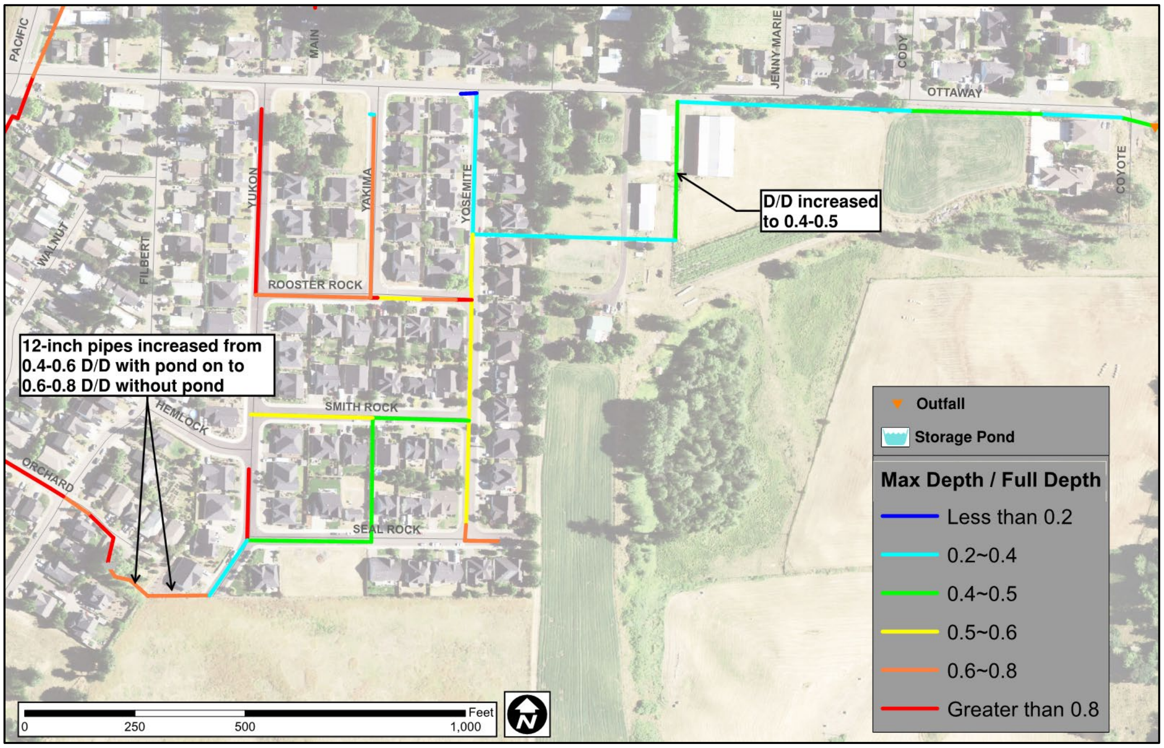


FIGURE 6-12: MAX DEPTH / FULL DEPTH WITHOUT ORCHARD POND



SECTION 7 - SUMMARY OF ALTERNATIVES

This section summarizes improvement alternatives to address deficiencies identified in Section 6. Each alternative's benefits and drawbacks have been summarized where multiple alternatives are considered. Problem areas that only had one alternative considered are shown in Section 8. Note, some of the problem areas identified in Section 6 have been combined in this chapter to group mutually beneficial projects together.

7.1 AIRPORT ROAD: PA-1 & PA-10

Flooding was identified along Airport Road and Ehlen Road from undersized culverts and pipes. The following alternatives alleviate flooding by increasing the capacity of the conveyance system to handle the 25-year storm event.

Alternative 1

Replace the section of culverts and open ditches with a buried, 18-inch pipe network from Kasel Court to the 36-inch culvert where water crosses to the east side of Airport Road. Inlets to the pipeline and manholes will need to be constructed along Airport Road.

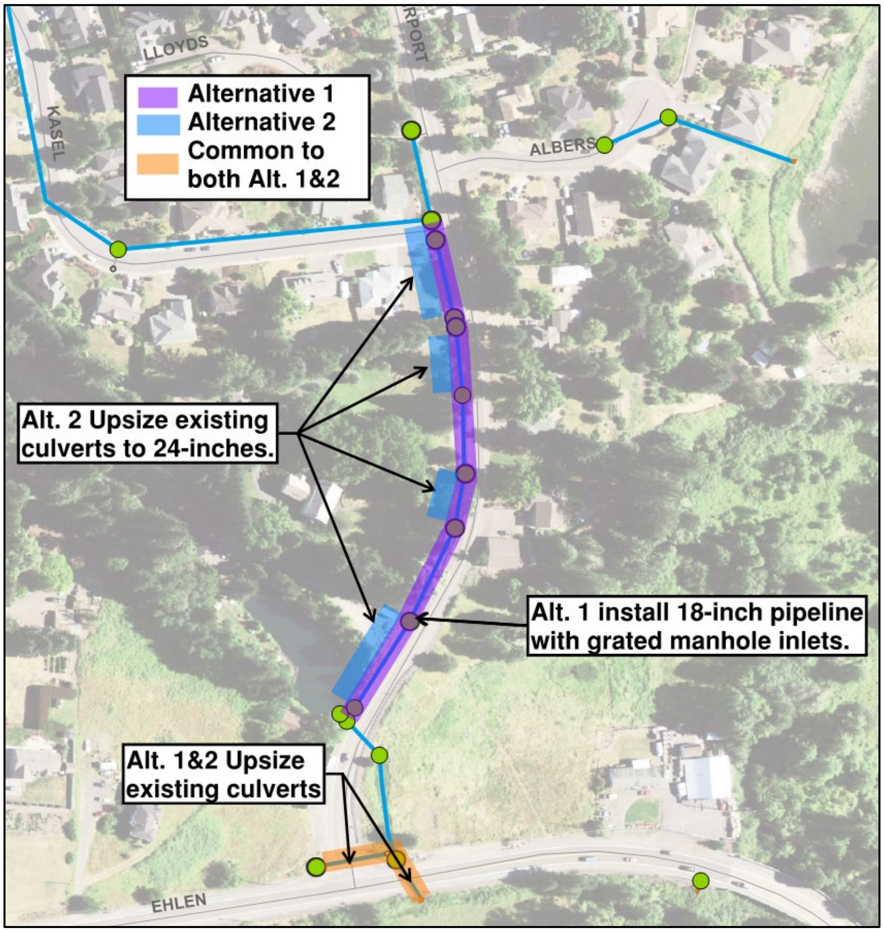
Alternative 2

Upsize existing 12-inch and 18-inch culverts to 24-inches. The pipe network directly connected from Kasel Court to the ditch outlet south of Kasel Court is to be upsized from 12-inches to 18-inches. Upsize the existing 12-inch pipe network that directly connects to the 36-inch culvert draining water to the east side of Airport Road to 24-inch pipes. The existing catch basins connected to this pipe network need to be replaced.

Both alternatives include upsizing the existing culvert crossing under Airport Road, parallel with Ehlen Road, from 18-inches to 24-inches. Upsizing the existing 24-inch parallel culverts crossing Ehlen to either parallel 30-inch pipes or a single 42-inch pipe is also included.

Alternatives 1 and 2 are both potential solutions to alleviate the flooding along Airport Road. The two alternatives are illustrated in Figure 7-1. Detailed cost estimates for each alternative can be found in Appendix B.

FIGURE 7-1: AIRPORT ROAD (PA-1) ALTERNATIVES



Recommendation

Based on the information presented above and in Appendix B, Keller Associates recommends that the City pursue Alternative 2 as the best solution to alleviate flooding in this area. This alternative requires less pipeline, manholes, and catch basin installation and has lower overall capital costs.

7.2 MAIN STREET AND 1ST STREET: PA-2

Flooding was identified near the intersection of 1st Street/Ehlen Road and Main Street. The 12-inch pipes should be upsized to provide capacity for the design storm event and upstream improvements. Figure 7-2 illustrates the alternatives described below.

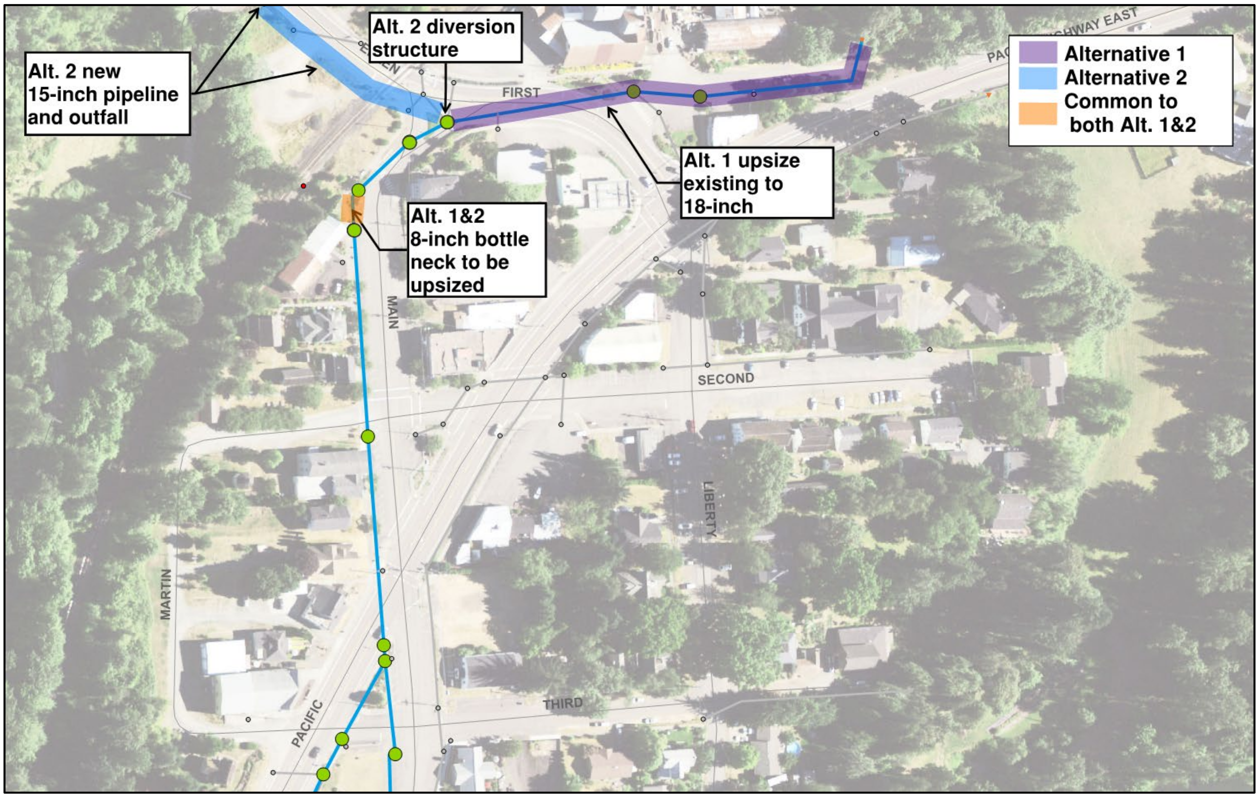
Alternative 1

Upsize the existing 12-inch pipe to 18-inches from the intersection of Ehlen Road/1st Street and Main Street to the outfall to the Pudding River. The existing 8-inch bottleneck should be upsized to 12-inch and the inverts should be adjusted to the existing manhole inverts.

Alternative 2

Install a diversion manhole at the intersection of Ehlen Road/1st Street and Main Street to split flows between the Pudding River and Mill Creek. Divert flow from the Pudding River outfall to relieve surcharging and flooding in the pipe network (approximately 70% of the existing flows directed to Mill Creek). Install a 15-inch pipe from the diversion manhole to the existing pipe outlet on the south side of Ehlen Road. Connect the existing 12-inch pipe to the new 15-inch trunkline. Install 15-inch pipe in the existing ditch section and upsize the existing outfall pipe from 12-inches to 15-inches. This pipe installation will include a railroad crossing. The existing 8-inch bottleneck described in Alternative 1 should also be addressed in Alternative 2.

FIGURE 7-2: MAIN STREET AND 1ST STREET (PA-2) ALTERNATIVES



Recommendation

Alternatives 1 and 2 are both potential solutions to alleviate the flooding along Highway 99. Detailed cost estimates for each alternative can be found in Appendix B. Alternative 1 is recommended to reduce flooding and surcharging. Alternative 1 maintains the existing stormwater discharge at the same outfall location and eliminates the need for a railroad crossing. Upsizing the existing pipe will provide the needed capacity for improvements needed upstream in the pipe network.

7.3 3RD STREET AND MAIN STREET: PA-4

Stormwater flows out of the existing pipe network, down curb and gutter, and drains into another pipe network draining to the outfall. These alternatives eliminate the “bubble-up” and surface flow between the pipe networks. Figure 7-3 (next page) illustrates the alternatives described below.

Alternative 1

Install a 12-inch pipe from the existing “bubble-up” on the north side of 3rd Street to the manhole at the southeast corner of 2nd Street and Highway 99. This alternative includes replacing the existing 10-inch connector pipe with a 12-inch pipe. Note, this alternative would require completing improvements to the downstream pipe network to correct deficiencies identified in Section 6.1 (PA-5), which include upsizing the 12-inch downstream network along Highway 99 from Liberty Street to the outfall to 15-inch pipes (Priority Improvement Project 3A as discussed in Section 8.1.3).

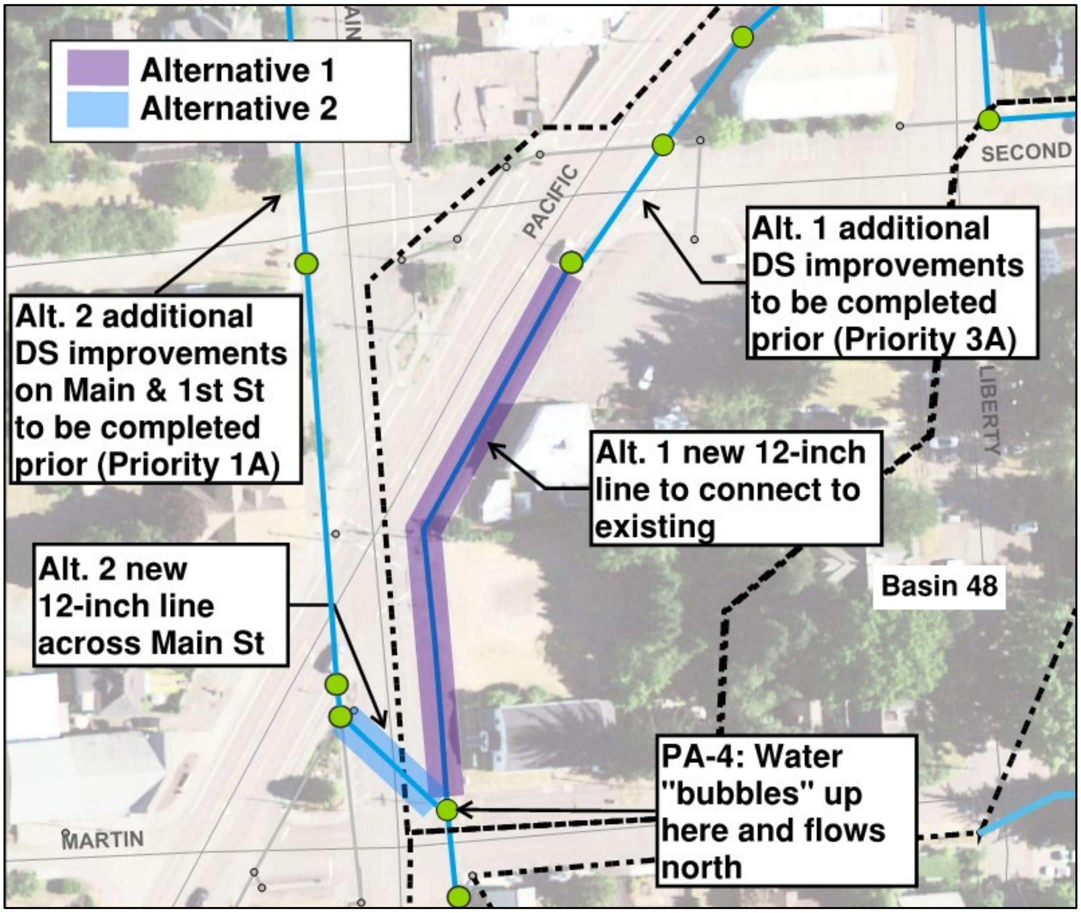
Alternative 2

Install a 12-inch pipe segment from the existing "bubble-up" across Main Street to the existing manhole in between Highway 99 and Main Street. Note, this alternative requires the improvements discussed in Section 7.2 (PA-2) to be completed prior to construction of this alternative.

Recommendation

Alternative 2 is recommended because it includes less new pipeline installation. The downstream improvements (PA-2) are recommended regardless of if Alternative 2 is completed or not.

FIGURE 7-3: 3RD AND MAIN STREET (PA-4) ALTERNATIVES



7.4 MAIN STREET NORTH OF OTTAWAY ROAD: PA-6 & PA-7

Flooding was identified in the model along Main Street from undersized pipes and pipes with slopes lower than the recommended minimum slopes. There are two pipe networks along Main Street: one on the east side of the street and one on the west side of the street. These alternatives evaluate draining stormwater from Main Street to one or the other pipe network and minimize the length of improvements required. Alternatives 1 and 2 are shown in Figure 7-4.

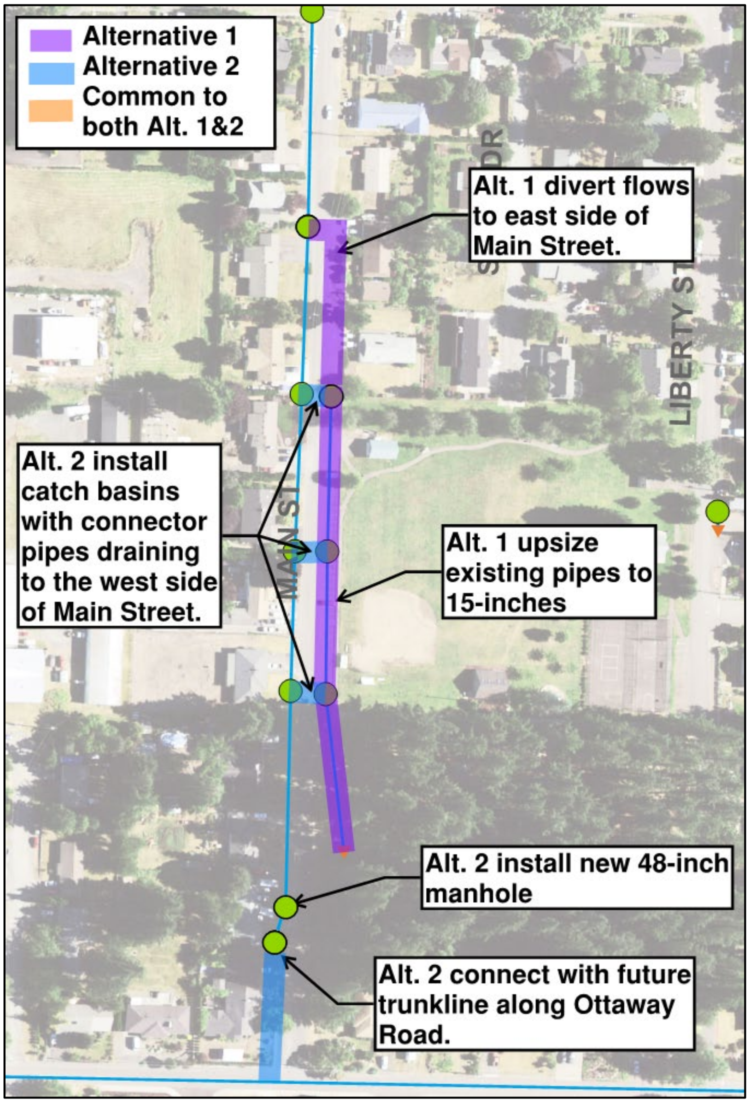
Alternative 1

Divert flows from the existing pipe network on the west side of Main Street to the existing pipe network on the east side of Main Street. Upsize the existing pipe network on the east side of Main Street to 15-inch pipes and install at minimum recommended pipe slopes. The stormwater discharge to the open area east of Main Street and north of Ottaway Road would not change.

Alternative 2

Replace the existing pipe network on the east side of Main Street with catch basins connecting to the existing pipe network on the west side of Main Street. A new manhole should replace the existing drywell/infiltration manhole, and a 21-inch pipe should be installed from the new manhole to the future trunkline along Ottaway Road.

FIGURE 7-4: MAIN STREET NORTH OF OTTAWAY ROAD (PA 6 & 7) ALTERNATIVES



Recommendation

Alternative 2 is recommended because less infrastructure is required. The Ottaway Road pipeline must be extended as described in Priority 2A (Section 8.1.2) before these improvements could be completed. A regional detention pond may be considered with this project to maintain peak flows to the Ottaway Road outfall. A proposed detention facility is discussed in more detail in the next section in relation to the Cody Lane and Park Avenue alternatives.

7.5 CODY LANE AND PARK AVE: PA-8

The City has seen historical flooding along Cody Lane if the drywells are not cleaned and maintained consistently. The City requested alternatives be evaluated to decommission the drywells and drain the stormwater to the outfall along Ottaway Road. There is no existing stormwater infrastructure along Park Avenue. The City reported there is no localized ponding on Park Avenue because of the slope, but stormwater has been known to sheet flow down the road. Alternatives 1 through 2 are shown in Figure 7-5.

Alternative 1

Install a 12-inch pipe draining east along Park Avenue to Cody Lane. Install a 21-inch and 24-inch trunkline draining south along Cody Lane to a new regional detention pond. Install a new regional detention pond to limit peak flows and volumes at the Ottaway outfall to be equal to existing and pre-development peak flows. Re-grade the existing 36-inch trunkline east of Cody Lane to drain out of the detention pond to the existing outfall.

Alternative 2

Install a 12-inch pipe draining east along Park Avenue similar to Alternative 1. Continue installing 21-inch pipe along Park Avenue, east of Cody Lane, to a new outfall that drains to the Pudding River. Install 21-inch pipe along Cody Lane, draining north to the new outfall off of Park Avenue.

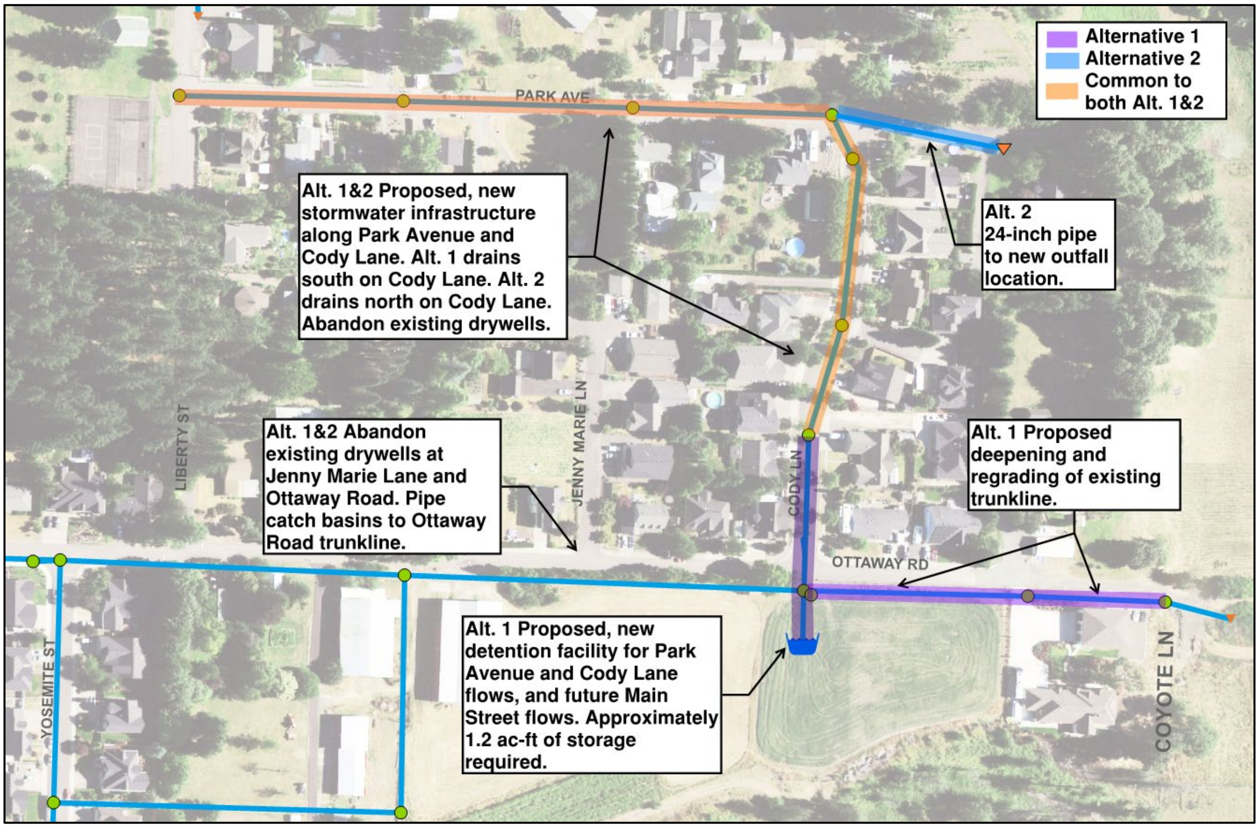
Alternative 3

Schedule regular cleaning and maintenance of the existing drywells to reduce the probability of flooding. Install two additional drywells along Park Avenue to capture stormwater.

Recommendation

Alternative 2 is not recommended because of the additional permitting processes with creating a new outfall. As discussed in Section 6.1, infiltration rates near Cody Lane are not ideal for drywells. Additionally, the DEQ MOA requires regular monitoring of the drywells, which involves sampling and laboratory testing costs. For these reasons and City staff preference to decommission the drywells, Alternative 3 is not recommended. Alternative 1 is recommended to maintain the current stormwater volumes and peak discharges into the Pudding River. The detention basin will limit the outfall discharge to the existing and pre-development conditions. Additional outfall permitting with Alternative 1 is not anticipated because the improvements maintain peak outfall flows and do not extend to the outfall structure. Detention facility predesign should include consideration of the Main Street improvements and associated flows discussed in the section above.

FIGURE 7-5: CODY LANE AND PARK AVENUE ALTERNATIVES



7.6 HIGHWAY 99 ACROSS OTTAWAY ROAD: PA-9

Stormwater is discharged along the highway to a ditch with no outlet, which floods nearby residential areas. The two alternatives are shown in Figure 7-6.

Alternative 1

Extend the existing 12-inch pipe where it discharges with a 21-inch pipe and install an area drain at the low point to drain existing ponding. Install a new 21-inch pipe crossing Highway 99 to a new 30-inch pipe draining north along the west side of Highway 99 and connect to the existing manhole and 18-inch pipe. The City has an existing easement on the west side of the highway along this portion. Upsize the existing 18-inch pipe leading to the outfall to 30-inches. Remove the existing, collapsed 18-inch pipe and install a new 21-inch pipe to connect to the new 30-inch pipe along Highway 99. Upsize the existing 12-inch culvert crossing to 18-inches.

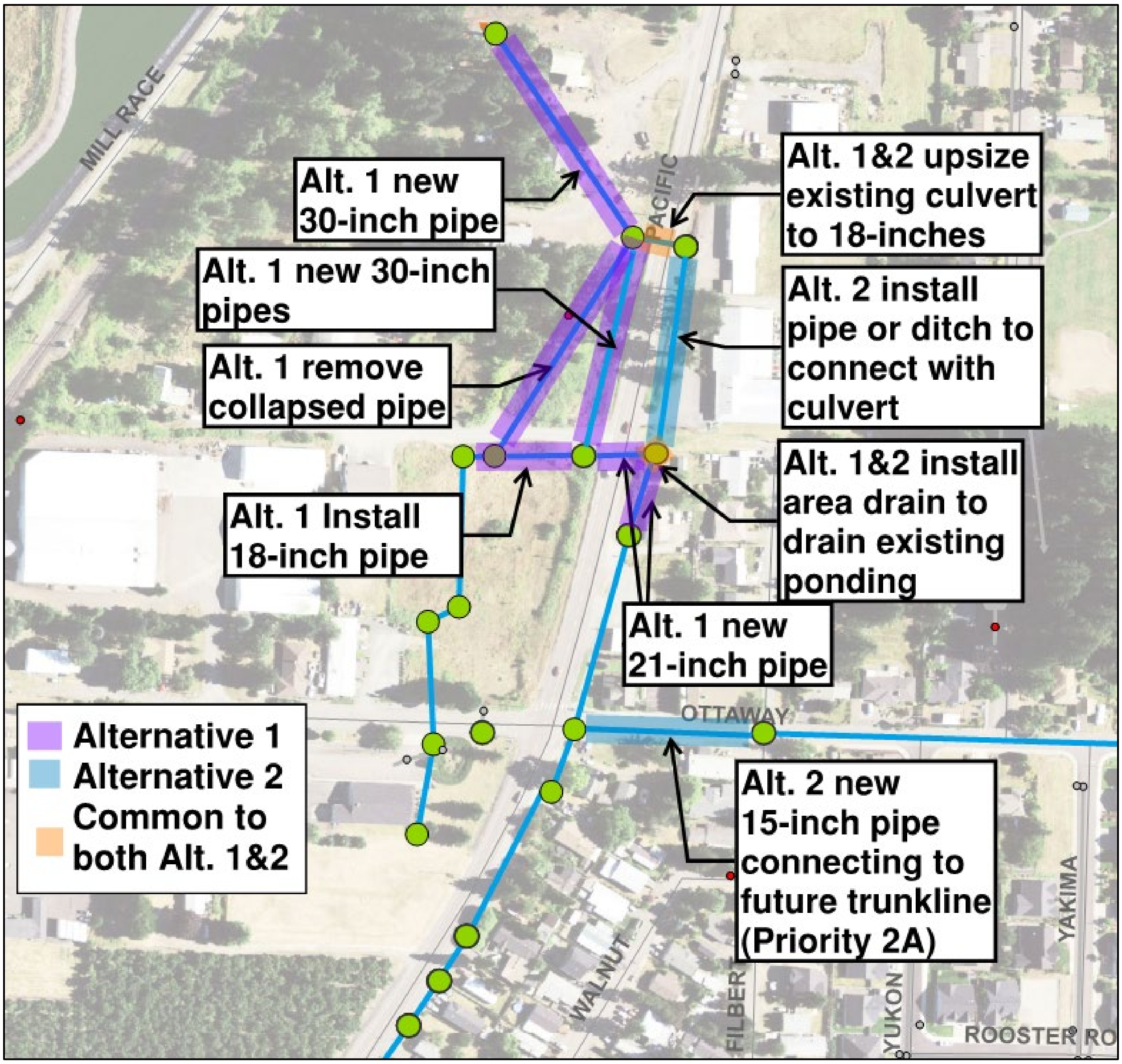
Alternative 2

Install a 15-inch pipe from the intersection of Ottaway Road and Highway 99 and connect to the proposed trunkline along Ottaway Road. Install an area drain at the low point along Highway 99 and install an 18-inch pipe or improved ditch section along Highway 99 to connect to the existing culvert between Bobs Avenue and Ottaway Road. Upsize the existing culvert to 18-inches and connect to the existing 18-inch pipe draining to the northwest. This alternative requires the Ottaway Road pipeline extension as described in Priority 2A (Section 8.1.2) be installed before these improvements could be completed.

Recommendation

Alternative 1 is recommended because the flooding along Highway 99 is a higher priority than the installation of the trunkline extension along Ottaway Road (Section 8.1.2, Priority 2B), which is required to complete Alternative 2. The City has had initial discussions on a potential development on the west side of Highway 99, north of Ottaway Road. It is recommended that stormwater improvements for the area be assessed holistically to evaluate beneficial options for both the City and potential development.

FIGURE 7-6: HIGHWAY 99 ACROSS OTTAWAY ROAD ALTERNATIVES



7.7 WALNUT STREET AND FILBERT STREET: PA-5A

There is also localized ponding along Walnut Street and Filbert Street due to the lack of stormwater infrastructure. Alternatives 1 and 2 are illustrated in Figure 7-7.

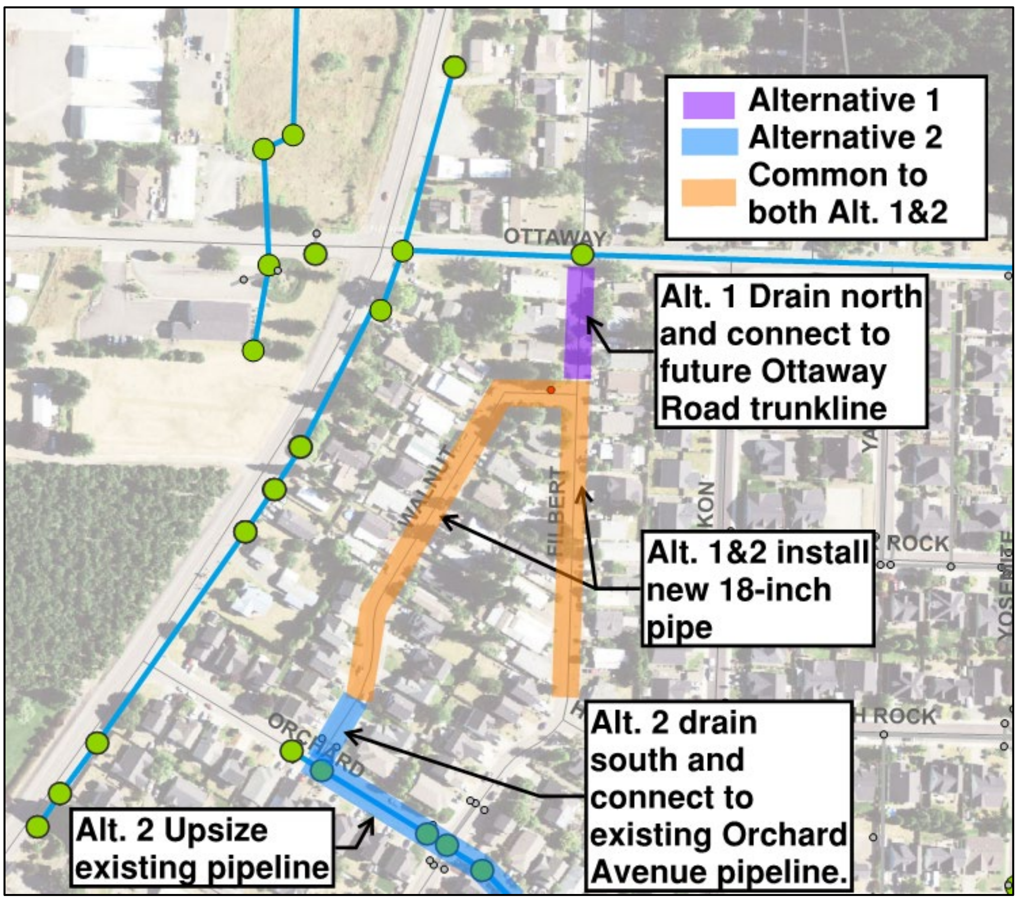
Alternative 1

Install an 18-inch pipe draining north along Walnut Street from Orchard Avenue to Filbert Street and connect to the proposed trunkline along Ottaway Road.

Alternative 2

Install piping along Walnut Street draining south and connect to the existing pipe network along Orchard Avenue. The 12-inch pipes along Orchard Avenue will be upsized to 18-inches through to Yukon Street.

FIGURE 7-7: FILBERT AND WALNUT STREET (PA-5A) ALTERNATIVES



Recommendation

Alternative 1 is recommended because of the large amount of pipe along Orchard Avenue that requires upsizing in Alternative 2. Note, Alternative 1 must be installed after the completion of the Ottaway Road Improvements (Section 8.1.2, Priority 2A).

SECTION 8 - CAPITAL IMPROVEMENT PLAN

This section summarizes recommended capital improvements with associated planning level cost estimates. Recommended improvements are illustrated in Figure 8A and 8B in Appendix A, and the details on each improvement are presented in Appendix F. This section also summarizes annual operation and maintenance for the proposed alternatives.

8.1 CAPITAL IMPROVEMENT PLAN (CIP)

The capital improvement plan (CIP) consists of improvements necessary to alleviate identified flooding and surcharging in the 25-year storm event. The projects identified in this evaluation were prioritized by their urgency to mitigate the identified deficiencies. Table 8-1 summarizes the criteria used to prioritize projects in this study.

TABLE 8-1: CIP PRIORITIZATION CRITERIA

Priority	Criteria
1	Alleviate historically known flooding issues identified by the City.
2	Alleviate additional 2-year flooding areas identified in the model.
3	Alleviate deficiencies identified in 10-year and 25-year storm events.

8.1.1 PRIORITY 1 IMPROVEMENTS

Priority 1 improvements consist of areas where both the City and the model have identified flooding in storm events with a lower recurrence interval (e.g., 2-year storm event). Priority 1 improvements also include projects to install stormwater infrastructure where there is localized ponding due to lack of stormwater infrastructure.

1A – Main Street and 1st Street:

Upsize the existing 12-inch pipe to 18-inches. Replace an 8-inch diameter bottleneck with a 12-inch pipe and install to it match the existing manhole inverts. Flooding in this section of the stormwater system is expected to first occur during a 10-year storm event. However, this project is downstream of Priority 1B and must be completed before Priority 1B can be completed to prevent additional flooding.

1B – 3rd Street and Main Street:

Install a 12-inch pipe from the existing catch basin on the northeast corner of 3rd and Main Streets to the existing manhole on the pedestrian island between Main Street and Highway 99. This project must be completed in conjunction with or after Priority 1A.

1C – Orchard Detention Pond Improvements:

Install 12-inch pipe through the existing detention pond and connect directly to the outfall structure. Fill in the Orchard Detention Pond.

1D – Highway 99 North of Ottaway Road:

Extend the existing 12-inch pipe where it discharges with a 21-inch pipe and install an area drain at the low point to drain existing ponding. Install a new 21-inch pipe crossing Highway 99 to a new 30-inch pipe draining north along the west side of Highway 99 and connect to the existing manhole and 18-inch pipe. The City has an existing easement on the west side of the highway along this portion. Upsize the existing 18-inch pipe leading to the outfall to 30-inches. Remove the existing, collapsed 18-inch pipe and install a new 21-inch pipe to connect to the new 30-inch pipe along Highway 99. Upsize the existing 12-inch culvert crossing to 18-inches.

1E – 2nd Street (Church Parking Lot):

Upsize existing 8-inch pipes to 12-inch pipes and install a curb inlet catch basin at the low point in the parking lot.

1F – Liberty Street and Sayre Drive:

Install stormwater trunklines along Sayer Drive and Liberty Street to alleviate historical localized flooding. Curb and gutter will be installed to route stormwater to curb inlets to the trunklines. Includes upsizing the existing pipes which drain to the outfall on 4th Street to 21-inches.

1G – Filbert Street and Walnut Street:

Install an 18-inch trunkline along Walnut Street from north of Orchard Avenue to the new trunkline along Ottaway Road. Install curb and gutter on both sides of Walnut Street and on Filbert Street between Walnut Street and Ottaway Street for stormwater collection. This project could be combined with Priority 2A and could provide cost savings. This should be evaluated at the time Priority 2A moves to the design phase.

8.1.2 PRIORITY 2 IMPROVEMENTS

Priority 2 improvements include areas with deficiencies identified in the model during the 2-year storm event.

2A – Park Avenue and Cody Lane:

Install a 12-inch pipe draining east along Park Avenue to Cody Lane. At the intersection of Cody Lane and Park Avenue, install a 24-inch pipe draining south along Cody Lane, across Ottaway Road to a new regional detention pond. Re-grade the existing 36-inch pipes along Ottaway Road to drain the detention pond to the existing outfall.

2B – Ottaway Road:

Install an 18-inch trunkline along Ottaway Road from Highway 99, draining east to the existing 36-inch trunkline on Ottaway Road near Jenny Marie Lane. Install curb and gutter on the north side of Ottaway Road and curb inlet catch basins to collect stormwater. The swale at the end of Ottaway Road, which drains to the Pudding River, should be evaluated for water quality before these improvements are completed.

2C – Main Street North of Ottaway Road:

Install catch basins along the east side of Main Street to drain to the trunkline on the west side of Main Street. Replace the existing infiltration manhole with a new manhole and install a new 21-inch pipe from the new manhole to the new trunkline along Ottaway Road. The regional detention pond in Priority 2C would maintain the Ottaway Road peak outfall flows with these improvements.

2D – Airport Road Improvements:

Upsize existing pipes and culverts along Airport Road and under Ehlen Road to increase capacity and alleviate flooding across Airport Road.

2E – Filbert Street North of Ottaway Road:

Install stormwater infrastructure along Filbert Street, north of Ottaway Road. Infrastructure to drain north, then, west and connect to the improvements from Priority 1D along Highway 99.

2F – Martin Street to Main Street:

Install stormwater trunklines along Martin Street and the railroad ditch and connect to the existing manhole on Main Street.

8.1.3 PRIORITY 3 IMPROVEMENTS

Priority 3 improvements include deficiencies observed in the model during the 10-year and/or 25-year storm event.

3A – Highway 99 North of 2nd Street:

Upsize existing 12-inch pipes to 15-inch to increase capacity and alleviate flooding and surcharging in the design storm event.

3B – Albers Way:

Upsize the existing 8-inch pipe network to 12-inches to increase capacity.

3C – 3rd Street Outfall:

Upsize the existing 6-inch pipe network to 12-inches to increase capacity.

8.2 IMPROVEMENTS SUMMARY

Capital costs developed for the recommended improvements are planning-level estimates and can vary depending on market conditions. Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate when a project is bid. The range of accuracy for planning level cost estimates is broad, but these are typical accuracy levels for planning work. As a result, the final project costs will vary from the estimated presented in this document. Estimated costs shall be updated as the project is further refined in the project development, pre-design, and design phases.

The costs are based on experience with similar recent stormwater upgrade projects. The total estimated probable project costs include contractor markups and 30% contingencies, which is typical of a planning-level estimate. Overall project costs include total construction costs, costs for engineering design, construction management services, inspection, and administrative costs. Improvements within County or ODOT ROW are assumed to be design and constructed to the respective agency's standards.

A summary of the recommended improvements and associated capital costs are organized by priority in Table 8-2. Planning level cost estimates were developed using 2021 dollars. A detailed summary sheet for each improvement is provided in Appendix C.

TABLE 8-2: CAPITAL IMPROVEMENT PLAN (CIP)

Project Identifier	Project Name	Estimated Cost (Rounded)
1A	Main Street and 1st Street	$405,000
1B	3rd Street and Main Street	$42,000
1C	Orchard Detention Pond Improvements	$45,000
1D	Highway 99 North of Ottaway Road	$533,000
1E	2nd Street (Church Parking Lot)	$90,000
1F	Liberty Street and Sayre Drive	$1,437,000
1G	Filbert Street and Walnut Street	$603,000
	Total Priority 1 Improvements (rounded):	**$3,155,000**
2A	Park Avenue and Cody Lane	$1,509,000
2B	Ottaway Road	$726,000
2C	Main Street North of Ottaway Road	$154,000
2D	Airport Road Ditch	$317,000
2E	Filbert Street North of Ottaway Road	$192,000
2F	Martin Street to 2nd Street	$290,000
	Total Priority 2 Improvements (rounded):	**$3,188,000**
3A	Highway 99 North of 2nd Street	$339,000
3B	Albers Way	$131,000
3C	3rd Street Outfall	$136,000
	Total Priority 3 Improvements (rounded):	**$606,000**
	Total Stormwater System Improvements:	**$6,949,000**

The cost estimate herein is concept level information only based on our perception of current conditions at the project location and its accuracy is subject to significant variation depending upon project definition and other factors. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. This cost opinion is in 2021 dollars and does not include escalation of time of actual construction. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices, or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented herein.

8.3 OPERATIONS AND MAINTENANCE

The annual operations and maintenance costs may increase with the addition of pipelines and additional catch basins. The improvements included in the CIP add a total of 8,400 LF of new pipeline, two new sedimentation manholes, and 54 new catch basins or catch manholes. Existing drywells are recommended to be cleaned annually, and one of the ten drywells in the Strawberry Meadows development is required to be sampled annually. Assuming a closed circuit-television (CCTV) and cleaning cycle of five years, the total additional operations and maintenance costs are summarized below in Table 8-3.

TABLE 8-3: ADDITIONAL ANNUAL OPERATIONS AND MAINTENANCE COSTS

Item	Unit Cost	Unit	Annual Quantity[1]	Annual Cost
Cleaning and CCTV of Storm Pipe	$3	LF	1,700	$5,100
Cleaning of Catch Basins	$60	EA	10	$600
Cleaning of Drywells[2]	$1,250	EA	12	$15,000
Drywell Monitoring[3]	$1,000	EA	1	$1,000
			Total Annual Cost	**$21,700**

1) Assumes 5-year annual cleaning cycle.

2) Assumes annual cleaning of all drywells.

3) MAO requires annual sampling of one of the ten drywells in Strawberry Meadows.

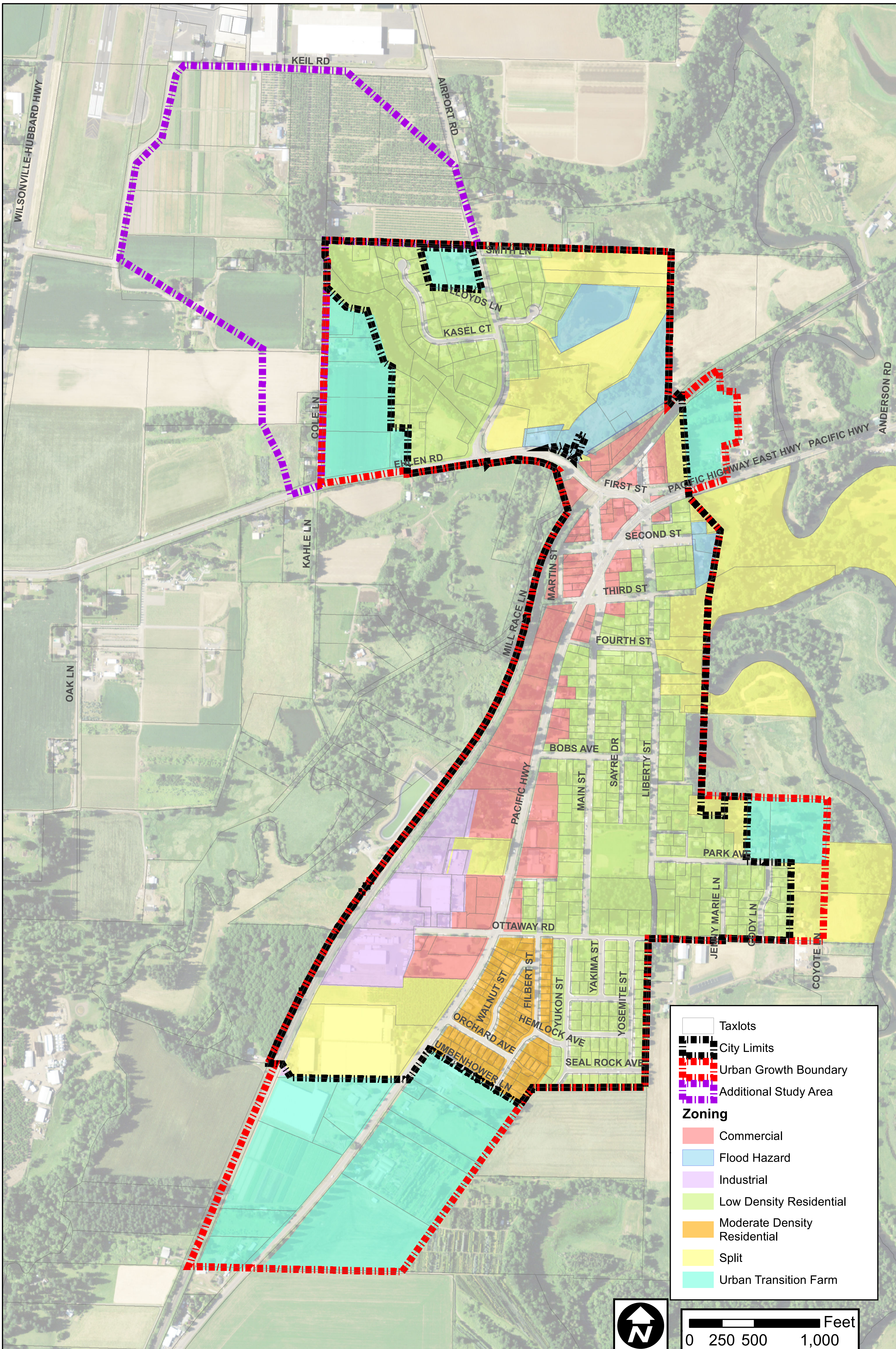
8.4 SYSTEM DEVELOPMENT CHARGES AND FUNDING

The scope of this evaluation did not include evaluating the City's current system development charges (SDC). It is recommended that the City complete an SDC study to evaluate potential SDC impacts of the recommended capital improvement plan (CIP) and identify potential funding sources to offset impacts. As the City begins to prepare and proceed on CIP projects, it is recommended they set up a one-stop meeting with Business Oregon to identify and assess potential funding sources for the stormwater projects.

Appendix A

Figures

KELLER ASSOCIATES



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 1 - Study Area and Zoning.mxd

KELLER ASSOCIATES

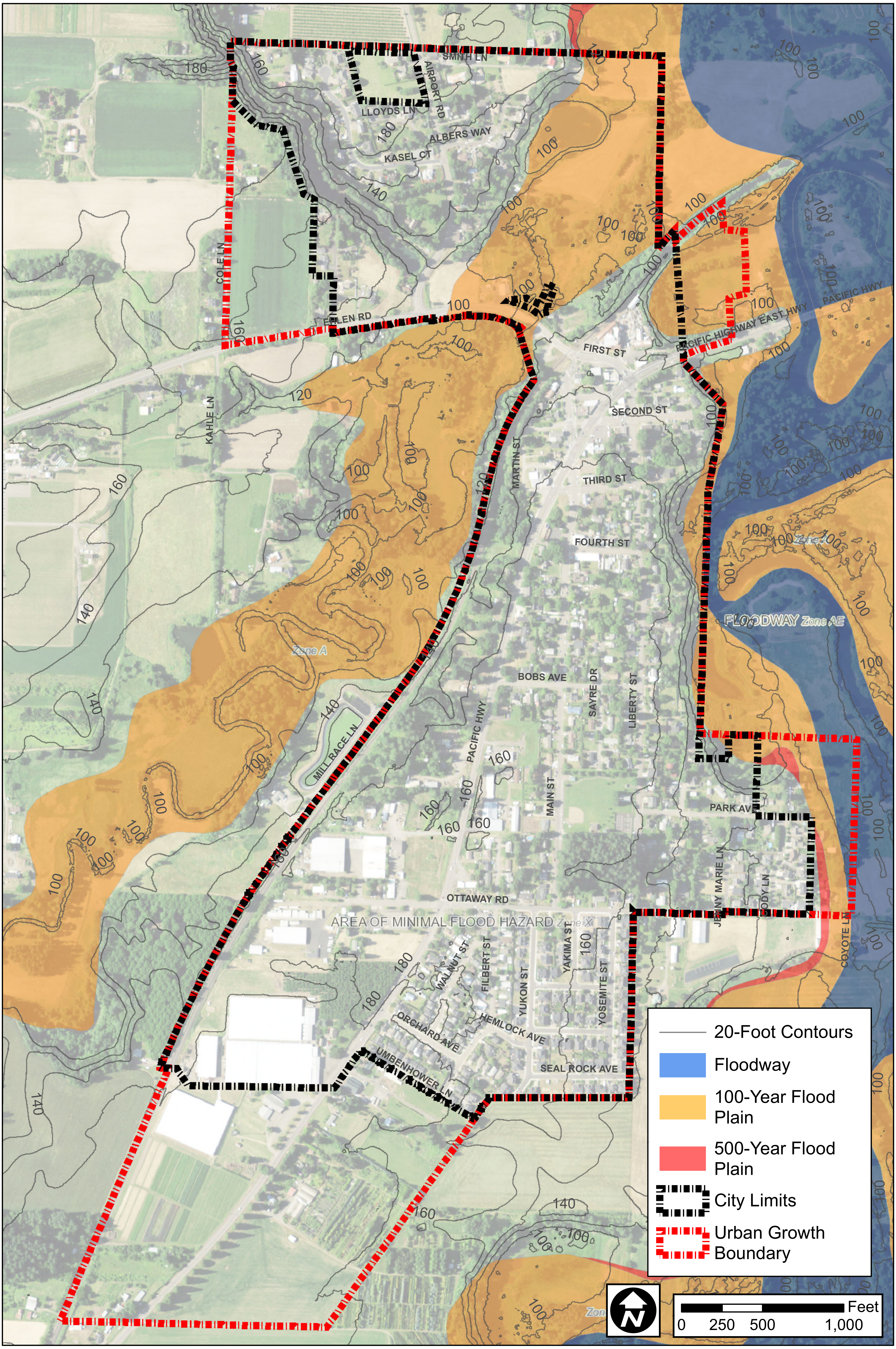
Study Area and Zoning

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 1

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 2 - Floodplains and Topography.mxd

KELLER ASSOCIATES

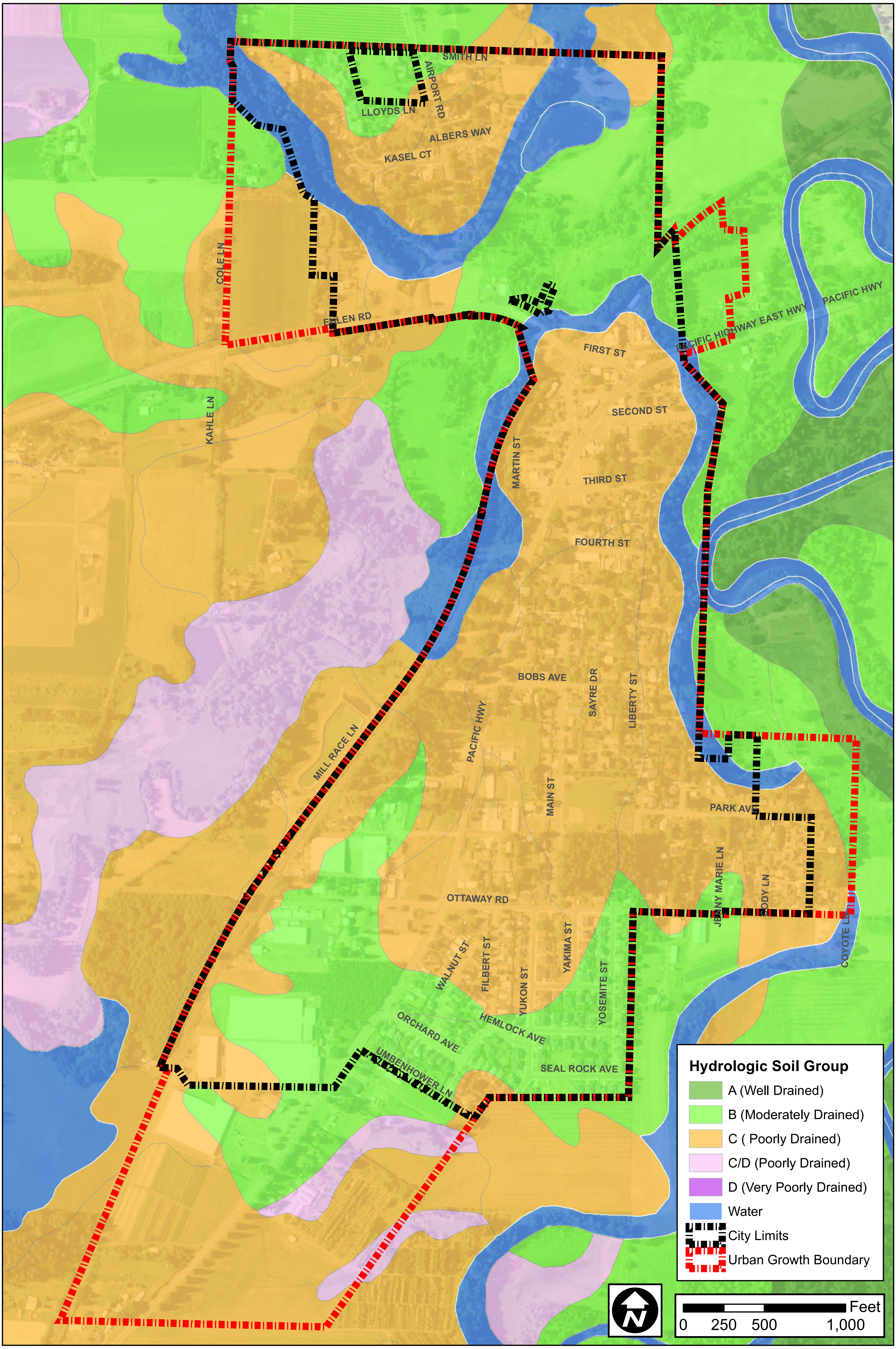
Floodplain and Topography

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 2

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 3 - Hydrologic Soil Groups.mxd

KELLER ASSOCIATES

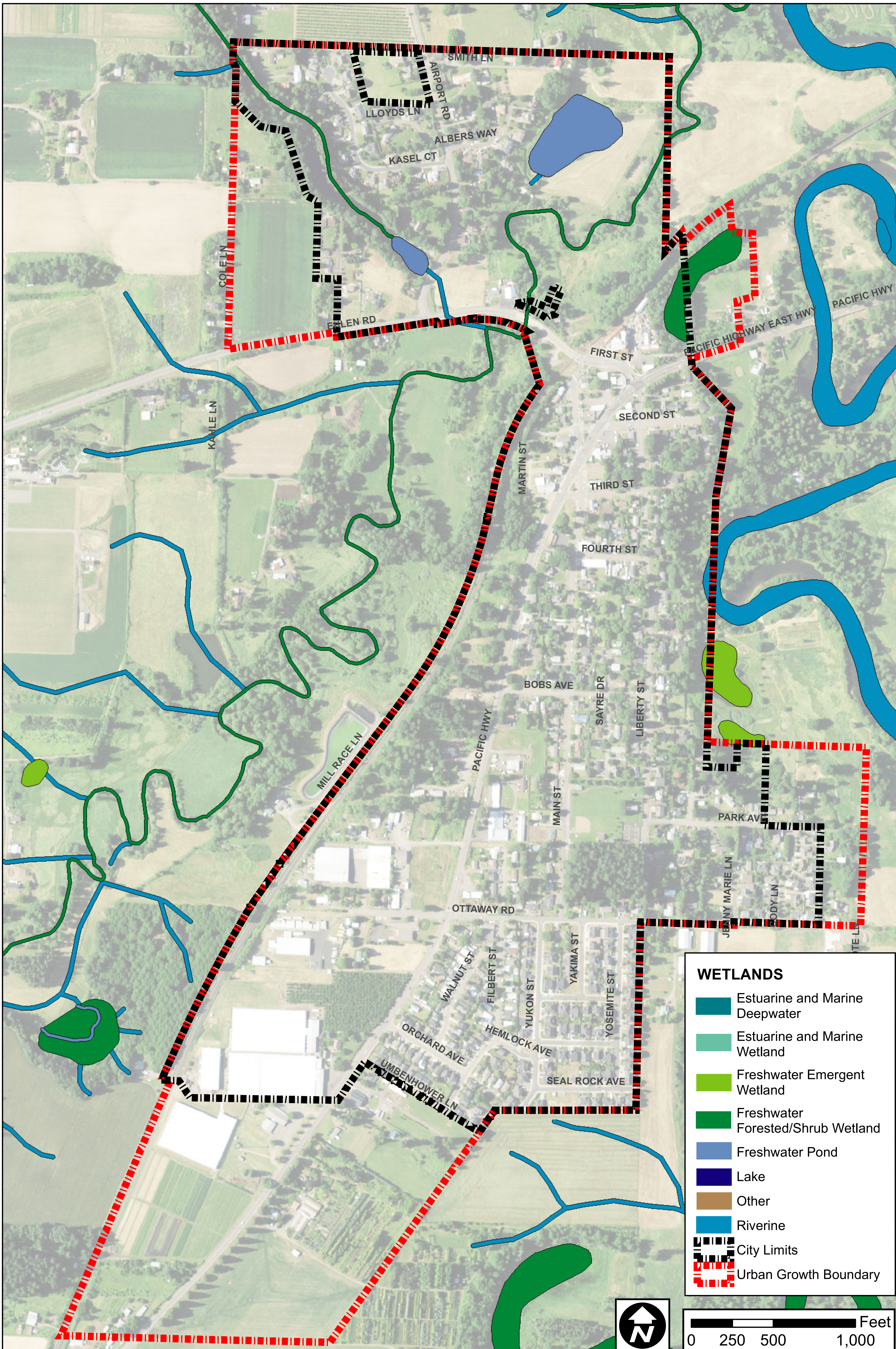
Hydrologic Soil Groups

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 3

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 4 - Wetlands and Waterways.mxd

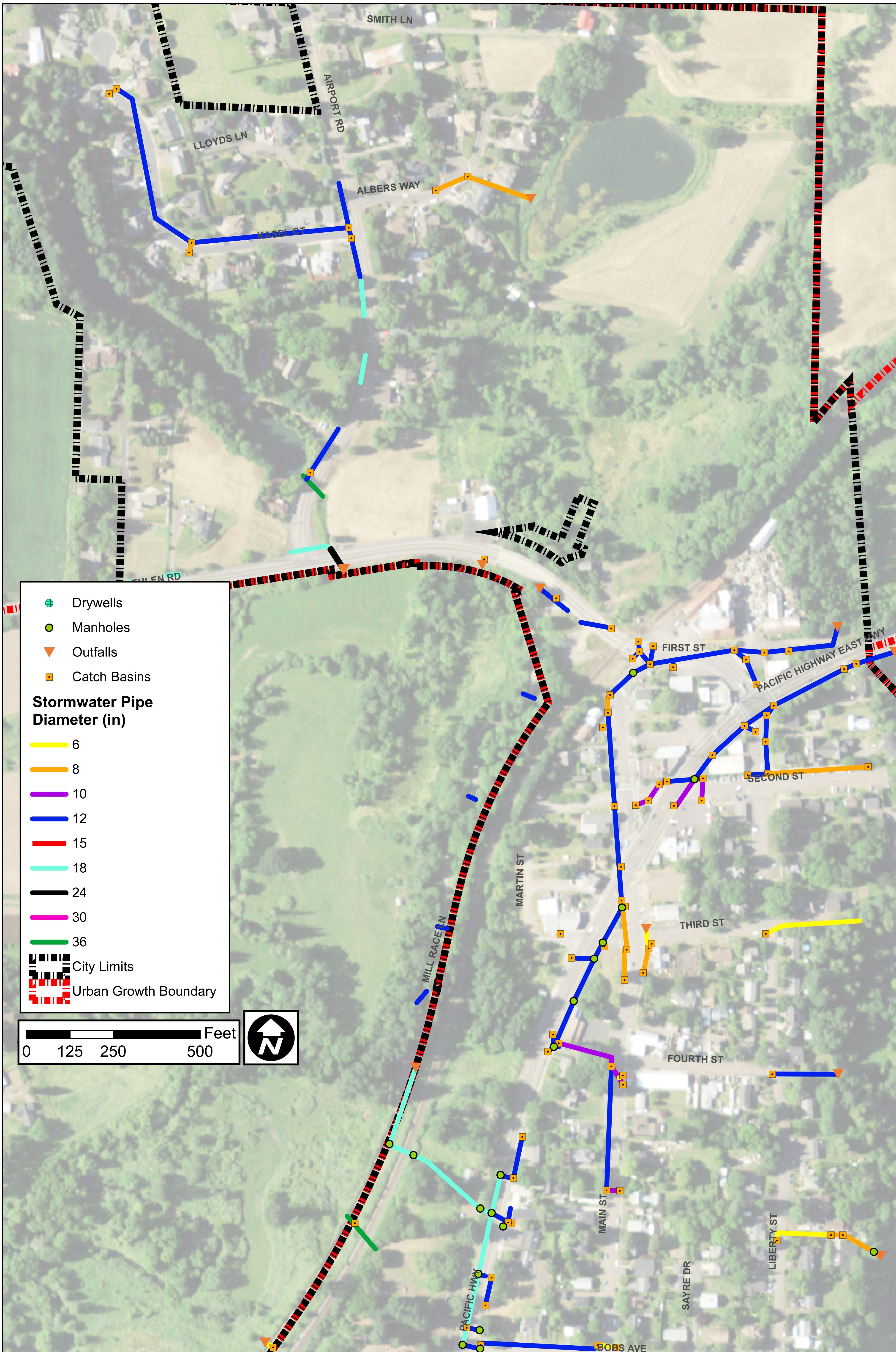
KELLER ASSOCIATES

Wetlands and Waterways

Storm Water Master Plan

Figure 4

City of Aurora, OR



KELLER ASSOCIATES

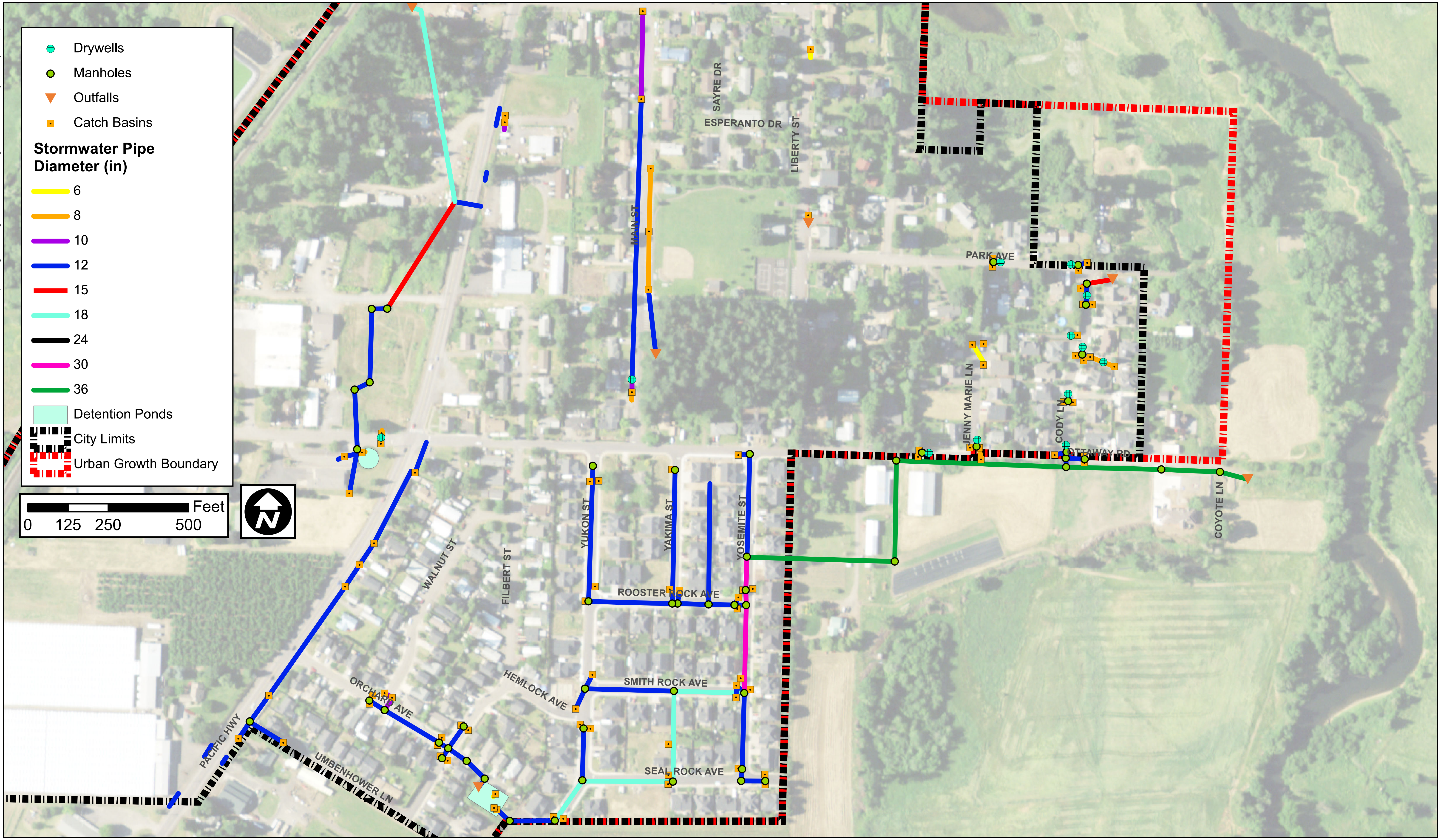
Existing Stormwater System (North)

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 5A

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 5B - Existing Stormwater System (South).mxd

KELLER ASSOCIATES

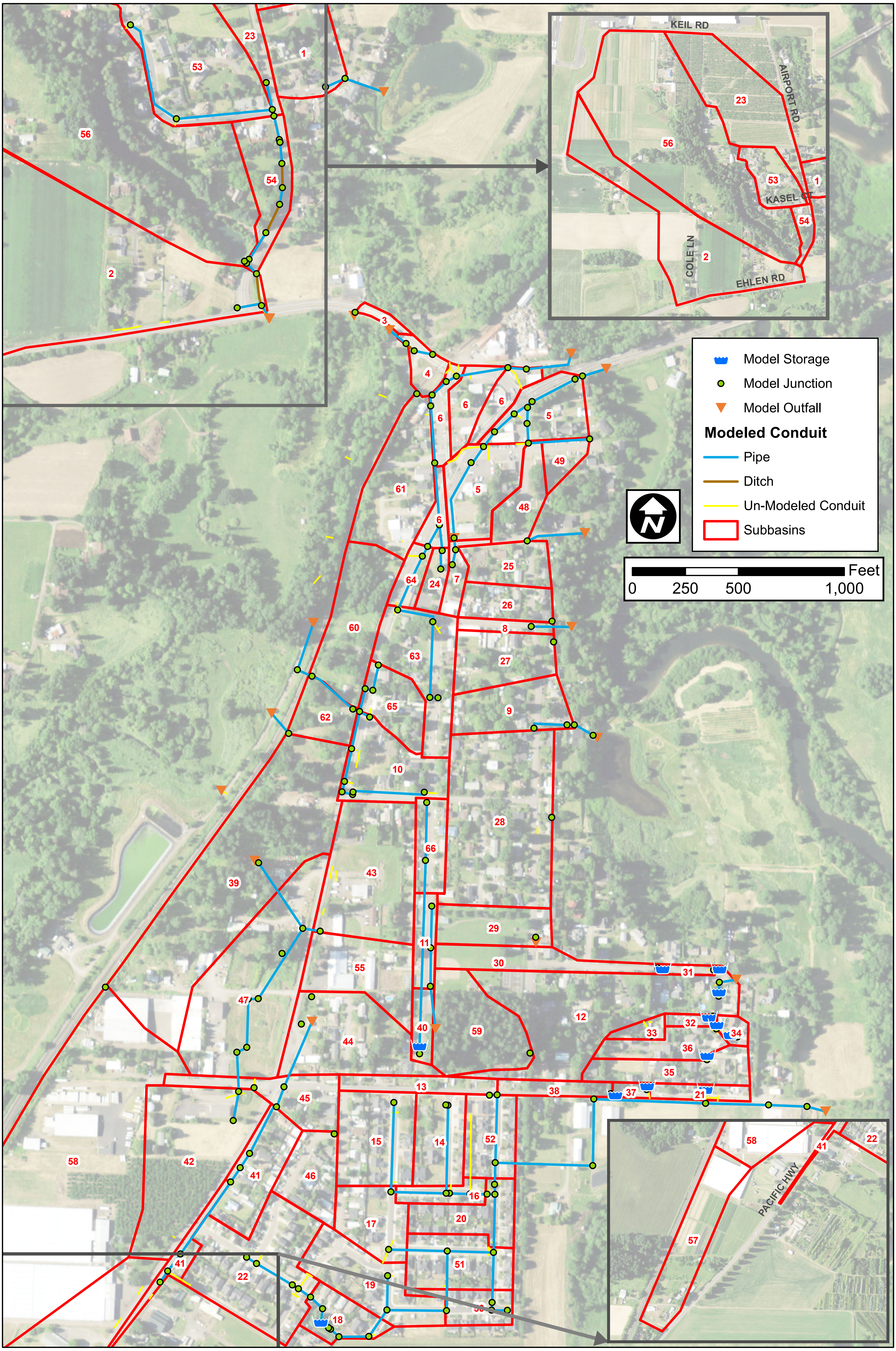
Existing Stormwater System (South)

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 5B

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 6 - Modeled System.mxd

KELLER ASSOCIATES

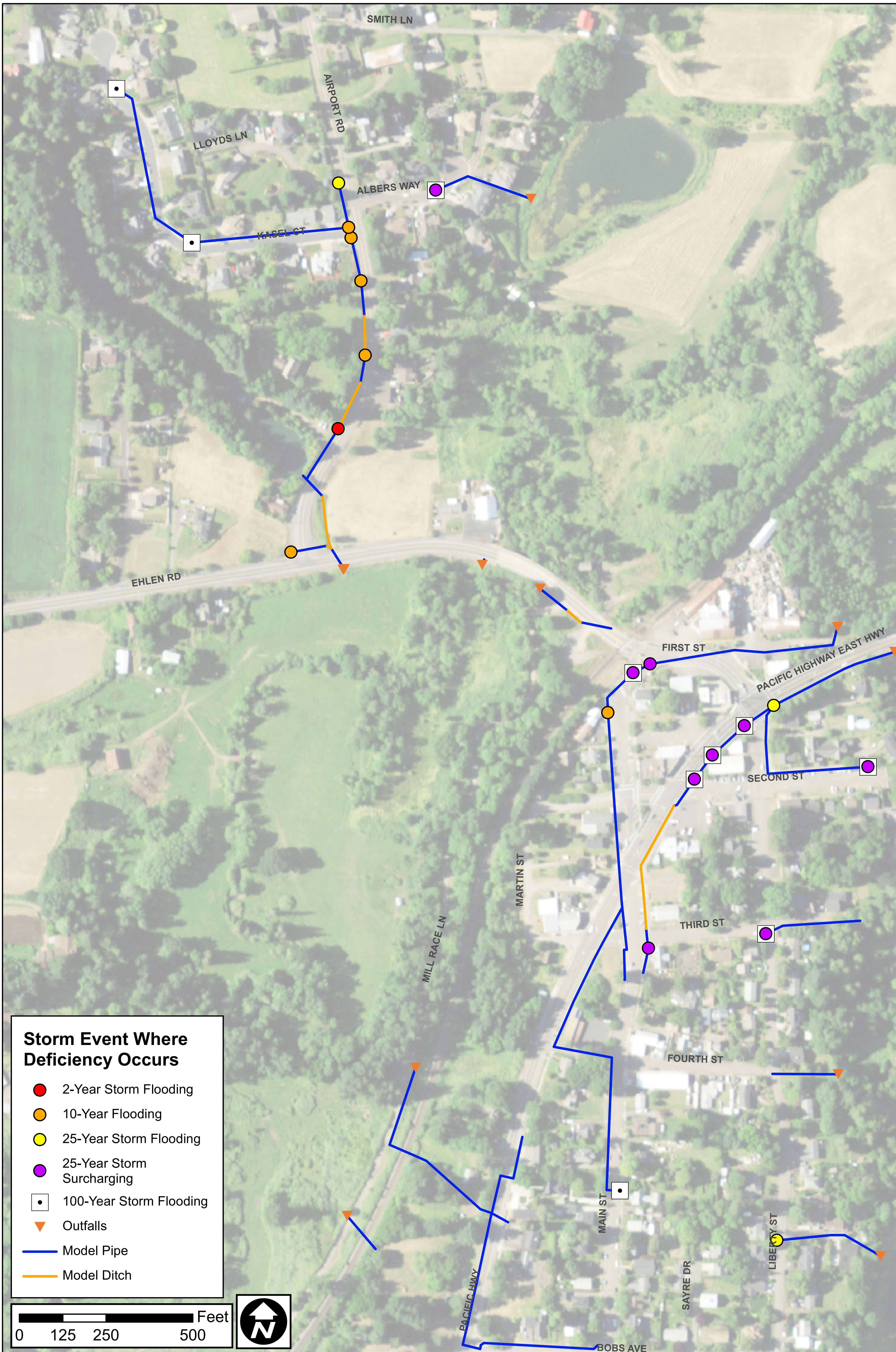
Modeled System

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 6

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 7A - Existing Conditions (North).mxd

KELLER ASSOCIATES

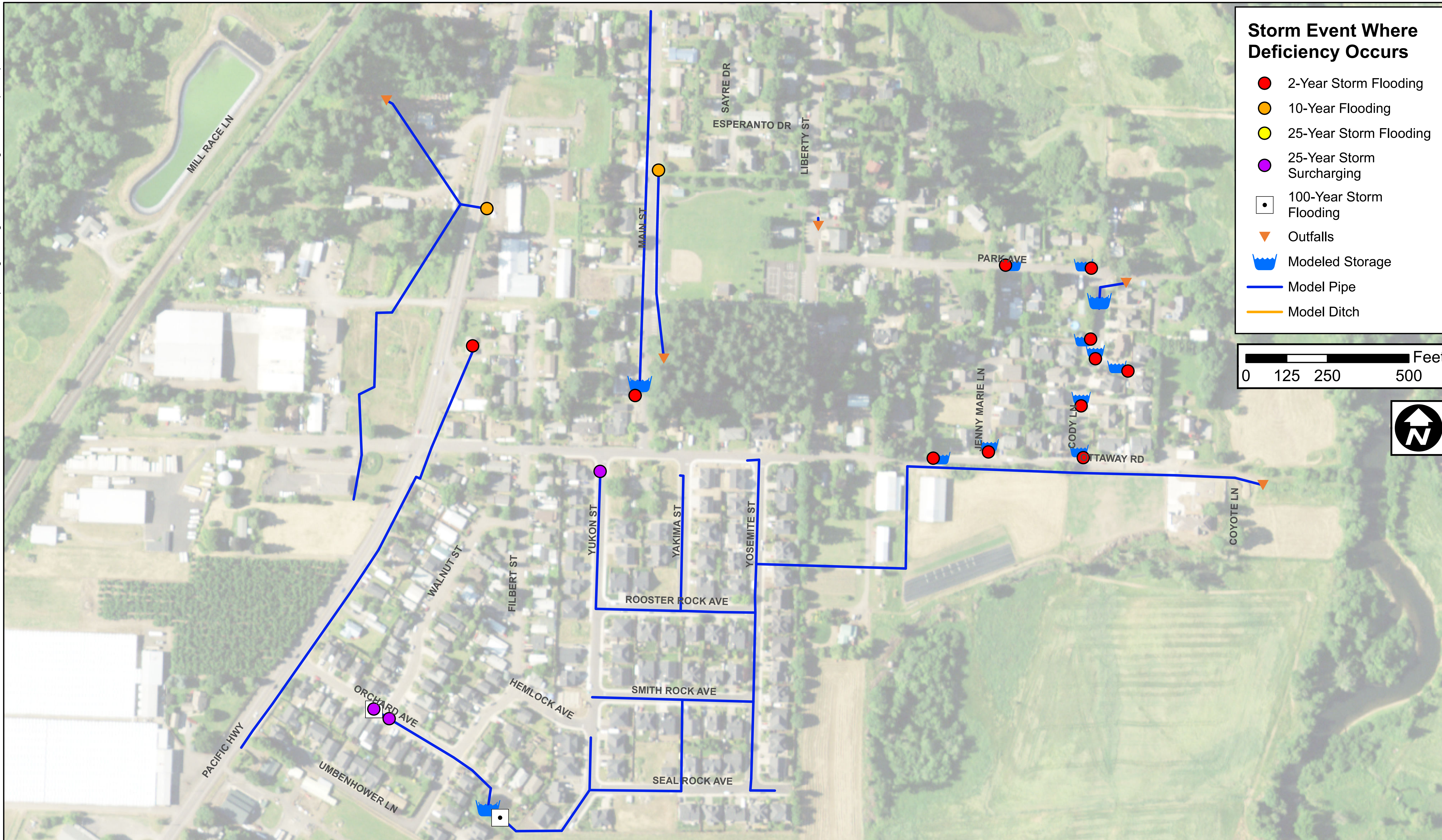
Existing Conditions (North)

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 7A

City of Aurora, OR



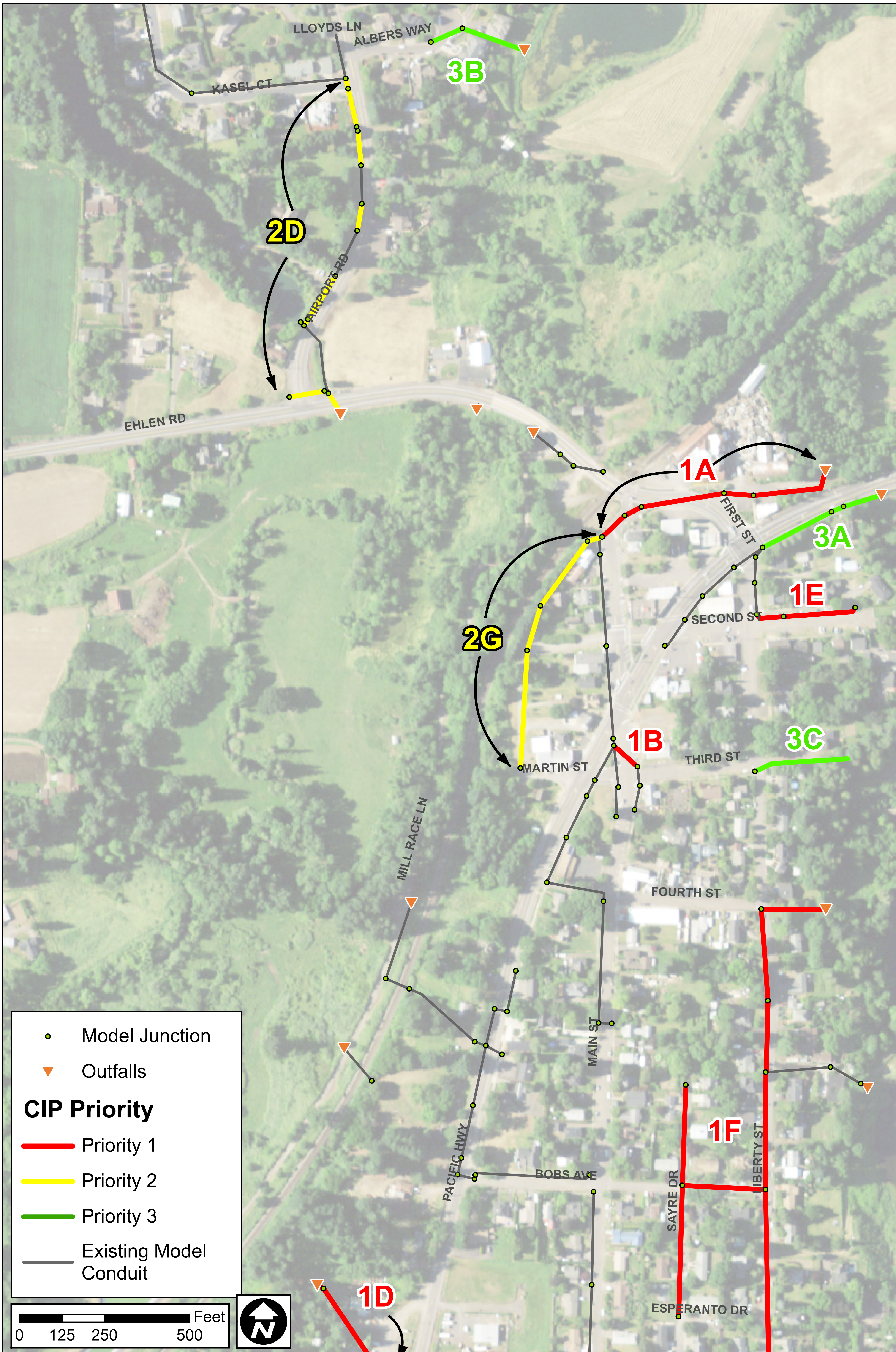
KELLER ASSOCIATES

Existing Conditions (South)

Storm Water Master Plan

Figure 7B

City of Aurora, OR



Document Path: C:\Users\tbuster\KELLER ASSOCIATES, INC\215120-003 Aurora SWMP - Documents\General\zGIS\MXD\Report Figures\Figure 8A - CIP Projects (North).mxd

KELLER ASSOCIATES

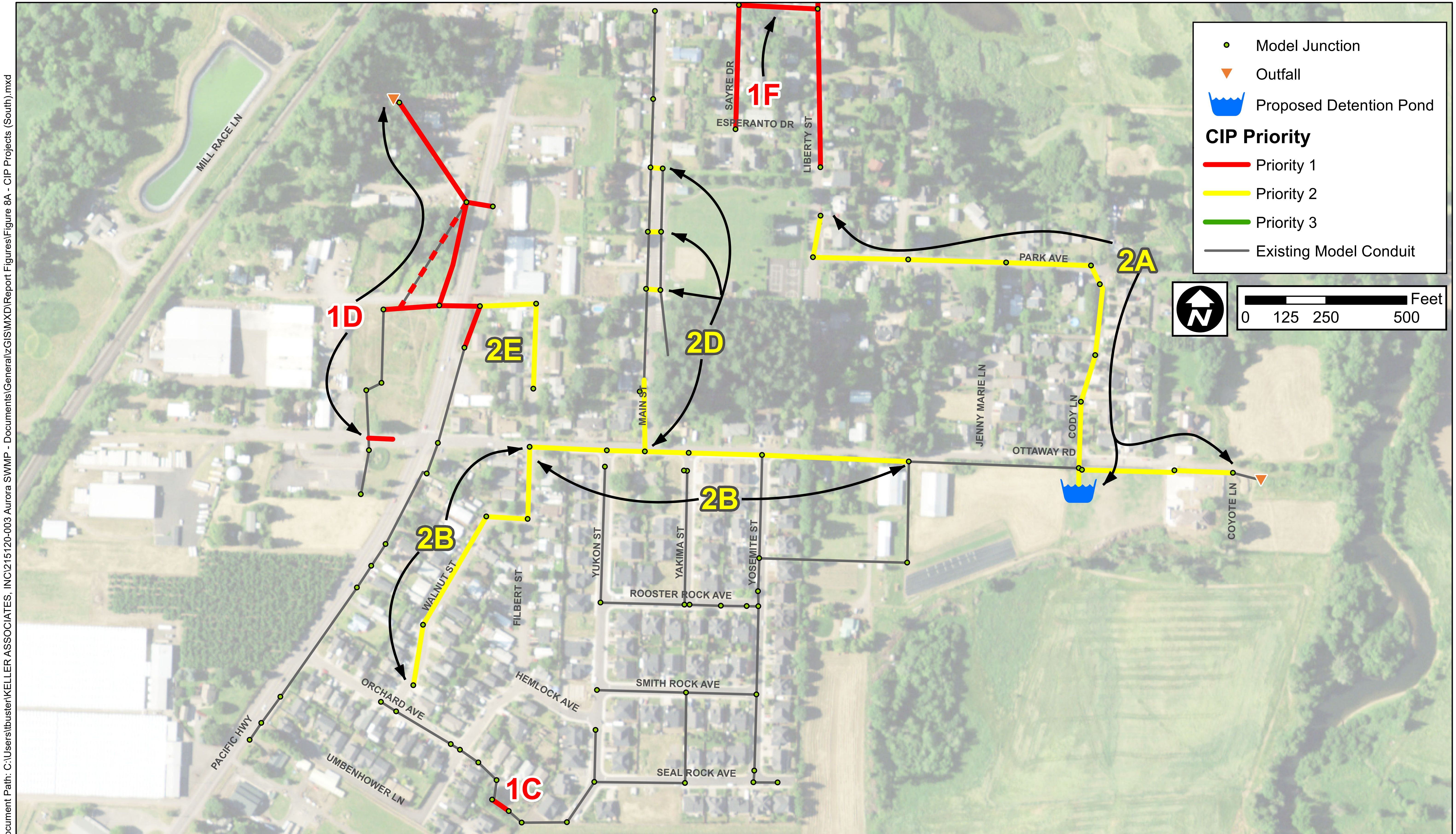
Capital Improvement Plan (North)

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 8A

City of Aurora, OR



KELLER ASSOCIATES

Capital Improvement Plan (South)

Storm Water Master Plan

CITY OF AURORA HISTORIC DISTRICT 1856

Figure 8B

City of Aurora, OR

Appendix B

Detailed Alternatives
Opinion of Probable Cost

KELLER ASSOCIATES

Client: City of Aurora
Project: Stormwater Master Plan
Project No.: 215120-003

Airport Road - Alternative Cost Estimates

Airport Road - Alternative 1				
General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	770	$142,450
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	4	$30,800
Re-connect catch basin	EA	$500	1	$500
24-inch Pipe - Excavation, Backfill Culvert	LF	$205	105	$21,525
30-inch Pipe - Excavation, Backfill Culvert	LF	$230	70	$16,100
Local Road Full Lane Asphalt Repair	LF	$60	190	$11,400
Soil Surface Repair	LF	$5	685	$3,425
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - With Flagging	LF	$8	875	$7,000
Outfall Permitting	EA	$20,000	1	$20,000
			Construction Subtotal (rounded)	$257,000
Mobilization	%	5	-	$12,850
Contingency	%	30	-	$77,100
Engineering and CMS	%	25	-	$64,250
			Total Project Cost (rounded)	$412,000

Airport Road - Alternative 2				
General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	145	$26,825
24-inch Pipe - Excavation, Backfill	LF	$205	182	$37,310
24-inch Pipe - Excavation, Backfill Culvert	LF	$205	285	$58,425
30-inch Pipe - Excavation, Backfill Culvert	LF	$230	70	$16,100
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	1	$7,700
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	2	$4,000
Re-connect catch basin	EA	$500	1	$500
Ditch Dredging/Cleanout	LF	$10	425	$4,250
Outfall Restoration	EA	$4,000	1	$4,000
Local Road Full Lane Asphalt Repair	LF	$60	190	$11,400
Soil Surface Repair	LF	$5	422	$2,110
Traffic Control - With Flagging	LF	$8	612	$4,896
Outfall Permitting	EA	$20,000	1	$20,000
			Construction Subtotal (rounded)	$198,000
Mobilization	%	5	-	$9,900
Contingency	%	30	-	$59,400
Engineering and CMS	%	25	-	$49,500
			Total Project Cost (rounded)	$317,000

Client: City of Aurora
Project: Stormwater Master Plan
Project No.: 215120-003

Main and First Street to Highway 99 - Alternative Cost Estimates

Main and First to Highway 99 - Alternative 1				
General Line Items	**Unit**	**Unit Price**	**Quantity**	**Cost**
18-inch Pipe - Excavation, Backfill	LF	$185	730	$135,050
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	6	$46,200
Re-connect catch basin	EA	$500	2	$1,000
Local Road Full Lane Asphalt Repair	LF	$60	600	$36,000
Soil Surface Repair	LF	$5	55	$275
Concrete Sidewalk (4-inch)	SF	$12	300	$3,600
Concrete Curbs, Curb and Gutter	LF	$50	75	$3,750
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - With Flagging	LF	$8	392	$3,136
Outfall Permitting	LS	$20,000	1	$20,000
Construction Subtotal (rounded)				**$253,000**
Mobilization	%	5	-	$12,700
Contingency	%	30	-	$75,900
Engineering and CMS	%	25	-	$63,300
Total Project Cost (rounded)				**$405,000**

Main and First to Highway 99 - Alternative 2				
General Line Items	**Unit**	**Unit Price**	**Quantity**	**Cost**
15-inch Pipe - Exvavation, Backfill	LF	$170	300	$51,000
Railroad Boring	LF	$900	90	$81,000
48-Inch, Standard Manhole	EA	$5,200	4	$20,800
Diversion Manhole	EA	$20,000	1	$20,000
Re-connect catch basin	EA	$500	1	$500
Local Road Asphalt Repair	LF	$225	300	$67,500
Soil Surface Repair	LF	$5	160	$800
Concrete Curbs, Curb and Gutter	LF	$35	75	$2,625
Outfall Restoration	EA	$4,000	1	$4,000
Outfall Pemitting	EA	$20,000	1	$20,000
Construction Subtotal (rounded)				**$268,000**
Mobilization	%	5	-	$13,400
Contingency	%	30	-	$80,400
Engineering and CMS	%	25	-	$67,000
Total Project Cost (rounded)				**$429,000**

Appendix C

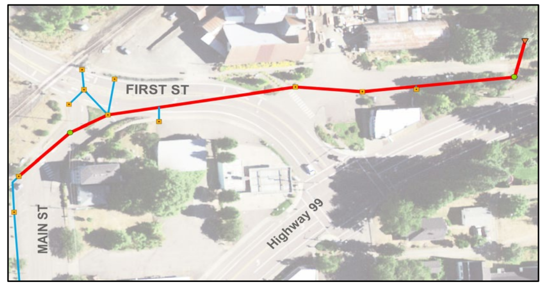
Detailed CIP
Opinion of Probable Cost

KELLER
ASSOCIATES

Project Title: Main Street and 1st Street Improvements

Project Priority: 1A

Objective: Increase the existing capacity in the trunkline draining Main Street to the outfall at the Pudding River to alleviate existing surcharging and flooding, and to provide capacity for upstream improvements.

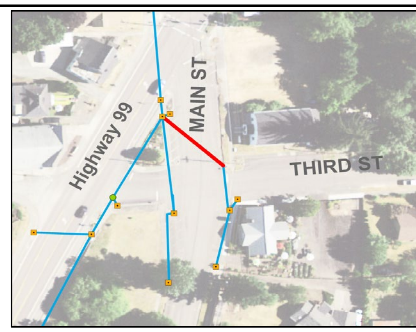


General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	730	$135,050
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	6	$46,200
Re-connect catch basin	EA	$500	2	$1,000
Local Road Full Lane Asphalt Repair	LF	$60	600	$36,000
Soil Surface Repair	LF	$5	55	$275
Concrete Sidewalk (4-inch)	SF	$12	300	$3,600
Concrete Curbs, Curb and Gutter	LF	$50	75	$3,750
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - With Flagging	LF	$8	392	$3,136
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	$253,000
Mobilization	%	5	-	$12,700
Contingency	%	30	-	$75,900
Engineering and CMS	%	25	-	$63,300
			Total Project Cost (rounded)	$405,000

Project Title: 3rd Street and Main Street Improvements

Project Priority: 1B

Objective: Resolve existing catch basin overflow and overland flow by installing a new 12-inch pipe across Main Street to an existing manhole.

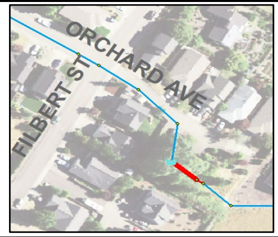


General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	100	$16,000
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	1	$2,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
Local Road Full Lane Asphalt Repair	LF	$60	100	$6,000
Traffic Control - Without Flagging	LF	$4	100	$400
			Construction Subtotal (rounded)	$26,000
Mobilization	%	5	-	$1,300
Contingency	%	30	-	$7,800
Engineering and CMS	%	25	-	$6,500
			Total Project Cost (rounded)	$42,000

Project Title: Orchard Detention Pond Improvements

Project Priority: 1C

Objective: Replace the existing detention pond with stormwater piping.

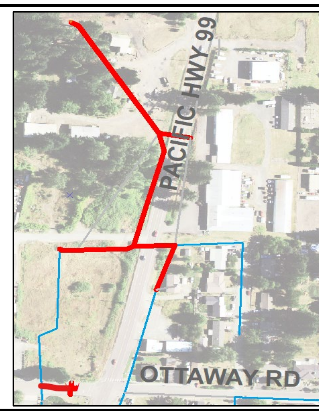


General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	65	$10,400
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
			Construction Subtotal (rounded)	$28,000
Mobilization	%	5	-	$1,400
Contingency	%	30	-	$8,400
Engineering and CMS	%	25	-	$7,000
			Total Project Cost (rounded)	$45,000

Project Title: Highway 99 North of Ottaway Road Improvements

Project Priority: 1D

Objective: Install stormwater piping from the existing outlet and drain to the west under Highway 99. Potential for alignment to be in shoulder or drive lane of Highway 99. Upsize existing culvert connecting to the existing trunkline on the west side of Highway 99. Upsize the existing 18-inch pipe draining to the outfall.



General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	75	$12,000
18-inch Pipe - Excavation, Backfill	LF	$185	195	$36,075
Highway Boring (<21-inch pipe)	LF	$900	185	$166,500
21-inch Pipe - Excavation, Backfill	LF	$195	140	$27,300
30-inch Pipe - Excavation, Backfill	LF	$230	735	$169,050
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
60-Inch, Standard Manhole	EA	$14,000	7	$98,000
Gravel Surface Repair	LF	$10	540	$5,400
Soil Surface Repair	LF	$5	530	$2,650
Local Road Full Lane Asphalt Repair	LF	$60	75	$4,500
Traffic Control - Without Flagging	LF	$4	400	$1,600
			Construction Subtotal (rounded)	$333,000
Mobilization	%	5	-	$16,700
Contingency	%	30	-	$99,900
Engineering and CMS	%	25	-	$83,300
			Total Project Cost (rounded)	$533,000

Project Title: 2nd Street (Church Parking Lot) Improvements

Project Priority: 1E

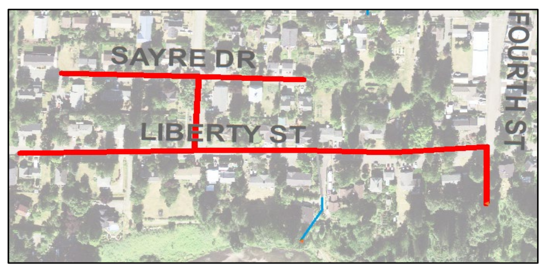
Objective: Drain ponding at low point by installing a catch basin and upsize existing pipe.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	290	$46,400
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	2	$4,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
Gravel Surface Repair	LF	$10	290	$2,900
Traffic Control - Without Flagging	LF	$4	290	$1,160
			Construction Subtotal (rounded)	**$56,000**
Mobilization	%	5	-	$2,800
Contingency	%	30	-	$16,800
Engineering and CMS	%	25	-	$14,000
			Total Project Cost (rounded)	**$90,000**

Project Title: Liberty Street and Sayre Drive Improvements

Project Priority: 1F

Objective: Install stormwater infrastructure along Sayre Drive and Liberty Street and drain to existing outfall to the Pudding River.



General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	925	$148,000
21-inch Pipe - Excavation, Backfill	LF	$195	490	$95,550
24-inch Pipe - Excavation, Backfill	LF	$205	1,020	$209,100
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
60-Inch, Standard Manhole	EA	$14,000	5	$70,000
Standard Catch Basin with Connector Pipe	EA	$3,500	14	$49,000
Concrete Curbs, Curb and Gutter	LF	$50	2,470	$123,500
Local Road Full Lane Asphalt Repair	LF	$60	2,415	$144,900
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - Without Flagging	LF	$4	2,415	$9,660
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	**$898,000**
Mobilization	%	5	-	$44,900
Contingency	%	30	-	$269,400
Engineering and CMS	%	25	-	$224,500
			Total Project Cost (rounded)	**$1,437,000**

Project Title: Filbert Street and Walnut Street Improvements

Project Priority: 1G

Objective: Install stormwater piping and drainage structures along Filbert Street and Walnut Street to reduce ponding.

General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	935	$172,975
48-Inch, Standard Manhole	EA	$8,000	4	$32,000
Standard Catch Basin with Connector Pipe	EA	$3,500	12	$42,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
Concrete Curbs, Curb and Gutter	LF	$50	1,360	$68,000
Local Road Full Lane Asphalt Repair	LF	$60	935	$56,100
Traffic Control - Without Flagging	LF	$4	935	$3,740
			Construction Subtotal (rounded)	$377,000
Mobilization	%	5	-	$18,900
Contingency	%	30	-	$113,100
Engineering and CMS	%	25	-	$94,300
			Total Project Cost (rounded)	$603,000

Project Title: Park Avenue and Cody Lane Improvements

Project Priority: 2A

Objective: Install a trunkline along Park Avenue draining south to Cody Lane. Decommission existing drywells along Cody Lane and install a trunkline draining south to a new regional detention facility.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	990	$158,400
24-inch Pipe - Excavation, Backfill	LF	$205	650	$133,250
36-inch Pipe - Excavation, Backfill (>10' depth)	LF	$365	470	$171,550
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	1	$7,700
60-Inch, Standard Manhole	EA	$14,000	4	$56,000
72-Inch, Standard Manhole (>10' depth)	EA	$22,000	2	$44,000
Re-connect catch basin	EA	$500	12	$6,000
Standard Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Concrete Curbs, Curb and Gutter	LF	$50	820	$41,000
Decommision Drywell	EA	$3,000	10	$30,000
Local Road Full Lane Asphalt Repair	LF	$60	1,640	$98,400
Pond Excavation and Earthwork	CY	$22	5,800	$127,600
Concrete Outlet Control Structure	EA	$15,000	1	$15,000
Concrete Headwall, Inlet	EA	$10,000	1	$10,000
Traffic Control - Without Flagging	LF	$4	1,640	$6,560
			Construction Subtotal (rounded)	$943,000
Mobilization	%	5	-	$47,200
Contingency	%	30	-	$282,900
Engineering and CMS	%	25	-	$235,800
			Total Project Cost (rounded)	$1,509,000

Project Title: Ottaway Road Improvements

Project Priority: 2B

Objective: Install stormwater piping and drainage structures along Ottaway Road to reduce ponding.

General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	1,180	$218,300
48-Inch, Standard Manhole	EA	$8,000	5	$40,000
Standard Catch Basin with Connector Pipe	EA	$3,500	11	$38,500
Connect to Existing Manhole	EA	$1,750	1	$1,750
Concrete Curbs, Curb and Gutter	LF	$50	1,600	$80,000
Local Road Full Lane Asphalt Repair	LF	$60	1,175	$70,500
Traffic Control - Without Flagging	LF	$4	1,175	$4,700
			Construction Subtotal (rounded)	**$454,000**
Mobilization	%	5	-	$22,700
Contingency	%	30	-	$136,200
Engineering and CMS	%	25	-	$113,500
			Total Project Cost (rounded)	$726,000

Project Title: Main Street North of Ottaway Road Improvements

Project Priority: 2C

Objective: Drain stormwater to the existing trunkline on the west side of Main Street to alleviate flooding on the east trunkline. Install pipe connecting to future Ottaway Road Trunkline.

General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	225	$41,625
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	2	$15,400
Standard Catch Basin with Connector Pipe	EA	$3,500	4	$14,000
Abandonment of existing manholes or drywells	EA	$500	1	$500
Connect to Existing Manhole	EA	$1,750	1	$1,750
Local Road Full Lane Asphalt Repair	LF	$60	350	$21,000
Traffic Control - Without Flagging	LF	$4	350	$1,400
			Construction Subtotal (rounded)	**$96,000**
Mobilization	%	5	-	$4,800
Contingency	%	30	-	$28,800
Engineering and CMS	%	25	-	$24,000
			Total Project Cost (rounded)	$154,000

Project Title: Airport Road Improvements

Project Priority: 2D

Objective: Alleviate flooding along Airport Road from undersized pipes and culverts. This project will upsize existing pipe and culverts, and clean out existing ditch sections to provide an unobstructed flow path.

General Line Items	Unit	Unit Price	Quantity	Cost
18-inch Pipe - Excavation, Backfill	LF	$185	145	$26,825
24-inch Pipe - Excavation, Backfill	LF	$205	182	$37,310
24-inch Pipe - Excavation, Backfill Culvert	LF	$205	285	$58,425
30-inch Pipe - Excavation, Backfill Culvert	LF	$230	70	$16,100
Concrete Storm Manhole with Grate, 48-inch	EA	$7,700	1	$7,700
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	2	$4,000
Re-connect catch basin	EA	$500	1	$500
Ditch Dredging/Cleanout	LF	$10	425	$4,250
Local Road Full Lane Asphalt Repair	LF	$60	190	$11,400
Outfall Restoration	EA	$4,000	1	$4,000
Soil Surface Repair	LF	$5	422	$2,110
Traffic Control - With Flagging	LF	$8	612	$4,896
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	$198,000
Mobilization	%	5	-	$9,900
Contingency	%	30	-	$59,400
Engineering and CMS	%	25	-	$49,500
			Total Project Cost (rounded)	$317,000

Project Title: Filbert Street North of Ottaway Road Improvements

Project Priority: 2E

Objective: Install stormwater infrastructure along Filbert Street, north of Ottaway Road. Infrastructure to drain north, then, west and connect to the improvements from Priority 1D along Highway 99.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	440	$70,400
48-Inch, Standard Manhole	EA	$8,000	2	$16,000
Standard Catch Basin with Connector Pipe	EA	$3,500	2	$7,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
Concrete Curbs, Curb and Gutter	LF	$50	415	$20,750
Gravel Surface Repair	LF	$10	265	$2,650
Traffic Control - Without Flagging	LF	$4	415	$1,660
			Construction Subtotal (rounded)	$120,000
Mobilization	%	5	-	$6,000
Contingency	%	30	-	$36,000
Engineering and CMS	%	25	-	$30,000
			Total Project Cost (rounded)	$192,000

Project Title: Martin Street to Main Street Improvements

Project Priority: 2F

Objective: Install stormwater infrastructure along Martin Street and connect to upsized trunkline along Main Street.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	350	$56,000
15-inch Pipe - Excavation, Backfill	LF	$170	420	$71,400
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
Standard Catch Basin with Connector Pipe	EA	$3,500	1	$3,500
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	1	$2,000
Connect to Existing Manhole	EA	$1,750	1	$1,750
Concrete Curbs, Curb and Gutter	LF	$50	350	$17,500
Gravel Surface Repair	LF	$10	350	$3,500
Concrete Sidewalk (4-inch)	SF	$12	25	$300
Traffic Control - Without Flagging	LF	$4	350	$1,400
			Construction Subtotal (rounded)	$181,000
Mobilization	%	5	-	$9,100
Contingency	%	30	-	$54,300
Engineering and CMS	%	25	-	$45,300
			Total Project Cost (rounded)	$290,000

Project Title: Highway 99 North of 2nd Street Improvements

Project Priority: 3A

Objective: Upsize existing 12-inch pipes to 15-inch to increase capacity and alleviate flooding and surcharging in the larger design storm events.

General Line Items	Unit	Unit Price	Quantity	Cost
15-inch Pipe - Excavation, Backfill	LF	$170	380	$64,600
48-Inch, Standard Manhole	EA	$8,000	3	$24,000
ODOT Road Asphalt Repair	LF	$225	380	$85,500
Standard Catch Basin with Connector Pipe	EA	$3,500	3	$10,500
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - With Flagging	LF	$8	380	$3,040
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	$212,000
Mobilization	%	5	-	$10,600
Contingency	%	30	-	$63,600
Engineering and CMS	%	25	-	$53,000
			Total Project Cost (rounded)	$339,000

Project Title: Albers Way Improvements

Project Priority: 3B

Objective: Upsize existing pipe network along Albers Way.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	290	$46,400
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	2	$4,000
Local Road Full Lane Asphalt Repair	LF	$60	100	$6,000
Soil Surface Repair	LF	$5	190	$950
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - Without Flagging	LF	$4	100	$400
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	**$82,000**
Mobilization	%	5	-	$4,100
Contingency	%	30	-	$24,600
Engineering and CMS	%	25	-	$20,500
			Total Project Cost (rounded)	$131,000

Project Title: 3rd Street Outfall Improvements

Project Priority: 3C

Objective: Upsize existing pipe network along 3rd Street.

General Line Items	Unit	Unit Price	Quantity	Cost
12-inch Pipe - Excavation, Backfill	LF	$160	277	$44,320
Concrete Inlet, Curb-Inlet Catch Basin	EA	$2,000	1	$2,000
48-Inch, Standard Manhole	EA	$8,000	1	$8,000
Local Road Full Lane Asphalt Repair	LF	$60	90	$5,400
Soil Surface Repair	LF	$5	190	$950
Outfall Restoration	EA	$4,000	1	$4,000
Traffic Control - Without Flagging	LF	$4	90	$360
Outfall Permitting	LS	$20,000	1	$20,000
			Construction Subtotal (rounded)	**$85,000**
Mobilization	%	5	-	$4,300
Contingency	%	30	-	$25,500
Engineering and CMS	%	25	-	$21,300
			Total Project Cost (rounded)	$136,000

Appendix D

Model Parameters

Client: City of Aurora
Project: Stormwater Master Plan
Project No.: 215120-003

Subcatchment Parameters and 25-Year Storm Event Results

							25-Year Storm Event	
Sub-Basin ID	Load Placement	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Curve Number	Initial Abstraction (in)	Total Rainfall (in)	Peak Flow (cfs)
1	A-CB2	3.3	5.7	528	85.5	0.09	4.0	3.5
2	B-I6	37.9	2.2	3,763	77.9	0.14	4.0	13.7
3	C-CB1	0.3	4.2	286	97.1	0.02	4.0	0.4
4	D-CB2	0.8	4.4	411	93.4	0.04	4.0	1.2
5	F8-CB1	3.0	5.0	519	90.5	0.05	4.0	3.8
6	E2-CB2	1.4	2.8	578	94.1	0.03	4.0	1.8
7	H2-CB2	0.8	2.4	245	91.1	0.05	4.0	1.0
8	K-CB1	0.6	1.4	352	90.8	0.05	4.0	0.7
9	M-CB3	2.8	3.4	643	82.5	0.11	4.0	2.3
10	J14-CB2	3.3	3.3	299	87.9	0.07	4.0	4.0
11	R-CB3	1.1	0.5	196	89.2	0.06	4.0	1.2
12	X2-MH1	8.3	4.1	1,457	60.0	0.33	4.0	2.0
13	AG8-CB1	1.3	1.6	697	89.4	0.06	4.0	1.3
14	AG15-CB2	2.4	2.9	488	89.6	0.06	4.0	2.8
15	AG17-MH1	3.7	0.9	457	89.5	0.06	4.0	3.6
16	AG16-MH1	0.9	5.5	437	90.7	0.05	4.0	1.2
17	AG24-MH1	2.3	2.4	464	86.0	0.08	4.0	2.8
18	AH-MH1	1.6	2.8	211	86.3	0.08	4.0	1.9
19	AG27-MH1	3.5	2.5	483	88.8	0.06	4.0	3.9
20	AG11-MH1	2.2	3.3	603	86.4	0.08	4.0	2.2
21	AG2-MH1	0.8	2.6	227	89.9	0.06	4.0	1.0
22	AH8-MH1	6.3	0.3	292	88.9	0.06	4.0	5.7
23	B2-I1	27.0	1.3	2,641	74.4	0.17	4.0	8.3
24	G1-CB2	0.7	2.0	202	86.8	0.08	4.0	0.8
25	I-CB1	1.8	2.8	353	85.6	0.08	4.0	1.9
26	KJ-102	1.6	2.2	445	86.1	0.08	4.0	1.6
27	KJ-104	2.7	2.3	520	83.1	0.10	4.0	2.2
28	KJ-106	9.4	3.3	488	84.9	0.09	4.0	9.1
29	S-CB1	2.3	3.1	458	79.3	0.13	4.0	1.5
30	V-MH1	2.2	4.7	1,015	84.2	0.09	4.0	1.6
31	W-MH1	0.3	3.4	265	88.8	0.06	4.0	0.4
32	Y-CB1	0.3	3.5	226	70.0	0.86	4.0	0.1
33	AB1-CB1	0.5	3.7	217	86.7	0.08	4.0	0.6
34	AA2-CB1	0.4	1.6	62	89.6	0.06	4.0	0.6
35	AC-MH1	2.3	3.5	684	86.3	0.08	4.0	1.8
36	Z-MH1	1.6	3.4	644	87.3	0.07	4.0	1.6
37	AE-MH1	0.3	4.2	144	81.0	0.12	4.0	0.3
38	AD-MH1	0.9	6.0	530	85.0	0.09	4.0	0.9
39	X-06	14.0	2.4	1,781	78.3	0.14	4.0	8.6
40	Q1-CB1	0.8	0.6	311	91.7	0.05	4.0	0.9
41	U2-CB1	1.1	0.7	809	95.0	0.09	4.0	0.8
42	PRVT-03	7.4	1.2	845	75.5	0.16	4.0	3.4
43	X-04	6.1	2.9	752	85.7	0.08	4.0	4.2
44	KJ-110	4.9	4.4	364	86.7	0.08	4.0	4.3
45	T-CB1	2.4	1.3	461	89.6	0.06	4.0	2.5

							25-Year Storm Event	
Sub-Basin ID	Load Placement	Area (acres)	Average Slope (%)	Characteristic Length (ft)	NRCS Curve Number	Initial Abstraction (in)	Total Rainfall (in)	Peak Flow (cfs)
46	X-10	2.2	1.0	403	89.0	0.06	4.0	2.2
47	KJ-108	9.1	1.9	518	84.9	0.09	4.0	8.0
48	F1-CB3	1.6	5.1	550	83.3	0.10	4.0	1.5
49	F3-CB1	0.8	4.8	336	90.5	0.05	4.0	1.1
50	AG22-MH1	1.4	4.5	443	90.8	0.05	4.0	1.8
51	AG18-MH1	2.9	3.4	537	87.0	0.07	4.0	3.0
52	AG7-MH1	2.2	3.8	521	87.6	0.07	4.0	2.4
53	B2-CB4	8.4	2.7	1,092	82.6	0.11	4.0	5.4
54	B2-CB2	2.8	6.5	553	80.7	0.12	4.0	2.4
55	X-04	3.5	2.3	698	89.2	0.06	4.0	3.5
56	B-I5	72.9	2.3	3,695	68.1	0.23	4.0	16.7
57	58	13.3	0.4	1,811	84.0	0.10	4.0	5.8
58	KJ-112	22.9	1.2	1,946	86.6	0.08	4.0	10.6
59	KJ-114	4.0	4.4	688	74.4	0.17	4.0	2.4
60	61	4.1	5.3	761	57.4	0.37	4.0	1.1
61	KJ-100	4.4	3.7	965	85.5	0.09	4.0	3.7
62	60	1.6	9.2	283	70.5	0.21	4.0	1.1
63	E15-CB2	3.8	0.9	440	86.4	0.08	4.0	3.3
64	E11-MH2	0.8	0.9	227	92.4	0.04	4.0	0.9
65	J5-CB1	1.9	3.0	328	84.2	0.09	4.0	1.6
66	Q-CB2	1.5	1.5	271	89.6	0.06	4.0	1.8
41A	U1-CB4	2.8	0.6	356	84.6	0.09	4.0	1.7
5A	F6-MH1	2.6	5.0	519	90.5	0.05	4.0	3.3
6A	E7-MH1	0.7	4.8	248	94.1	0.03	4.0	1.1
6B	E5-CB3	0.9	5.3	336	94.1	0.03	4.0	1.4
6C	E-CB3	1.0	2.8	578	94.1	0.03	4.0	1.4

Client: City of Aurora
Project: Stormwater Master Plan
Project No.: 215120-003

Junction Parameters and 25-Year Storm Event Results

			25-Year Storm Event			
Junction ID	Rim Elevation (ft)	Invert Elevation(ft)	Maximum Depth (ft)	Minimum Freeboard (ft)	Flood Volume (gallons)	Flood Time (hours)
AG8-CB1	160.01	164.18	0.19	3.97	0	0.0
AG8-MH1	153.73	161.84	0.26	7.85	0	0.0
AG9-MH1	136.36	148.35	1.37	10.62	0	0.0
AG-MH1	98.32	103.68	1.47	3.89	0	0.0
AH1-MH1	171.75	176.11	1.19	3.17	0	0.0
AH2-MH1	172.87	177.09	1.10	3.12	0	0.0
AH5-MH1	173.23	176.63	1.38	2.01	0	0.0
AH6-MH1	174.34	178.08	3.49	0.24	0	0.0
AH8-MH1	174.71	178.49	4.00	0.00	2,000	0.3
AH-MH1	169.95	174.35	1.85	2.55	0	0.0
B2-CB1	115.23	117.68	0.74	1.71	0	0.0
B2-CB2	150.67	153.58	4.10	0.00	14,000	2.7
B2-CB3	151.33	154.17	5.15	0.00	46,000	3.0
B2-CB4	177.68	180.78	0.70	2.41	0	0.0
B2-I1	158.35	159.35	3.13	0.00	24,000	1.7
B3-CB1	162.88	166.13	0.74	2.51	0	0.0
B-I2	145.26	146.76	1.76	0.00	3,000	3.0
B-I3	134.47	135.97	1.75	0.00	3,000	3.0
BI-4	122.98	123.98	4.04	0.00	38,000	6.0
B-I5	106.89	109.89	0.78	2.22	0	0.0
B-I6	104.78	106.28	5.53	0.00	47,000	2.3
B-I7	102.82	104.82	1.08	0.92	0	0.0
B-J1	106.49	109.49	0.98	2.02	0	0.0
B-O1	146.25	147.25	0.81	0.69	0	0.0
B-O2	140.24	141.24	0.92	0.58	0	0.0
B-O3	129.96	131.46	0.94	0.56	0	0.0
B-O4	104.54	107.54	1.13	1.87	0	0.0
B-O6	104.12	105.62	0.29	1.21	0	0.0
C-CB1	105.64	107.99	0.16	2.19	0	0.0
D-CB2	121.09	125.17	0.30	3.78	0	0.0
D-I1	116.20	117.20	0.20	1.30	0	0.0
D-O1	118.49	119.49	0.31	1.19	0	0.0
E11-MH1	160.27	165.60	2.56	2.77	0	0.0
E11-MH2	160.98	166.71	3.27	2.46	0	0.0

			25-Year Storm Event			
Junction ID	Rim Elevation (ft)	Invert Elevation(ft)	Maximum Depth (ft)	Minimum Freeboard (ft)	Flood Volume (gallons)	Flood Time (hours)
AG8-CB1	160.01	164.18	0.19	3.97	0	0.0
AG8-MH1	153.73	161.84	0.26	7.85	0	0.0
AG9-MH1	136.36	148.35	1.37	10.62	0	0.0
AG-MH1	98.32	103.68	1.47	3.89	0	0.0
AH1-MH1	171.75	176.11	1.19	3.17	0	0.0
AH2-MH1	172.87	177.09	1.10	3.12	0	0.0
AH5-MH1	173.23	176.63	1.38	2.01	0	0.0
AH6-MH1	174.34	178.08	3.49	0.24	0	0.0
AH8-MH1	174.71	178.49	4.00	0.00	2,000	0.3
AH-MH1	169.95	174.35	1.85	2.55	0	0.0
B2-CB1	115.23	117.68	0.74	1.71	0	0.0
B2-CB2	150.67	153.58	4.10	0.00	14,000	2.7
B2-CB3	151.33	154.17	5.15	0.00	46,000	3.0
B2-CB4	177.68	180.78	0.70	2.41	0	0.0
B2-I1	158.35	159.35	3.13	0.00	24,000	1.7
B3-CB1	162.88	166.13	0.74	2.51	0	0.0
B-I2	145.26	146.76	1.76	0.00	3,000	3.0
B-I3	134.47	135.97	1.75	0.00	3,000	3.0
BI-4	122.98	123.98	4.04	0.00	38,000	6.0
B-I5	106.89	109.89	0.78	2.22	0	0.0
B-I6	104.78	106.28	5.53	0.00	47,000	2.3
B-I7	102.82	104.82	1.08	0.92	0	0.0
B-J1	106.49	109.49	0.98	2.02	0	0.0
B-O1	146.25	147.25	0.81	0.69	0	0.0
B-O2	140.24	141.24	0.92	0.58	0	0.0
B-O3	129.96	131.46	0.94	0.56	0	0.0
B-O4	104.54	107.54	1.13	1.87	0	0.0
B-O6	104.12	105.62	0.29	1.21	0	0.0
C-CB1	105.64	107.99	0.16	2.19	0	0.0
D-CB2	121.09	125.17	0.30	3.78	0	0.0
D-I1	116.20	117.20	0.20	1.30	0	0.0
D-O1	118.49	119.49	0.31	1.19	0	0.0
E11-MH1	160.27	165.60	2.56	2.77	0	0.0
E11-MH2	160.98	166.71	3.27	2.46	0	0.0

			25-Year Storm Event			
Junction ID	Rim Elevation (ft)	Invert Elevation(ft)	Maximum Depth (ft)	Minimum Freeboard (ft)	Flood Volume (gallons)	Flood Time (hours)
E14-CB2	167.08	171.18	0.76	3.34	0	0.0
E15-CB1	170.34	173.39	0.74	2.31	0	0.0
E15-CB2	171.14	173.50	1.01	1.35	0	0.0
E2-CB2	122.04	128.75	6.80	0.00	1,000	0.3
E5-CB1	130.41	133.61	1.67	1.53	0	0.0
E5-CB2	134.39	136.49	0.62	1.49	0	0.0
E5-CB3	148.37	150.49	0.63	1.49	0	0.0
E5-CB5	157.43	160.46	0.66	2.38	0	0.0
E5-MH1	125.33	129.16	4.49	0.00	8,000	0.5
E5-MH2	157.73	161.71	1.15	2.82	0	0.0
E7-MH1	158.97	162.99	2.17	1.85	0	0.0
E9-MH1	159.79	164.09	1.86	2.44	0	0.0
E-CB2	118.80	124.10	0.71	4.59	0	0.0
E-CB3	119.70	129.49	3.37	6.42	0	0.0
F1-CB1	125.10	128.95	3.38	0.47	0	0.0
F1-CB2	128.69	132.51	0.36	3.46	0	0.0
F1-CB3	132.62	138.60	0.46	5.53	0	0.0
F3-CB1	133.83	135.23	1.44	0.00	0	0.0
F4-CB1	128.18	132.28	4.10	0.00	0	0.0
F6-CB1	135.04	138.49	3.45	0.00	0	0.0
F6-MH1	140.44	143.29	2.74	0.11	0	0.0
F8-CB1	145.89	148.06	0.60	2.07	0	0.0
F-CB1	111.43	115.63	2.77	1.43	0	0.0
F-CB2	114.37	116.67	0.73	1.57	0	0.0
F-CB3	123.68	127.03	3.66	0.00	4,000	0.2
G1-CB1	163.97	165.42	0.26	1.19	0	0.0
G1-CB2	164.89	166.24	0.45	0.90	0	0.0
H2-CB2	165.60	167.00	0.39	1.01	0	0.0
H-CB1	163.92	165.58	1.66	0.00	0	0.0
H-O1	162.74	163.90	1.31	0.35	0	0.0
I-CB1	160.16	161.94	1.78	0.00	0	0.0
J11-CB1	158.77	165.52	0.77	5.98	0	0.0
J13-MH1	159.04	165.40	0.97	5.39	0	0.0
J14-CB1	163.09	166.94	0.32	3.53	0	0.0

			25-Year Storm Event			
Junction ID	Rim Elevation (ft)	Invert Elevation(ft)	Maximum Depth (ft)	Minimum Freeboard (ft)	Flood Volume (gallons)	Flood Time (hours)
J14-CB2	172.04	174.85	0.58	2.23	0	0.0
J14-MH1	160.69	166.47	0.56	5.23	0	0.0
J1-CO	127.13	140.00	0.51	12.36	0	0.0
J1-MH1	147.28	151.67	0.42	3.97	0	0.0
J2-MH1	147.98	165.83	0.69	17.15	0	0.0
J3-MH1	159.19	166.57	0.00	7.38	0	0.0
J4-CB1	160.65	165.90	0.00	5.25	0	0.0
J4-CB2	163.52	166.18	0.00	2.66	0	0.0
J5-CB1	157.98	166.00	0.21	7.81	0	0.0
J9-MH1	157.96	165.71	0.65	7.11	0	0.0
J-MH1	124.12	128.03	0.62	3.29	0	0.0
K-CB1	163.16	165.91	0.17	2.58	0	0.0
KJ-84	171.13	172.62	0.58	0.91	0	0.0
KJ-86	170.40	172.67	1.10	1.17	0	0.0
KJ-88	169.75	172.74	1.55	1.44	0	0.0
M-CB1	145.83	148.88	0.23	2.81	0	0.0
M-CB2	146.37	149.32	1.00	1.95	0	0.0
M-CB3	162.00	163.05	1.16	0.00	1,000	0.3
M-MH1	106.84	111.40	0.42	4.14	0	0.0
P2-MH1	152.67	164.28	0.79	10.82	0	0.0
P3-MH1	154.69	162.43	0.63	7.11	0	0.0
P4-MH1	161.64	165.06	0.52	2.90	0	0.0
P5-MH1	162.91	166.69	0.56	3.22	0	0.0
P6-MH1	168.21	172.47	0.55	3.71	0	0.0
PRVT-03	169.44	171.88	0.84	1.60	0	0.0
PRVT-MH1	150.66	169.00	0.82	17.53	0	0.0
PRVT-MH2	139.63	162.00	0.79	21.58	0	0.0
Q1-CB1	168.74	170.47	2.26	0.00	6,000	20.5
Q-CB1	171.91	172.91	1.07	0.00	1,000	0.2
Q-CB2	173.83	175.38	0.66	0.89	0	0.0
R-CB1	170.85	172.74	0.30	1.59	0	0.0
R-CB2	170.77	172.67	1.30	0.60	0	0.0
R-CB3	170.92	172.62	1.82	0.00	1,000	0.4
S-CB1	156.23	157.75	0.33	1.19	0	0.0

			25-Year Storm Event			
Junction ID	Rim Elevation (ft)	Invert Elevation(ft)	Maximum Depth (ft)	Minimum Freeboard (ft)	Flood Volume (gallons)	Flood Time (hours)
U1-CB1	173.37	175.87	0.90	1.60	0	0.0
U1-CB2	175.76	178.11	0.63	1.72	0	0.0
U1-CB3	176.41	178.41	0.67	1.33	0	0.0
U1-CB4	176.95	178.80	0.71	1.15	0	0.0
U1-CB5	178.83	181.53	0.38	2.31	0	0.0
U1-MH1	178.93	182.63	0.56	3.13	0	0.0
U1-MH2	173.00	175.00	0.78	1.22	0	0.0
U2-CB1	180.23	182.65	0.26	2.17	0	0.0
V-MH1	113.01	124.16	10.51	0.65	0	0.0
W-MH1	103.55	115.60	12.63	0.00	7,000	16.9
X-04	152.97	153.97	1.42	0.00	5,000	0.3
X-06	121.49	124.46	0.57	2.43	0	0.0
X2-MH1	107.90	112.00	2.12	1.98	0	0.0
X-MH1	108.89	113.27	0.38	4.00	0	0.0
Y-CB1	111.14	112.84	2.44	0.00	8,000	15.2
Z-MH1	102.22	113.26	10.81	0.24	0	0.0

Client: City of Aurora
Project: Stormwater Master Plan
Project No.: 215120-003

Conduit Parameters and 25-Year Storm Event Results

									25-Year Storm Event				
Conduit ID (Char)	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Type	Diameter (in)	Full Flow (cfs)	Maximum Flow (cfs)	Percent Slope (%)	Max.Flow/Full Flow	Max.Depth/Full Depth
AC-P1	23	0.013	108.00	AC-MH1	106.62	AC-DRYWELL	Pipe	12	6.3	3.2	23.2	0.5	0.5
AE-P2	21	0.013	119.13	AE-MH1	118.73	AE-DRYWELL	Pipe	12	2.8	3.2	4.6	1.1	1.0
AF-P2	22	0.013	106.87	AF-MH1	106.47	AF-DRYWELL	Pipe	12	13.8	1.8	15.1	0.1	1.0
AG-P1	89	0.013	98.32	AG-MH1	97.68	AG-OUTFALL	Pipe	36	18.3	0.0	26.3	0.0	1.0
AG-P10	528	0.012	119.77	AG5-MH1	110.40	AG2-MH1	Pipe	36	4.9	0.0	1.9	0.0	0.0
AG-P100	51	0.013	168.90	ORCHARD_POND	167.59	AG30-CB2	Pipe	36	56.5	27.2	0.7	0.5	0.5
AG-P11	314	0.012	122.48	AG6-MH1	119.83	AG5-MH1	Pipe	36	96.2	26.6	1.8	0.3	0.4
AG-P12	460	0.012	135.50	AG7-MH1	122.48	AG6-MH1	Pipe	36	106.6	18.6	2.6	0.2	0.6
AG-P13	237	0.012	141.33	AG20-MH1	140.05	AG18-MH1	Pipe	12	66.4	26.7	0.8	0.4	0.4
AG-P15	36	0.012	141.61	AG21-MH1	141.56	AG20-MH1	Pipe	12	121.6	27.0	2.8	0.2	0.4
AG-P16	75	0.012	141.92	AG22-MH1	141.65	AG21-MH1	Pipe	12	2.8	1.7	0.5	0.6	0.6
AG-P19	161	0.012	158.90	AG27-MH1	158.32	AG26-MH1	Pipe	12	1.4	1.8	0.1	1.2	0.6
AG-P2	321	0.012	153.73	AG8-MH1	137.16	AG7-MH1	Pipe	12	2.3	1.8	0.4	0.8	0.7
AG-P23	282	0.012	158.11	AG26-MH1	152.55	AG25-MH1	Pipe	18	2.3	3.9	0.4	1.7	0.9
AG-P24	140	0.012	164.48	AG29-MH1	161.55	AG28-MH1	Pipe	12	8.8	1.3	5.2	0.1	0.3
AG-P25	54	0.012	167.49	AG30-CB1	164.62	AG29-MH1	Pipe	12	16.0	7.2	2.0	0.4	0.5
AG-P26	62	0.012	171.85	ORCHARD_POND	171.85	AG30-CB1	Pipe	36	5.6	5.3	2.1	0.9	0.8
AG-P3	36	0.012	160.01	AG8-CB1	153.88	AG8-MH1	Pipe	12	8.9	5.8	5.4	0.6	0.7
AG-P31	274	0.012	138.80	AG18-MH1	137.14	AG10-CB1	Pipe	30	2.9	0.0	0.0	0.0	0.0
AG-P32	281	0.012	152.55	AG25-MH1	146.51	AG23-MH1	Pipe	18	16.0	1.3	17.2	0.1	0.2
AG-P34	218	0.012	146.36	AG23-MH1	139.15	AG18-MH1	Pipe	18	34.6	14.4	0.6	0.4	0.5
AG-P35	277	0.012	158.40	AG24-MH1	146.46	AG23-MH1	Pipe	12	16.7	7.1	2.1	0.4	0.5
AG-P40	422	0.012	167.13	AG17-MH1	165.42	AG16-MH1	Pipe	12	20.7	9.8	3.3	0.5	0.5
AG-P41	261	0.012	164.95	AG16-MH1	150.37	AG14-MH1	Pipe	12	8.0	2.8	4.3	0.3	0.5
AG-P44	102	0.012	136.36	AG9-MH1	135.51	AG7-MH1	Pipe	30	2.5	3.6	0.4	1.5	0.9
AG-P45	47	0.012	137.10	AG10-CB1	136.70	AG9-MH1	Pipe	30	9.1	4.4	5.6	0.5	0.7
AG-P49	36	0.012	139.34	AG11-MH1	137.96	AG10-CB1	Pipe	12	40.5	23.6	0.8	0.6	0.5
AG-P50	81	0.012	144.28	AG12-MH1	139.47	AG11-MH1	Pipe	12	41.1	23.6	0.9	0.6	0.6
AG-P51	97	0.012	149.79	AG13-MH1	144.25	AG12-MH1	Pipe	12	7.5	10.7	3.8	1.4	1.0
AG-P52	16	0.012	150.36	AG14-MH1	149.85	AG13-MH1	Pipe	12	9.4	8.9	6.0	0.9	0.9
AG-P54	151	0.012	161.62	AG28-MH1	158.44	AG26-MH1	Pipe	18	9.2	9.7	5.7	1.0	0.9
AG-P55	416	0.012	162.97	AG15-MH1	150.40	AG14-MH1	Pipe	12	6.8	11.2	3.1	1.6	1.0
AG-P56	10	0.012	164.56	AG15-CB2	162.99	AG15-MH1	Pipe	12	16.5	4.9	2.1	0.3	0.4
AG-P8	182	0.012	107.50	AG1-MH1	99.08	AG-MH1	Pipe	36	6.7	2.7	3.0	0.4	0.7
AG-P9	297	0.012	110.05	AG2-MH1	107.92	AG1-MH1	Pipe	36	15.5	2.8	16.1	0.2	0.4
AG-P99	47	0.013	168.40	ORCHARD_POND	168.40	AG30-CB2	Pipe	4	155.5	27.2	4.6	0.2	0.3
AH-P11	61	0.012	169.95	AH-MH1	169.13	ORCHARD_POND	Pipe	12	61.2	27.2	0.7	0.4	0.5
AH-P12	78	0.012	171.75	AH1-MH1	170.05	AH-MH1	Pipe	12	0.2	0.3	1.1	1.5	1.0
AH-P13	69	0.012	172.87	AH2-MH1	171.92	AH1-MH1	Pipe	12	4.5	6.3	1.3	1.4	1.0

									25-Year Storm Event				
Conduit ID (Char)	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Type	Diameter (in)	Full Flow (cfs)	Maximum Flow (cfs)	Percent Slope (%)	Max.Flow/Full Flow	Max.Depth/Full Depth
AH-P15	34	0.012	173.23	AH5-MH1	173.10	AH2-MH1	Pipe	12	5.7	5.0	2.2	0.9	1.0
AH-P16	197	0.012	174.34	AH6-MH1	173.43	AH5-MH1	Pipe	12	4.5	4.9	1.4	1.1	1.0
AH-P17	56	0.012	174.71	AH8-MH1	174.45	AH6-MH1	Pipe	12	2.4	4.9	0.4	2.1	1.0
A-P1	194	0.012	142.70	A-CB1	98.82	A-OUTFALL	Pipe	8	2.6	4.9	0.5	1.9	1.0
A-P2	101	0.012	147.44	A-CB2	142.79	A-CB1	Pipe	8	2.6	4.9	0.5	1.9	1.0
B-P10	80	0.012	134.47	B-I3	129.96	B-O3	Pipe	18	27.0	8.7	5.6	0.3	0.8
B-P11	101	0.012	145.26	B-I2	140.24	B-O2	Pipe	18	25.4	8.7	5.0	0.3	0.8
B-P12	115	0.013	150.67	B2-CB2	146.25	B-O1	Pipe	12	7.0	8.7	3.9	1.2	0.9
B-P13	32	0.013	151.33	B2-CB3	150.64	B2-CB2	Pipe	12	5.1	8.3	2.1	1.6	1.0
B-P14	149	0.013	122.98	BI-4	115.28	B2-CB1	Pipe	12	8.1	9.6	5.2	1.2	1.0
B-P15	22	0.013	115.28	B2-CB1	107.99	B-J1	Pipe	12	21.0	9.5	34.6	0.5	0.6
B-P2	529	0.012	177.68	B2-CB4	162.92	B3-CB1	Pipe	12	6.4	5.4	2.8	0.8	0.7
B-P4	455	0.012	162.88	B3-CB1	151.49	B2-CB3	Pipe	12	6.1	5.3	2.5	0.9	0.9
B-P5	131	0.013	158.35	B2-I1	151.54	B2-CB3	Pipe	12	8.1	7.0	5.2	0.9	1.0
B-P6	119	0.013	104.78	B-I6	104.12	B-O6	Pipe	18	7.8	12.2	0.6	1.6	0.6
B-P7	70	0.013	102.82	B-I7	101.25	B-OUTFALL2	Pipe	24	33.8	38.0	2.2	0.6	0.5
B-P9	14	0.013	106.89	B-I5	106.49	B-J1	Pipe	36	112.2	16.7	2.8	0.1	0.3
CDT_21	68	0.013	106.49	B-J1	104.54	B-O4	Pipe	36	8.2	0.4	5.3	0.1	0.2
C-P1	17	0.013	105.64	C-CB1	104.74	C-OUTFALL	Pipe	12	112.9	25.9	2.9	0.2	0.4
DITCH-1	12	0.025	146.25	B-O1	145.26	B-I2	Ditch	-	6.1	1.2	2.9	0.2	0.3
DITCH-25	113	0.025	140.24	B-O2	134.47	B-I3	Ditch	-	13.3	1.2	11.9	0.1	0.2
DITCH-27	148	0.025	129.96	B-O3	122.98	BI-4	Ditch	-	26.3	8.7	8.0	0.3	0.8
DITCH-29	152	0.025	104.54	B-O4	102.82	B-I7	Ditch	-	20.9	8.7	5.1	0.4	0.8
DITCH-33	51	0.025	118.49	D-O1	116.20	D-I1	Ditch	-	20.1	8.7	4.7	0.4	0.8
D-P1	89	0.013	121.09	D-CB2	118.49	D-O1	Pipe	12	72.8	25.9	1.1	0.4	0.6
D-P4	101	0.012	116.20	D-I1	104.20	D-OUTFALL	Pipe	12	19.6	1.2	4.5	0.1	0.2
E1-P6	122	0.013	163.97	G1-CB1	158.57	E5-MH2	Pipe	8	3.5	6.8	0.9	2.0	1.0
E-P10	87	0.013	119.70	E-CB3	118.88	E-CB2	Pipe	12	7.4	6.0	4.3	0.8	1.0
E-P11	92	0.013	130.41	E5-CB1	126.51	E5-MH1	Pipe	12	4.2	5.0	1.4	1.2	1.0
E-P12	55	0.013	125.33	E5-MH1	124.56	E2-CB2	Pipe	12	3.3	5.7	0.8	1.8	1.0
E-P13	246	0.013	122.04	E2-CB2	119.99	E-CB3	Pipe	12	3.8	3.3	3.0	0.9	1.0
E-P2	195	0.013	167.08	E14-CB2	161.21	E11-MH2	Pipe	10	4.2	16.6	1.2	4.0	1.0
E-P20	20	0.012	157.73	E5-MH2	157.50	E5-CB5	Pipe	12	7.0	6.0	3.3	0.9	0.7
E-P21	274	0.012	157.43	E5-CB5	148.46	E5-CB3	Pipe	12	2.2	3.8	0.3	1.7	1.0
E-P25	143	0.012	160.98	E11-MH2	160.51	E11-MH1	Pipe	12	2.2	3.8	0.3	1.8	1.0
E-P26	136	0.012	160.27	E11-MH1	159.84	E9-MH1	Pipe	12	3.9	3.8	1.0	1.0	1.0
E-P27	52	0.012	159.79	E9-MH1	159.26	E7-MH1	Pipe	12	2.3	4.4	0.3	1.9	0.9
E-P28	116	0.012	158.97	E7-MH1	158.57	E5-MH2	Pipe	12	8.0	6.8	5.1	0.8	0.7
E-P3	252	0.013	118.80	E-CB2	106.08	E-OUTFALL	Pipe	12	8.7	6.1	5.1	0.7	0.6

									25-Year Storm Event				
Conduit ID (Char)	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Type	Diameter (in)	Full Flow (cfs)	Maximum Flow (cfs)	Percent Slope (%)	Max.Flow/Full Flow	Max.Depth/Full Depth
E-P30	56	0.012	134.39	E5-CB2	131.53	E5-CB1	Pipe	12	3.0	3.3	1.8	1.1	1.0
E-P4	39	0.013	171.14	E15-CB2	170.43	E15-CB1	Pipe	10	3.6	3.3	0.9	0.9	0.7
E-P5	357	0.012	170.34	E15-CB1	167.18	E14-CB2	Pipe	12	8.8	6.1	5.2	0.7	0.6
E-P8	268	0.012	148.39	E5-CB3	134.39	E5-CB2	Pipe	12	2.5	0.8	4.4	0.3	0.4
F-P1	98	0.012	145.89	F8-CB1	140.44	F6-MH1	Pipe	10	5.6	4.8	5.5	0.9	0.9
F-P10	290	0.012	133.83	F3-CB1	132.62	F1-CB3	Pipe	8	0.6	0.9	0.2	1.3	0.8
F-P11	116	0.012	111.43	F-CB1	107.24	F-OUTFALL	Pipe	12	7.3	8.1	3.6	1.1	1.0
F-P12	38	0.013	114.37	F-CB2	111.73	F-CB1	Pipe	12	9.4	8.2	6.9	0.9	0.9
F-P13	228	0.013	123.68	F-CB3	114.42	F-CB2	Pipe	12	7.2	8.1	4.1	1.1	1.0
F-P15	87	0.013	140.44	F6-MH1	135.47	F6-CB1	Pipe	12	8.5	8.0	5.7	0.9	1.0
F-P3	103	0.013	128.18	F4-CB1	123.93	F-CB3	Pipe	12	7.3	8.0	4.1	1.1	1.0
F-P6	125	0.013	135.04	F6-CB1	129.20	F4-CB1	Pipe	12	7.7	8.0	4.7	1.0	1.0
F-P7	36	0.013	125.10	F1-CB1	123.98	F-CB3	Pipe	12	6.3	4.2	3.1	0.7	1.0
F-P8	74	0.012	128.69	F1-CB2	125.14	F1-CB1	Pipe	12	8.4	2.4	4.8	0.3	0.7
F-P9	93	0.012	132.62	F1-CB3	130.69	F1-CB2	Pipe	12	5.6	2.4	2.1	0.4	0.5
H-OVERVLOW	380	0.013	163.90	H-O1	148.06	F8-CB1	Ditch	-	11.6	1.0	4.2	0.1	0.3
H-P1	58	0.012	164.05	H-CB1	162.74	H-O1	Pipe	6	0.9	1.0	2.3	1.1	1.0
H-P3	72	0.012	165.60	H2-CB2	163.92	H-CB1	Pipe	8	2.0	1.0	2.3	0.5	0.8
J-P1	249	0.012	147.28	J1-MH1	127.13	J1-CO	Pipe	18	32.4	5.5	8.1	0.2	0.3
J-P10	179	0.012	158.20	J9-MH1	149.95	J2-MH1	Pipe	18	24.4	3.9	4.6	0.2	0.3
J-P12	343	0.012	172.04	J14-CB2	163.19	J14-CB1	Pipe	12	6.2	3.9	2.6	0.6	0.6
J-P15	52	0.012	160.69	J14-MH1	159.17	J13-MH1	Pipe	12	6.6	3.9	2.9	0.6	0.7
J-P16	122	0.012	163.52	J4-CB2	162.73	J4-CB1	Pipe	12	3.1	0.0	0.6	0.0	0.0
J-P17	37	0.012	160.65	J4-CB1	159.32	J3-MH1	Pipe	12	7.3	0.0	3.6	0.0	0.0
J-P18	111	0.012	159.19	J3-MH1	150.03	J2-MH1	Pipe	18	32.8	0.0	8.3	0.0	0.0
J-P2	234	0.012	124.12	J-MH1	119.74	J-OUTFALL	Pipe	18	15.6	5.5	1.9	0.4	0.4
J-P20	54	0.012	157.98	J5-CB1	148.27	J2-MH1	Pipe	12	16.5	1.6	18.3	0.1	0.3
J-P3	76	0.012	127.13	J1-CO	124.25	J-MH1	Pipe	18	22.2	5.5	3.8	0.2	0.3
J-P40	12	0.012	163.09	J14-CB1	160.75	J14-MH1	Pipe	12	17.5	3.9	20.6	0.2	0.4
J-P5	34	0.012	147.98	J2-MH1	147.50	J1-MH1	Pipe	18	13.5	5.5	1.4	0.4	0.5
J-P8	50	0.012	159.04	J13-MH1	159.00	J11-CB1	Pipe	18	3.2	3.9	0.1	1.2	0.6
J-P9	159	0.012	158.77	J11-CB1	157.96	J9-MH1	Pipe	18	8.1	3.9	0.5	0.5	0.5
K-P1	190	0.013	163.16	K-CB1	144.37	K-OUTFALL	Pipe	12	11.2	0.7	10.0	0.1	0.2
M-P1	177	0.012	162.00	M-CB3	147.30	M-CB2	Pipe	6	1.8	1.9	8.3	1.1	1.0
M-P2	23	0.012	106.84	M-MH1	105.88	M-OUTFALL	Pipe	8	2.7	1.9	4.2	0.7	0.6
M-P3	102	0.013	145.83	M-CB1	107.66	M-MH1	Pipe	8	7.7	1.9	40.2	0.2	0.3
M-P4	34	0.012	146.37	M-CB2	146.03	M-CB1	Pipe	8	1.3	1.9	1.0	1.5	1.0
P-P1	83	0.013	152.97	X-04	150.86	PRVT-MH1	Pipe	12	5.7	6.3	2.5	1.1	1.0
P-P2	48	0.012	154.69	P3-MH1	153.98	P2-MH1	Pipe	12	4.7	3.4	1.5	0.7	0.6

									25-Year Storm Event				
Conduit ID (Char)	LENGTH (ft)	Manning's N	Upstream Invert (ft)	Upstream Node ID	Downstream Invert (ft)	Downstream Node ID	Type	Diameter (in)	Full Flow (cfs)	Maximum Flow (cfs)	Percent Slope (%)	Max.Flow/Full Flow	Max.Depth/Full Depth
P-P3	228	0.012	161.64	P4-MH1	155.48	P3-MH1	Pipe	12	6.3	3.4	2.7	0.5	0.5
P-P4	52	0.012	162.91	P5-MH1	161.76	P4-MH1	Pipe	12	5.7	3.4	2.2	0.6	0.6
P-P5	186	0.013	168.21	P6-MH1	163.37	P5-MH1	Pipe	12	5.7	3.4	2.6	0.6	0.6
P-P6	139	0.012	169.44	PRVT-03	168.37	P6-MH1	Pipe	12	3.4	3.4	0.8	1.0	0.8
P-P7	393	0.012	152.67	P2-MH1	150.86	PRVT-MH1	Pipe	15	4.8	3.4	0.5	0.7	0.6
PRVT-P1	373	0.013	150.66	PRVT-MH1	141.58	PRVT-MH2	Pipe	18	16.4	9.4	2.4	0.6	0.5
PRVT-P2	21	0.013	139.63	PRVT-MH2	136.97	PRVT-OUT1	Pipe	18	37.4	9.4	12.6	0.3	0.4
Q-P1	872	0.013	171.91	Q-CB1	168.72	KJ-84	Pipe	12	1.1	1.3	0.1	1.2	0.8
Q-P2	274	0.013	173.83	Q-CB2	171.91	Q-CB1	Pipe	10	1.8	1.8	0.7	1.0	0.9
R-P1	202	0.013	170.85	R-CB1	168.33	R-OUTFALL	Pipe	12	4.0	0.8	1.2	0.2	0.3
R-P2	181	0.012	170.77	R-CB2	170.88	R-CB1	Pipe	8	0.3	0.8	0.1	2.4	0.8
R-P3	197	0.012	170.92	R-CB3	170.85	R-CB2	Pipe	8	0.2	0.8	0.0	3.2	1.0
S-P1	26	0.013	156.23	S-CB1	155.38	S-OUTFALL	Pipe	12	6.4	1.5	3.2	0.2	0.3
SW-102	14	0.012	104.12	B-O6	102.82	B-I7	Pipe	24	0.0	12.2	9.2	-1.0	-1.0
SW-178	200	0.013	171.13	KJ-84	170.40	KJ-86	Pipe	12	2.2	1.2	0.4	0.6	0.8
SW-180	177	0.013	170.40	KJ-86	169.75	KJ-88	Pipe	12	2.2	1.2	0.4	0.6	1.0
SW-182	283	0.013	169.75	KJ-88	168.72	Q-DW	Pipe	12	2.2	1.2	0.4	0.6	1.0
SW-184	51	0.010	168.00	U1-O1	168.00	OFALL_10	Pipe	-	0.0	2.4	0.0	-1.0	-1.0
U1-P5	335	0.013	173.00	U1-MH2	168.00	U1-O1	Pipe	1	3.4	2.4	0.9	0.7	0.8
U-P1	265	0.013	175.76	U1-CB2	173.32	U1-CB1	Pipe	1	2.2	2.4	0.4	1.1	0.8
U-P2	101	0.013	173.37	U1-CB1	173.00	U1-MH2	Pipe	1	3.1	2.4	0.7	0.8	0.7
U-P3	81	0.013	176.41	U1-CB3	175.81	U1-CB2	Pipe	1	2.9	2.4	0.7	0.8	0.7
U-P4	81	0.013	176.95	U1-CB4	176.41	U1-CB3	Pipe	1	2.5	0.8	0.4	0.3	0.5
U-P5	414	0.012	178.83	U1-CB5	177.04	U1-CB4	Pipe	1	1.5	0.8	0.2	0.5	0.4
U-P6	100	0.012	178.98	U1-MH1	178.83	U1-CB5	Pipe	1	4.4	2.4	1.5	0.6	0.4
V-P1	21	0.013	115.30	V-MH1	114.90	V-DRYWELL	Pipe	1	4.9	1.6	1.9	0.3	1.0
W-P1	22	0.013	109.10	W-MH1	108.43	W-DRYWELL	Pipe	1	6.2	0.1	3.0	0.0	1.0
X-13	277	0.013	160.16	I-CB1	134.00	X-O1	Pipe	1	1.7	1.9	9.5	1.1	1.0
X-192	22	0.013	123.56	AD-MH1	123.16	AD-DRYWELL	Pipe	1	3.9	0.1	1.2	0.0	1.0
X-20	95	0.012	164.89	G1-CB2	163.89	G1-CB1	Pipe	1	1.3	0.8	1.0	0.6	0.5
X-30	40	0.013	168.74	Q1-CB1	168.68	Q-DW	Pipe	1	0.8	0.8	0.1	1.0	1.0
X-58	126	0.013	121.49	X-06	118.20	X-O6	Pipe	3	107.9	8.6	2.6	0.1	0.2
X-72	64	0.012	180.23	U2-CB1	178.93	U1-MH1	Pipe	1	5.5	0.8	2.0	0.1	0.4
X-P2	80	0.012	108.89	X-MH1	107.34	X-OUTFALL	Pipe	1	9.7	1.9	1.9	0.2	0.3
X-P3	23	0.012	107.90	X2-MH1	105.33	X2-DRWL	Pipe	1	12.9	2.0	11.2	0.2	1.0
X-P6	43	0.012	109.33	X2-DRWL	108.88	X-MH1	Pipe	1	3.9	1.9	1.0	0.5	0.5
Y-P1	22	0.013	111.14	Y-CB1	109.25	Y-DRYWELL	Pipe	1	3.5	0.1	8.5	0.0	1.0
Z-P1	23	0.013	105.38	Z-MH1	104.98	Z-DRYWELL	Pipe	1	4.7	1.6	1.7	0.4	1.0
Z-P4	37	0.013	110.51	AA2-CB1	107.97	AA-DRYWELL	Pipe	1	3.2	0.2	6.9	0.0	1.0

Appendix E

Mutual Order and Agreement

KELLER
ASSOCIATES

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

IN THE MATTER OF: CITY OF AURORA	)))))))	MUTUAL AGREEMENT AND ORDER IN LIEU OF PERMIT NO. WQ/[NUMBER?] MARION COUNTY

WHEREAS:

1. The city of Aurora is a municipality of the state of Oregon.

2. Aurora discharges stormwater to 10 drywells located in the Strawberry Meadows and Beth Heer residential subdivisions.

3. Pursuant to Oregon Revised Statutes (ORS) 468.050 and implementing rules, the activity specified above requires a permit issued by the Department or must be authorized by rule pursuant to OAR 340-044-0018.

4. Aurora cannot obtain a permit because the permit is under development and is not yet complete. The Department cannot authorize the activity by rule because seven of the underground injection system wells are located within 500 feet of a drinking water well. These injection systems cannot be authorized by rule pursuant to OAR 340-044-0018(3)(a)(E).

5. No other method of stormwater disposal, including construction or use of surface discharging storm sewer or surface infiltration designs, is appropriate. An appropriate method must protect groundwater quality and may consider management of surface water quality and watershed health issues.

6. Oregon Administrative Rule 340-045-0062(1) adopted pursuant to ORS 468.020, states:

"The Director may issue a mutual agreement and order (MAO) in lieu of or in addition to an NPDES permit or WPCF permit where the MAO is part of an enforcement action, for disposal

of wastewater associated with the cleanup of a spill, or for an activity that does not lend itself to the normal permitting process or permit term."

7. The Department finds that the issuance of this MAO satisfies the conditions set forth in OAR 340-045-0062(1).

8. Pursuant to OAR 340-045-0062(5), "[w]hen an MAO is used in lieu of a permit, the fee schedule for permits found in OAR 340-045-0075 will apply. On [DATE] [PARTY] conveyed the required $1,394.00 fees to DEQ.

9. Prior to issuing this MAO, it was put out for public review and comment for 30 days on [DATE].

10. This MAO is issued in lieu of a state Water Pollution Control Facilities (WPCF) permit issued pursuant to 40 CFR 144.25, the federal regulations requiring a permit under the federal Safe Drinking Water Act.

11. Aurora agrees that this MAO is enforceable in all ways as a permit and that any and all applications, notices, plans, records, reports, or other documents required by this MAO are required by ORS 468 and 468B and implementing state rules.

NOW THEREFORE, it is stipulated and agreed that:

12. The Director shall issue a final order:

A. Allowing Aurora to discharge stormwater to the Strawberry Meadows and Beth Heer subdivision drywells under the general conditions specified below:

a. The injection systems do not cause the direct movement of contaminants into groundwater where the resulting concentration of that contaminant may cause a violation of any primary drinking water regulation under the federal Safe Drinking Water Act or may exceed background groundwater concentrations.

b. No other waste, including agricultural drainage, industrial waste or sanitary waste, is mixed with storm water.

c. Aurora's development, design and construction practices must minimize stormwater runoff.

d. Aurora's injection systems must not exceed a depth of 100 feet and must not discharge directly into groundwater or below the highest seasonal groundwater level.

e. No soil or groundwater contamination is present that will be impacted by the use of the stormwater injection systems.

f. The injection systems are operated in a manner that protects groundwater from accidental or illicitly disposed wastes or contaminants, and can be temporarily blocked to prevent drainage into the injection system in the event of an accident or spill.

g. Aurora implements best management practices that prevent or treat stormwater contamination before injection.

h. Aurora must comply with all requests for information from DEQ within the time frame specified by DEQ

B. Requiring Aurora to:

a. within 30 days of execution of this MAO, submit written certification to DEQ that:

i. the injection system does not receive storm water from areas where hazardous substances and toxic materials are used, handled or stored, and

ii. that the storm water is not exposed to industrial activities or hazardous substances or toxic material.

b. within 150 days of execution of this MAO, prepare and implement a storm water management plan, which is based on current conditions, and that includes:

i. the location and construction details of all injection systems and other storm water management controls, an evaluation of the use and activities of all areas of exposed to storm water, and the identification and location of all hazardous substances and toxic materials that are used, handled or stored.

ii. an evaluation of the use and activities of all areas draining into the storm water system, and an evaluation based on available information of areas at high risk for accidental or illicit disposal of wastes or contaminants.

iii. best management practices including operational and structural source controls that minimize and prevent pollution from entering storm water and treatment that removes pollutants contained in storm water runoff. The storm water management plan must include a system-wide assessment; plans for operational control measures including spill prevention, spill response, maintenance, employee and public education; and routine evaluation of the effectiveness of the storm water management plan.

iv. site controls that include best management practices implemented at the facility for source control and treatment. Best management practices shall include measures to segregate areas of hazardous and toxic material storage or handling from storm water run-off and run-on, a spill prevention and response plan, a maintenance plan and schedule, an employee education plan, and the identification of personnel or contractors responsible for implementing these plans. Site controls must also include measures to eliminate storm water drainage from areas with high risk for accidental or illicit disposal. Minimum maintenance activities shall include monthly visual inspections and semi-annual physical maintenance of all catch basins that discharge to injection systems, and physical maintenance of all injection systems at least once every 5 years.

C. Requiring Aurora to not exceed the following waste discharge limitations:

Stormwater Parameter Discharge Limits		
Monitoring Parameter	**Effluent Discharge Limit at Injection Point (µg/L)**	**Analytical Method**
Benzo(a)pyrene	2	EPA 8270-SIM
Di(2-ethylhexyl)phthalate	60	EPA 8270-SIM
Pentachlorophenol	10	EPA 515.3
Antimony(Total)	6.0	EPA 200.8
Arsenic(Total)	10.0	EPA 200.8
Cadmium(Total)	5.0	EPA 200.8
Copper (Total)	1300	EPA 200.8
Lead (Total)	500	EPA 200.8
Zinc (Total)	5,000	EPA 200.8
Benzene	5.0	EPA 8260B
Toluene	1000	EPA 8260B
Ethylbenzene	700	EPA 8260B
Xylenes (Total)	10000	EPA 8260B
2,4 D	70	EPA 515.3
Dinoseb	7.0	EPA 515.3
Glyphosate	700	EPA 547

D. Requiring Aurora to comply with the following monitoring requirements for the stormwater parameters listed in Paragraph 12.C, above:

i. Collect samples from 10 percent of the injection system each year on a rotational basis such that all injection systems are sampled at least once over a ten-year period.

ii. To the extent practicable, within normal business operating hours and at the onset of wet weather conditions to represent "first flush" conditions to the extent practicable, collect the sample during a storm event of 0.1 inches or more in predicted precipitation accumulation.

iii. Under the first year of MAO issuance, collect stormwater parameter sample at least once between July 1 and December 31 and once between January 1 and June 30 with at least 14 days between sampling events within the first year following the execution of this MAO, and at least once annually every year thereafter.

iv. Grab samples must be collected at the last available sampling point before discharge into the underground injection systems. An alternate protocol for sampling may be used with prior written DEQ approval.

vi. Aurora must keep all sampling records for a period of three years after the termination of this MAO and make them available for on-site review.

vii. Aurora must report the monitoring results exceeding a discharge limit in Paragraph 12.C above to DEQ no later than 30 days after receipt of sampling results. No later than 120 days after receipt of the monitoring results, Aurora must report the actions taken or are being taken, to determine the cause of the exceedance and prevent further releases of contaminants into the injection systems. Alternatively, Aurora may demonstrate through a risk-based contaminant attenuation model that the exceedance does not adversely impact groundwater quality.

E. Requiring Aurora to submit the following to the appropriate DEQ regional office or agent:

i. Aurora registrant must submit by [DATE] of each year grab sampling and results for the previous monitoring period of July 1 through June 30. The permit registrant must also report the minimum detection levels and analytical methods for the parameters analyzed. Non-detections must be reported as "ND" with the detection limit in parentheses, e.g., ND (0.005 mg/L).

ii. Aurora must use a department-approved Discharge Monitoring Report (DMR) form for monitoring results.

F. Aurora must notify DEQ at least 90 days before Aurora adds an injection system to those authorized under this MAO.

G. Requiring Aurora to comply with the following:

i. General Conditions of Attachment 1 of this MAO. For purposes of this MAO, the term "permit" in Attachment 1 means "MAO."

ii. Notify DEQ within 90 days of any newly installed or modified injection system.

iii. Provide prior notice of conversion, abandonment, or decommissioning of any underground injection system you own or operate in accordance with notification requirements set forth in OAR 340-044-0040.

iv. Comply with the decommissioning and conversion requirements for injection systems, including reporting requirements, as specified in OAR 340-044-0040.

v. Apply for any abandonment or decommissioning of any underground injection system and pay fees for decommissioning, as authorized by ORS 468B.196.

H. Requiring Aurora, upon receipt of a Penalty Demand Notice from the Department, to pay a civil penalty for each day of each violation of this MAO. Penalties for violations of this MAO shall be calculated according to OAR 340-012-0045 using the penalty matrix, base penalty and factors that would normally apply to each violation as if it were a violation of a permit.

13. The terms of this MAO may be amended by mutual agreement of the Department and Aurora. The Department may amend the conditions in this MAO without the agreement upon finding that such modification is necessary because of changed circumstances or to protect public health or the environment. If Aurora contests the Amended MAO, the applicable procedures for conduct of contested cases in such matters will apply.

14. This MAO is not transferable. No changes in status relating to the injection shall in

any way alter Aurora's obligations under this MAO, unless otherwise approved in writing by DEQ.

15. All reports, notices and other communications required under or relating to this MAO should be directed to [David Cole, DEQ-Northwest Region, 2020 SW Fourth Avenue, Portland, OR 97201, 503-229-6371]. The contact person for Aurora is [WHO, ADDRESS, PHONE].

16. Aurora waives any and all rights and objections it may have to the form, content, manner of service, or timeliness of this MAO. Aurora acknowledges that it has actual notice of the contents and requirements of this MAO and that failure to fulfill any of the requirements hereof will constitute a violation of this MAO and subject Aurora to payment of civil penalties pursuant to Paragraph 12.G above.

17. Aurora shall allow the Department's representatives access to the Aurora's property and pertinent records at all reasonable times for the purposes of making inspections, surveys, collecting samples, obtaining data, reviewing and copying required records and otherwise conducting all necessary functions related to this MAO in accordance with ORS 468.095.

18. Any stipulated civil penalty imposed pursuant to Paragraph 12.G shall be due upon written demand. Stipulated civil penalties shall be paid by check or money order made payable to the "Oregon State Treasurer" and sent to: Business Office, Department of Environmental Quality, 811 S.W. Sixth Avenue, Portland, Oregon 97204. Within 21 days of receipt of a "Demand for Payment of Stipulated Civil Penalty" Notice from the Department, Aurora may request a hearing to contest the Penalty Demand Notice.

19. The terms of this MAO become effective on the date it is signed by DEQ's Regional Administrator on behalf of the Director and will terminate on the date Aurora discontinues the activity, obtains a permit covering the activity, or the Department denies Aurora's permit application, whichever is soonest. Aurora must apply for a permit within 30 days of receiving notice from the Department. Any penalties required pursuant to a Penalty Demand

Notice as described in Paragraph 16 shall remain due and owing until paid in full. Records required by this MAO must be maintained for the period specified in the MAO or for three years, whichever is longer.

CITY OF AURORA

7/12/12
Date

[PARTY REPRESENTATIVE]

DEPARTMENT OF ENVIRONMENTAL QUALITY

7/18/12
Date

Nina DeConcini
[REGIONAL OR DIVISION ADMINISTRATOR]

FINAL ORDER

IT IS SO ORDERED:

DEPARTMENT OF ENVIRONMENTAL QUALITY

7/18/12
Date

Nina DeConcini
[REGIONAL or DIVISION ADMINISTRATOR]
Department of Environmental Quality
Pursuant to OAR 340-045-0062(1)

Attachment 1 – General Conditions.