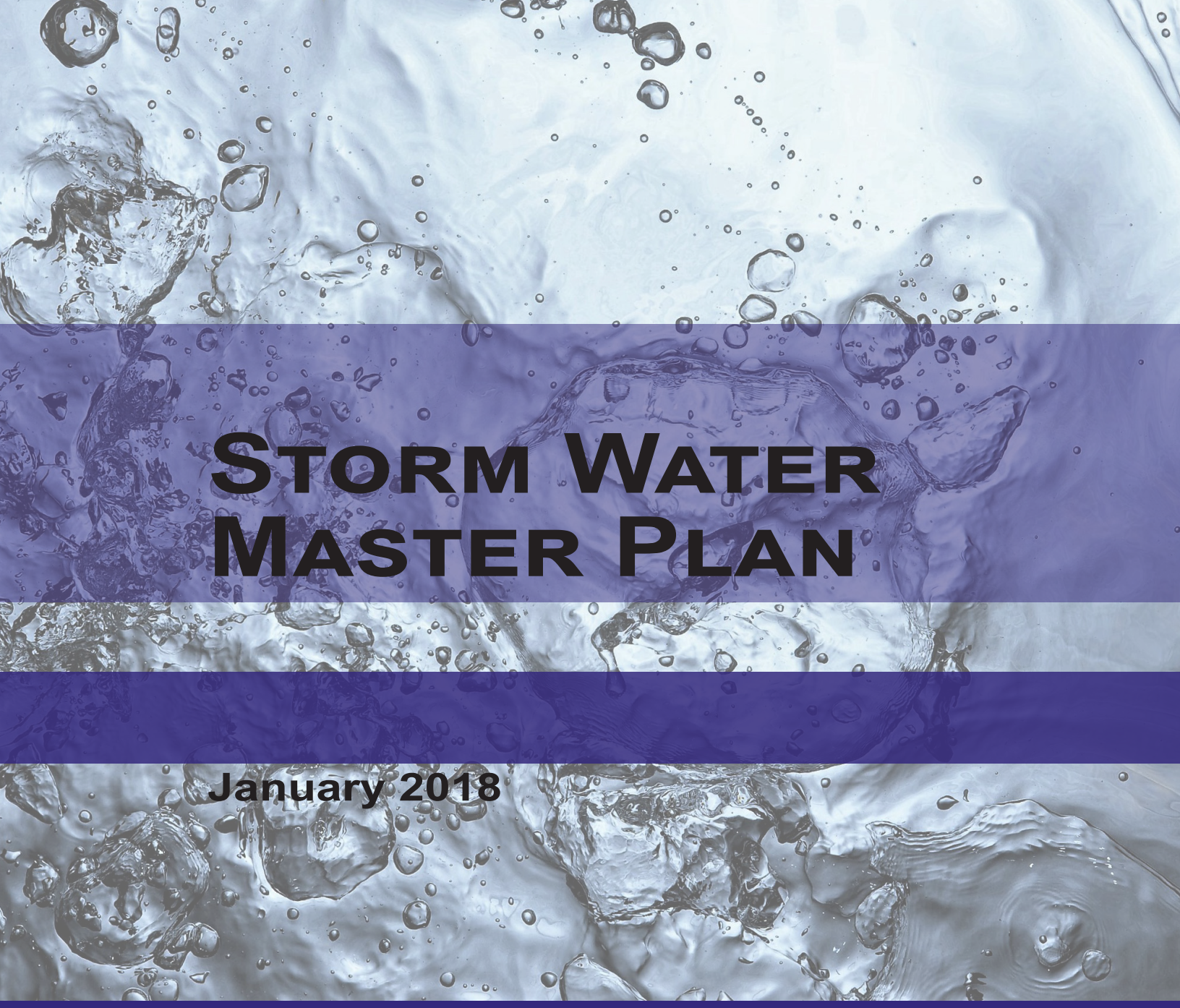


Storm Water Master Plan

January 2018

Prepared by:

BOWEN COLLINS & ASSOCIATES
Celebrating 20 Years

Prepared for:

OREM

STORM WATER MASTER PLAN

January 2018

Prepared for:

OREM

Prepared by:

BOWEN COLLINS & ASSOCIATES

Celebrating 20 Years

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS
(continued)

Page No.

LIST OF APPENDICES

TABLE OF CONTENTS
(continued)

LIST OF TABLES

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

INTRODUCTION

In 1998, the City of Orem (City) completed a comprehensive storm water master plan. As part of that master plan, the City developed a detailed capital facilities plan for the completion of storm water improvements throughout the City. Since that time, the City has completed some of the identified improvements from the plan, but many others have been delayed. The City has also seen growth and other changes that have affected the applicability of some components of the plan. As a result, the City determined that an updated storm water master plan was needed with a revised capital facilities plan that reflected current conditions. The Orem City Council approved the Storm Water Master Plan on January 26, 2016. Recent efforts by the West Union Canal Company to abandon their canal, which has been used to convey a significant amount of storm water, necessitated re-evaluation and reprioritization of the projects identified in the newly adopted plan. Bowen, Collins & Associated (BC&A), who prepared the 2016 plan, has been retained to revise the Storm Water Master Plan because of this unexpected situation.

The primary purpose of this Storm Water Master Plan is to provide recommended improvements to resolve existing and projected future deficiencies in the City's storm water system based on the adopted General Plan. The results of the 2016 study were incorporated into a Rate Study that was used to establish a five-year plan to adjust storm water rates to a level the would fund capital improvement projects to an acceptable level. There are no plans to change the five-year rate plan endorsed in 2016.

This document is a working document. Some of the recommended improvements identified in this report are based on the assumption that development and/or potential annexation will occur in a certain manner. If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years.

SCOPE OF SERVICES

The general scope of this project involved a thorough analysis of the City's storm water system and its ability to meet the present and future storm water needs of its residents. As part of this project, BC&A completed the following tasks:

Task 1: Reviewed an existing InfoSWMM model and other data provided by Orem City. Collected and reviewed state and federal guidelines.

Task 2: Reviewed existing deficiencies with City personnel and developed conceptual solutions. Categorized these deficiencies into 3 categories based on priority year.

Task 3: Worked with City personnel to collect supplemental data and input the data into an InfoSWMM model.

Task 4: Established appropriate rainfall depths for the hydrologic model for a storm with a 10% probability of occurring in any given year (10-yr Storm). Developed a hydrologic computer model of the study area for land use conditions using City zoning and land use information. Updated subcatchment boundaries for the use of this model. Developed parameters for these subcatchments. Calibrated the model to runoff that is reasonable for the area. Inserted detention basins with their associated stage storage curves.

Task 5: Modified the Existing Conditions Hydraulic model (Task 4) for future conditions based on the City's zoning and land use information. Identified both existing and future deficiencies. Proposed improvements for each deficiency including cost estimates and a phasing plan for implementing these improvements.

Task 6: Evaluated the City's storm water program and proposed recommended improvements. Developed strategies for new UPDES monitoring requirements and prepared an updated UPDES Storm Water Management Plan.

Task 7: Collected and reviewed the City's existing storm water standards. Identified any needed changes and applied these changes to a new storm water standards manual.

Task 8: Identified a rate approach for the city and developed a rate model for the city. Developed three CIP rate schedules and presented the results to city council.

Task 9: Involved the public in the master planning effort by presenting results at three city council meetings. Conducted three public information open houses.

Task 10: Prepared a draft master plan report that was reviewed with City personnel. Incorporated comments into a final master plan report.

This report is prepared as part of Task 10. Tasks 6 and 7 were completed as part of master plan activities but are documented in their own reports. In conjunction with the master plan, a rate study was also completed by BC&A's financial subconsultant, Lewis Young Robertson & Burningham. The results of these activities are also documented in a separate report.

ACKNOWLEDGMENTS

The BC&A team wishes to thank the Public Works Advisory Committee as well as the following individuals from Orem City for their cooperation and assistance in working with us in preparing this report:

Chris Tschirki	Public Works Director
Neal Winterton	Water Resources Division Manager
Sam Kelly	City Engineer
Reed Price	Maintenance Division Manager
Cody Steggell	Streets Section Manager
Rick Sabey	Public Works Field Supervisor
Steve Johnson	Storm Water Engineering Specialist

PROJECT STAFF

The project work was performed by the BC&A team members listed below. Team members' roles on the project are also listed. The project was completed in BC&A's Draper, Utah office. Questions may be addressed to Keith Larson, Project Manager at (801) 495-2224.

Mike Collins	Principal-in-Charge
Keith Larson	Project Manager
Andrew McKinnon	Project Engineer
Mike Hilbert	Word Processing

CHAPTER 2
EXISTING FACILITIES

INTRODUCTION

As part of this Master Plan, BC&A has assembled an inventory of existing infrastructure within the storm water system. The purpose of this chapter is to present a summary of the inventory of Orem City's existing storm water system that can be used as a reference for future studies.

SERVICE AREA

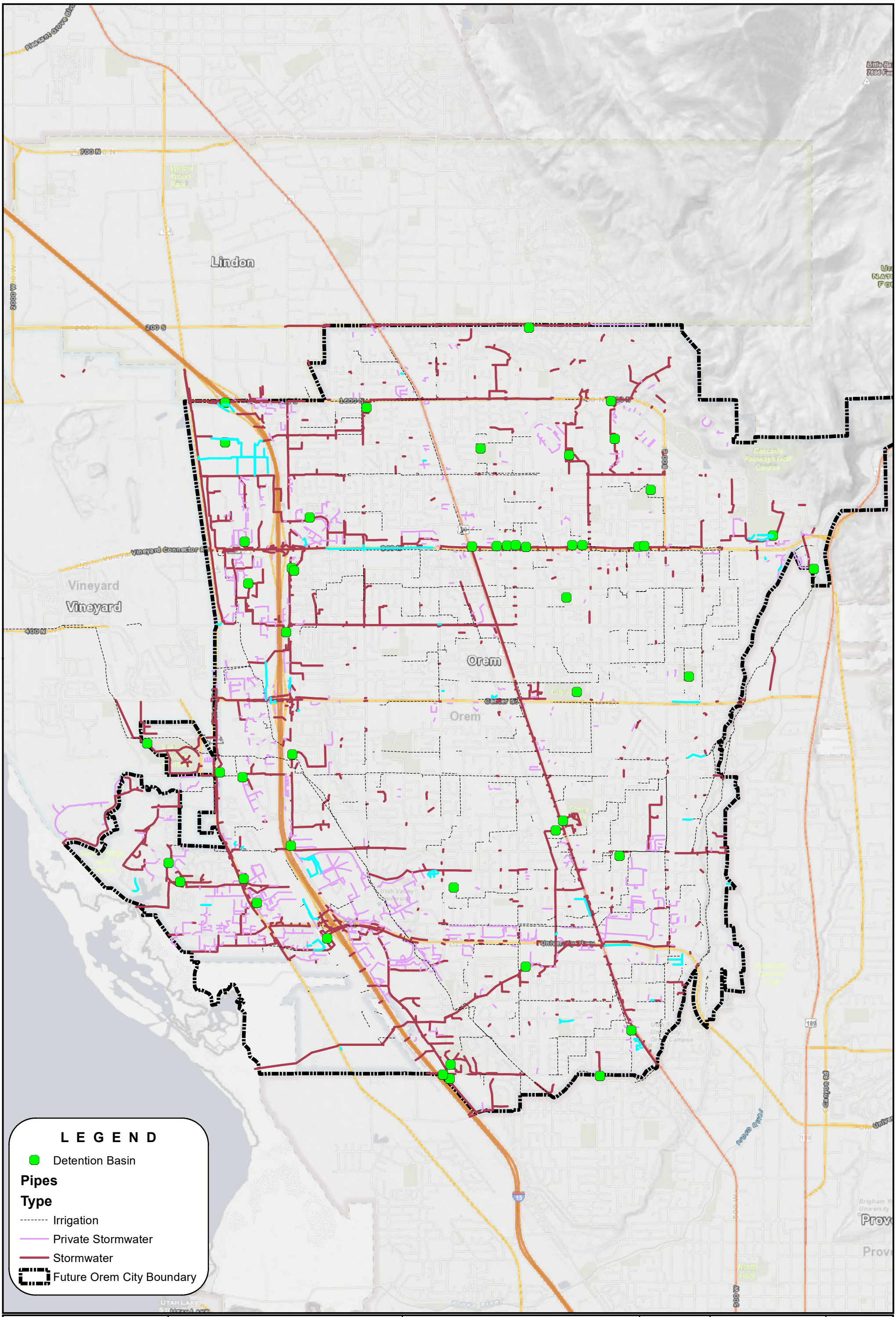
The City of Orem, is located about 30 miles south of Salt Lake City. Most of the City sits on a bench of the old Lake Bonneville. As a result, much of the City has relatively mild slopes with few major drainage channels. The Provo River runs along the eastern edge of the City, but only collects a small amount of runoff from the City. Most of the runoff from the City flows from east to west towards Utah Lake. Figure 2-1 shows the approximate planning extent of Orem along with the City's major storm water collection system components.

STORM WATER COLLECTION SYSTEM

There are just over 700,000 feet (134 miles) of storm water pipe and over 3,400 manholes in the Orem City Sewer System that are cataloged in the GIS database. Table 2-1 contains a summary of the storm water pipes for the Orem City collection system based on the City's GIS database. In addition to the storm water pipe lines included in the table, there are about 93 miles of irrigation canals, ditches, and pipe lines that can receive and convey limited amounts of storm water runoff.

Table 2-1
Orem Storm Water Pipe Lengths

Diameter (in)	Private Length (mi)	Public Length (mi)	Total Length (mi)
<12"	26	13	39
12"-17"	15	28	43
18"-23"	2	14	16
24"-29"	2	11	13
30"-35"	1	9	10
36"-41"	0	6	6
42"-47"	0	1	1
48"	0	1	1
>48"	0	3	3
Total	47	87	134



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

EXISTING STORM WATER SYSTEM

NORTH:

SCALE: 0 1,250 2,500 Feet

FIGURE NO. 2-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure2-1_Existing_Facilities.mxd amckinnon 9/22/2017

DETENTION BASINS

There are over 130 public and private detention facilities in the existing storm water system. The primary purpose of the detention facilities is to attenuate peak storm water discharges. However, many of the detention facilities also serve the dual purpose of a recreational park. Figure 2-1 shows all the regional detention facilities in the City. A total of 53 detention basins were included in the InfoSWMM model. The remaining portion of detention facilities in the City are considerably smaller detention basins and were not included in the model for this study. Those detention basins not included in the model generally serve a single development project and will be referred to as project level detention basins elsewhere in this report.

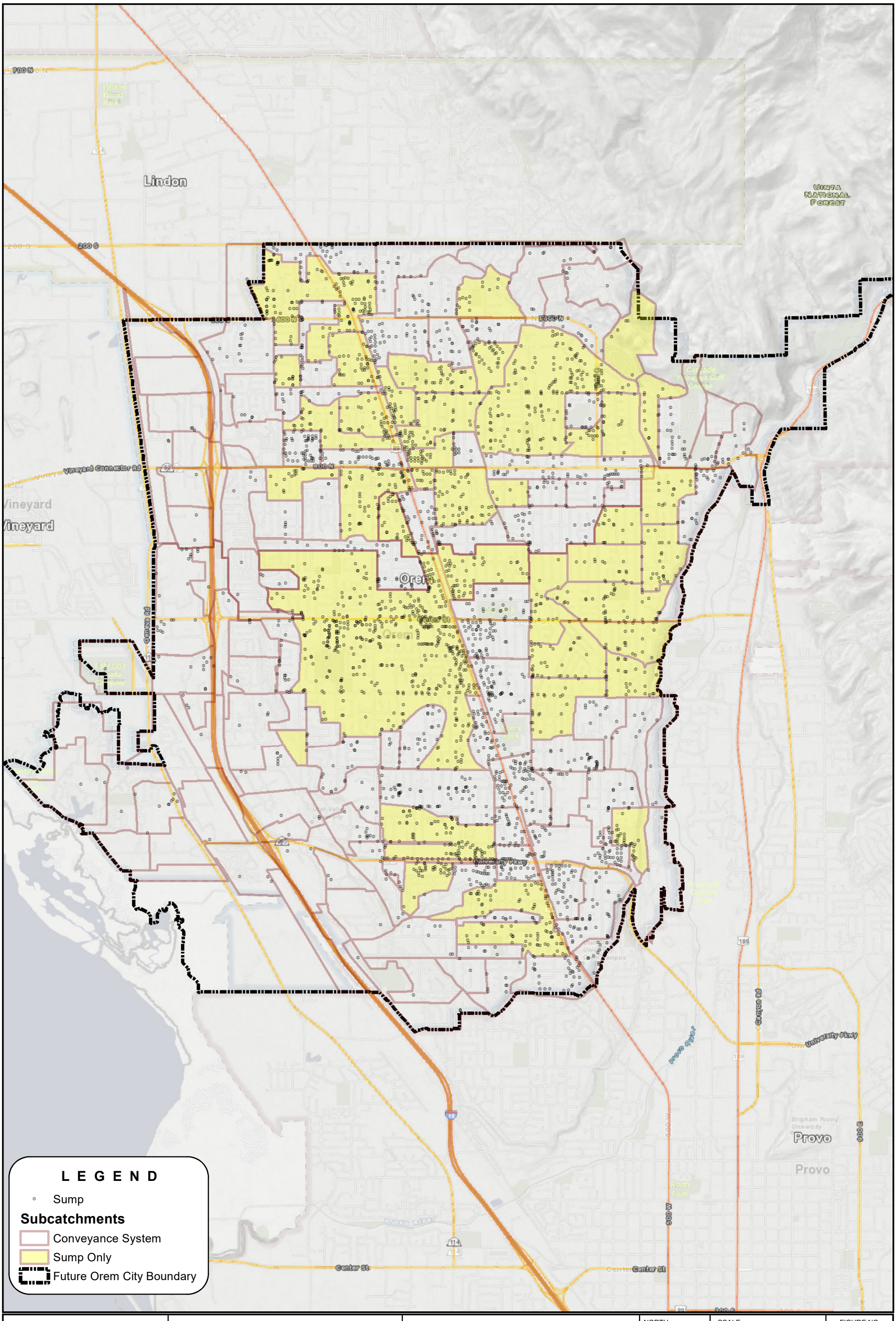
SUMPS AND INFILTRATION BASINS

A large portion of Orem City is built upon gravely soil which allows for significant infiltration of water. As a result, Orem City has historically used a large number of sumps and infiltration basins to capture and inject storm water into the ground. Currently, there are over 3,500 sumps located across most of Orem City as shown in Figure 2-2. From the City's GIS database, there are 1,821 Private and 1,752 Public sumps in Orem. Large portions of the city rely completely on sumps to manage the storm water runoff and are not connected to the storm water system of the City.

Orem City also has a few detention basins which have significant infiltration. Orem City personnel estimate the detention basins at Timpanogos High School and Bonneville ~~School~~ Park to have infiltration rates of 15 cfs and 10 cfs, respectively. There is also a perforated pipe in 400 North that has an estimated infiltration capacity of 70 cfs. With proper maintenance, it is expected that these facilities will continue to provide the stated infiltration rate into the future.

For the purpose of this report, the capacity/effectiveness of individual sumps was not analyzed. It was assumed that the areas with sumps that are not connected to the storm water system are currently effective in capturing the 10-year design storm event. As a result, it is not expected that these areas will produce runoff to surrounding subbasins during the 10-year event. Areas where this assumption has been made are shown in Figure 2-2. There are other areas of the City where sumps are interspersed with storm water pipes. To be conservative, the infiltration of sumps in areas connected to the collection system was not modeled.

It should be noted that with time, both sumps and infiltration basins may fill with sediment and other debris leading to a decrease in infiltration capacity. The city should maintain, monitor, and rehabilitate those facilities as necessary to maintain the necessary infiltration rates.



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

EXISTING SUMP STORM WATER SYSTEM

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 2-2

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure2-2_Existing_Sumps.mxd amckinnon 9/7/2017

CHAPTER 3
HYDROLOGIC ANALYSIS

To evaluate the capacity of the Orem City storm water system, it is necessary to perform both a hydrologic and hydraulic analysis. The hydrologic analysis estimates the storm water runoff volume and peak discharges generated by a design cloudburst event. The hydraulic analysis evaluates the capacity of storm water facilities to convey the predicted storm water discharges through the City. The purpose of this chapter is to document the hydrologic analysis performed for Orem City. Hydraulic modeling will be addressed in the following chapter.

HYDROLOGIC MODELING

Orem City was divided into two hydrologic study areas for the purposes of this master plan update, a North Study Area and a South Study Area. A hydrologic computer model was developed for both study areas in InfoSWMM, Suite 12.0. InfoSWMM uses an Environmental Protection Agency Storm Water Management Model (EPA-SWMM) engine to perform computations. As with EPA-SWMM, InfoSWMM has the capability to model the hydrologic and hydraulic components of storm water runoff, and was used to model both in this study.

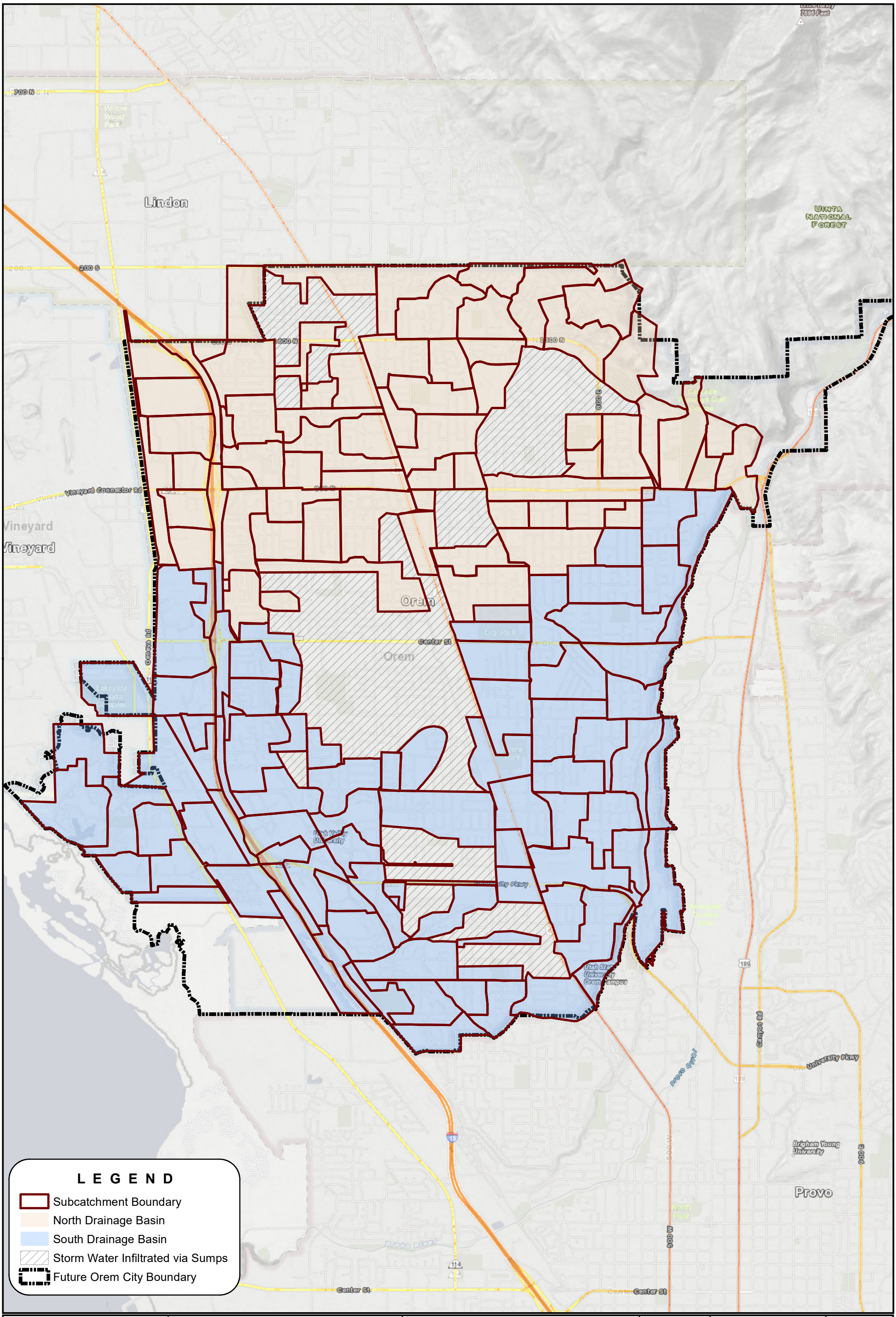
The hydrologic model development process includes delineating drainage basins, estimating hydrologic parameters, developing a design storm and calibrating the model. Each one of these steps is described below.

DRAINAGE BASIN DELINEATION

The first step in developing a computer hydrologic model is to delineate drainage basins and subcatchments. This involves dividing the overall service area into smaller areas based on topography. This is done for two reasons. First, it allows each area to be analyzed on a smaller scale to evaluate land use and development patterns more accurately. Second, it yields runoff projections that are distributed aerially across the service area, an important requirement when evaluating the capacity of individual facilities.

Two InfoSWMM models were developed for this study – a North Study Area and a South Study Area are shown in Figure 3-1[1]. As part of previous modeling efforts, Orem City staff had previously delineated over 450 drainage subcatchments in the City. Unfortunately, this large number of subcatchments resulted in an unwieldy model that was difficult to run and calibrate. Based on the City's experience with the previous model it was determined that some of the previous subcatchments should be combined to develop a more manageable model for this study. Ultimately, the number of subcatchments was reduced to approximately 150 for the two models. Subcatchment boundaries associated with the hydrologic model are shown in Figure 3-1.

[1] Hatched areas shown in the figure represent areas that are 100 percent captured by sumps in the safe sump zone. The unshaded area in the Southwest annexation area is considered to have its own independent storm water system that will drain directly to Utah Lake.



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

SUBCATCHMENT BOUNDARIES

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure3-1_Subcatchment_Boundaries.mxd amckinnon 11/15/2017

HYDROLOGIC MODEL PARAMETERS

The next step in developing the InfoSWWM hydrologic model is to define a set of hydrologic modeling parameters to be used for each subcatchment. Hydrologic parameters represent the physical characteristics of each subcatchment to be used in the calculation of potential runoff. Required hydrologic parameters will vary depending on the method of calculation selected for the model. For this study, the hydrologic calculation method is as follows:

- ***Hydrology Method.*** In the InfoSWMM software there are multiple options for Hydrology Method. The EPA-SWMM non-linear reservoir method was used in this study. The EPA-SWMM non-linear reservoir method is the same method EPA SWMM uses. This method requires "subcatchment width" and slope as input parameters. The subcatchment width was calculated using one of InfoSWMM's built in functions:

  $$W = k * Area^{0.5}$$

  Where:

  W – Subcatchment Width
  k – Coefficient
  Area – Area (acres)

  Several values of *k* were use throughout the City. See "Model Calibration" for additional information.

- ***Loss Method.*** The Soil Conservation Service (SCS) Curve Number method was used in InfoSWMM to calculate infiltration losses (see Natural Resources Conservation Service TR-55 publication for additional information). This method requires the input of a composite Curve Number and the percent impervious for each subcatchment.

These methods were selected because they are commonly used by professionals in the industry and have been shown to produce accurate results in neighboring communities.

Required hydrologic parameters for this approach are as follows:

- ***Composite Curve Number.*** Curve Numbers were estimated for each subcatchment based on soil type and vegetative ground cover. The hydrologic soil type was obtained from the Natural Resources Conservation Service Soil Survey Geographic (SSURGO) dataset. Table 3-1 shows the Curve Numbers used in this study, based on soil type and assumed vegetative ground cover for developed areas. See Appendix A for descriptions and locations of different soil types.

Table 3-1
SCS Curve Number

Soil Type	Curve Number*
A	39
B	61
C	74
D	80

* From Table 2-2 in TR-55 "Open Space – Grass Cover 75%"

- ***Directly-Connected Impervious Area.*** The amount of directly-connected impervious area for existing conditions was estimated using the City's 2012 High Resolution Orthophotography (HRO). Each land use type was analyzed and the estimated impervious area was recorded. The amount of directly-connected impervious area was also estimated for full build-out conditions based on land use from the General Plan. For areas that are currently undeveloped, the General Plan was used in conjunction with Table 3-2 to estimate the impervious area.

Table 3-2
Average Imperviousness Based on Land Use

General Plan Land Use Type	Directly Connected Imperviousness (Percent)
Open Space	0
Low Density Residential (LDR)	27
Medium Density Residential (MDR)	35
High Density Residential (HDR)	55
Industrial	72
Church	75
Light Industrial	85
Community Commercial	85
Professional Services	85
Regional Commercial	85

- ***Slope.*** The slope for each subcatchment was calculated using 2' contour data provided by Orem City. The average slope for each subcatchment was calculated using tools within InfoSWMM. Average slopes throughout the city ranged from 0.9% to 27%.

DESIGN STORM PARAMETERS

With the hydrologic parameters of each subcatchment defined, the next step in the modeling process is to select a design storm. The design storm defines how much precipitation falls and at what rate for a projected precipitation event. In the model, the design storm is applied to each subcatchment to see how much runoff is generated from the basin during the precipitation event.

The following data were used to define the design storm for this study, are commonly used by professionals in the industry, and have been shown to produce accurate results in neighboring communities:

- ***Storm Duration:*** 3 Hours
- ***Storm Distribution:*** Modified Farmer and Fletcher
- ***Recurrence Interval:***
    - Storm Water Pipelines: 10-Year Storm
    - Detention Basins: 25-Year Storm
- ***Storm Depth (From NOAA Atlas 14):***

  10-Year: 1.12 inches

MODEL CALIBRATION

The final step in the hydrologic modeling process is model calibration. In general, calibration of a hydrologic model of an urban area refers to the process of adjusting parameters to achieve results consistent with available reference information in nearby areas rather than adjusting for actual measured discharge observations in the study area.

Calibration Target Range

A study was performed in 1989 by the U.S. Geological Survey to help understand typical discharges for urban drainages along the Wasatch Front. The study was printed as the Water-Resources Investigations Report 89-4095 entitled, "Peak-Flow Characteristics of Small Urban Drainages along the Wasatch Front Utah". This report was used as a basis for estimating reasonable unit discharges for the subcatchments of Orem City. The hydrologic model output for the City was compared against expected results from this study to identify areas of needed calibration.

Subcatchment Width

The subcatchment width is the theoretical width of the overland flow. As documented above, calculation of the subcatchment width includes use of a coefficient that may vary depending on topographic and development conditions. For the purpose of this report, the subcatchment width coefficient was calculated as follows based on directly-connected impervious area (DCIA):

- Lower impervious areas (DCIA less than 38): $k = 0.2$
- Higher impervious areas (DCIA greater than 38): $k = 0.4$

Use of these coefficients achieved the best calibration between model results and expected unit discharges.

HYDROLOGIC MODELING ASSUMPTIONS

The following assumptions were also made in completing the hydrologic analyses of the study area:

1. Rainfall return frequency is equal to associated runoff return frequency.
2. Design storm rainfall has a uniform spatial distribution over the watershed.
3. Normal (SCS Type II) antecedent soil moisture conditions exist at the beginning of the design storm.
4. The hydrologic computer model adequately simulates watershed response to precipitation.
5. Hydrologic parameters for non-developable areas were assumed to have normal mid-summer vegetation cover, free from recent fire damage.
6. Runoff produced by the 10-yr storm event can collect in each detention basin and eventually flow into the City Facilities.
7. The collective assumption was made that there are enough existing storm water inlets in each subcatchment to collect runoff from a 10-year design storm event. In areas where ponding or flooding occurs, the inlet capacity should be evaluated and additional inlets should be added if necessary.

CHAPTER 4
HYDRAULIC MODELING

As discussed in the previous chapter, evaluation of the Orem City storm water system requires both a hydrologic and hydraulic analysis. The hydrologic analysis estimates to the storm water runoff volume and peak discharges generated by a design cloudburst event. The hydraulic analysis evaluates the capacity of storm drain facilities to convey the predicted storm water discharges through the City. The purpose of this chapter is to document the hydraulic analysis performed for Orem City.

A hydraulic computer model of the study area was developed in InfoSWMM, Suite 12.0. InfoSWMM uses an EPA-SWMM engine to perform hydraulic computations. There are two major types of data required to create a hydraulic model of a storm drain system, geometric data, and flow data. Development of the hydraulic model for each of these is discussed in the following sections.

GEOMETRIC MODEL DEVELOPMENT

Geometric data consists of all information in the model needed to represent the physical characteristics of the system, including pipelines, open channels and detention basins.

Modeled Conveyance

A basic framework for the model was developed using a previous InfoSWMM model provided by Orem City. Additional information on the physical characteristics of the trunklines included in the model was collected and assembled by Orem City personnel. The database included information on the type, diameter, depth, width, length, material and location of each pipe included in the model. Rim elevations were collected by a City survey crew. Inverts based on measure downs were included as well. Prior to finalizing the model, the profile of each existing trunkline was examined in the model for unusual data (i.e. adverse slopes, diameter contractions, etc.). Any areas identified as concerns were field verified by City personnel. Updated data was provided by City personnel and entered into the model.

It should be noted that the scope of this storm water master plan included a hydraulic analysis of only the storm water trunklines. The storm water trunklines included in the hydraulic model are shown in Figure 4-1. The storm drain trunklines that were evaluated in this model were coordinated with Orem City and generally exclude collection pipes with diameters under 18 inches and pipes that serve only a small area. Those pipelines not included in the model generally serve a single development project and will be referred to as project level pipelines elsewhere in this report.

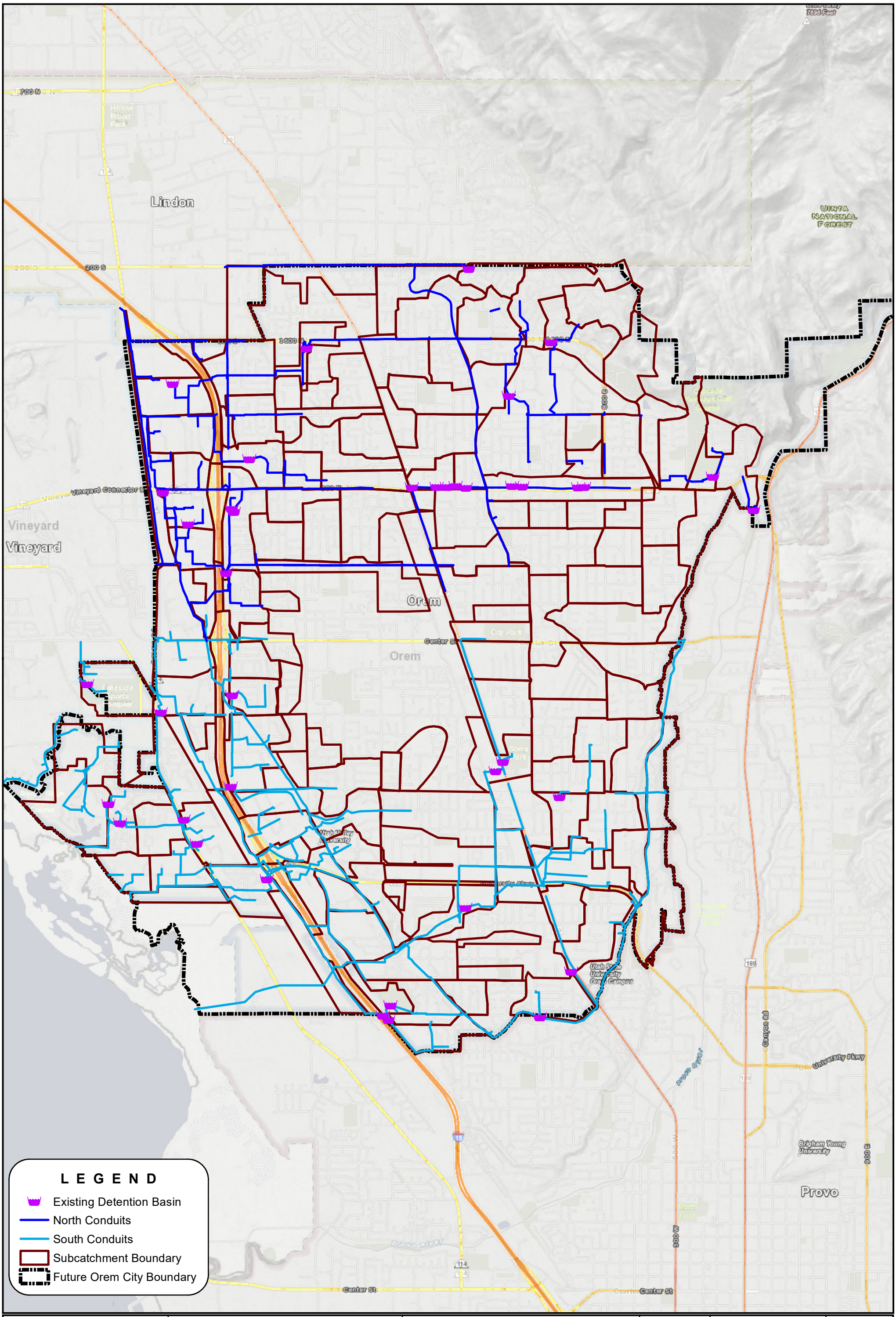
Detention Basins

Geometric information required for the modeling of detention basins includes storage volume and flow control data. Stage-storage curves for each detention basin were provided by City personnel and were entered into the model. Orifice information, including size, location, or lack thereof, was provided by the City, and was included in the existing conditions model. The majority of the detention basins are equipped with a flow control gate. Where flow control gates exist, orifice

sizes used in the model are an approximation based on the normal position of the gate reported by City personnel. If a detention facility does not currently have an orifice, it is recommended that a flow control gate be installed to regulate flow. Therefore, an outlet or an orifice was included on all detention facilities in the future conditions model. Future detention basins were modeled with a synthetic stage storage curve and an outlet that released the appropriate flow rate. Figure 4-1 shows the existing detention basins included in the model.

FLOW MODEL DEVELOPMENT

The second type of data required by the hydraulic model is storm drain runoff. Hydrologic parameters were estimated and a design storm was developed as described in Chapter 3. Subcatchment runoff (i.e. flow) was entered into the hydraulic model near the upstream side of each drainage area.



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

STORM WATER MODEL TRUNKLINES

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 4-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure4-1_Hydraulic_model.mxd amckinnon 11/15/2017

CHAPTER 5
SYSTEM EVALUATION

With the development and calibration of hydrologic and hydraulic storm water models, it is possible to simulate storm water system operating conditions for both existing and future conditions. The purpose of this chapter is to document the hydraulic performance evaluation of the collection system and identify potential hydraulic deficiencies.

EVALUATION CRITERIA AND LEVEL OF SERVICE

To evaluate the performance of the system, it is necessary to first define the required level of service for the various components of the system. There is no minimum State standard for storm water as there are with other utilities. Every city desires to protect their residents and infrastructure from flooding and attempts to balance the cost of storm drainage improvements with the potential for flow in the streets. The evaluation criteria for this study were provided by Orem City personnel at the beginning of this study and are documented below. The level of service provided by Orem City is consistent with the level of service provided by neighboring cities.

Storm Water Pipelines

Storm water pipelines should be designed to convey the 10-year storm event without surcharging into the street. In the event that storm water discharge is greater than the 10-year event, the pipes will pressurize and eventually surcharge into the streets. Since roadways become the major storm water conveyance facility during storms that are larger than the 10-year design event, it is important to design roadways with the capacity to convey flows for larger storms.

Open Channels

The City has historically relied on privately owned irrigation canals to convey storm water discharge in some areas. Because of concerns with water quality, canal capacity, liability issues, and maintenance, this master plan removes or minimizes discharge to open channels where possible. As a result, use of open channels to convey storm water in Orem City is expected to be limited.

Where storm water is conveyed in an open channel, the design criteria will vary depending on the consequence of overtopping. For small irrigation ditches or other open channels that can safely overtop into streets or other secondary conveyance facilities, open channels are expected to safely convey at least the 10-year design storm event. For larger canals where overtopping is not acceptable, storm water allowed to enter the channel should be limited to what can be safely conveyed. In some cases, the City will be eliminating connections to existing open channels (the West Union Canal) to reduce potential liability associated with channel overtopping.

It should be noted that flooding in large open channels may be regulated by the Federal Emergency Management Agency (FEMA). Currently there is only one floodplain in the City that is regulated by FEMA associated with the Provo River. Because there is only a minimal amount for storm water that Orem City discharges into the Provo River, evaluation of the floodplain was not

evaluated as part of this study. If there are new discharge points or locations where discharges are significantly increased, it will be necessary to contact the floodplain manager and obtain the necessary permits.

Culverts

Culverts should be designed to safely convey the 10-year design storm event except in locations where culvert surcharging would result in significant damage (i.e. areas with large embankments such as I-15). In these cases, culverts should be designed to safely convey at least the 100-year storm event.

Detention Basins

Detention facilities should be designed to have capacity for the 25-year design storm event, and have an emergency overflow with capacity greater than the 100-year storm event that directs water away from private property and into the streets or other secondary conveyance facilities.

Sumps and Infiltration Basins

There are currently over 3,500 sumps in Orem City. Sumps require special attention as they can impact both the storm water and drinking water systems. In Orem City's 1998 "Storm Drainage Master Plan", the City conducted an extensive review of the benefits and liabilities associated with using sumps as part of the City's overall storm water management system. As part of the evaluation, the City identified the following concerns regarding sumps:

- ***Groundwater Contamination*** – Sumps are used to inject storm water into the groundwater system. The City's historic sump design requirements do not provide for either "treatment" of storm water or structures for spill diversion or interception. Storm water may contain salts, oils, or other pollutants which are conveyed directly into the ground and may lead to contamination of drinking water wells. Loss of any of the City's existing drinking water wells to contamination would result in both immediate and long-term costs to the City.
- ***Regulation*** – Currently, storm water injection sumps are regulated under the State of Utah's Underground Injection Control (UIC) Program (Utah Administrative Code R317-7). As the program currently exists, storm water injection wells have a low priority in the regulatory process and do not require permitting. However, if it were determined by the Utah Department of Environmental Quality (UDEQ) that the sumps were degrading the quality of the aquifer, UDEQ could require a ground water discharge permit for each sump and treatment of all storm water prior to entering the sump. This would result in an immediate and significant economic impact to the City of Orem. Additionally, history has shown that storm water and drinking water requirements become more stringent with time. As regulations change, it is expected that requirements for treatment and maintenance at storm water injection sumps will significantly increase.
- ***Sump Maintenance*** – Storm water carries sediment and other debris which is deposited in the sumps. Over time this material accumulates in the voids, reducing the infiltration capacity of the sumps. If the sumps aren't cleaned and maintained, water will begin

ponding in the sumps and may lead to overtopping and possible flooding. Ongoing cleaning and maintenance costs associated with sumps represent a significant financial burden for the City.

At the end of the City's 18-month process of evaluating the use of storm water sumps, the following policy statement was adopted by City Council, City Staff, and the Citizens' Advisory Committee:

> *"The City of Orem, through a combined effort of the Water Utility and Storm Sewer Utility, should immediately begin a targeted and phased program of reducing the level of aquifer risk currently posed by its reliance on sumps for storm water disposal and ground water recharge… Design criteria and ordinances should be revised to include pre-treatment and spill diversion structures for all sumps located in Orem. Design criteria and ordinances should be revised immediately for new development to require pre-treatment and spill diversion structures for all sumps and to tie sumps together with a piping system as a provision to connect into a future conventional conveyance system. Longer term efforts, and the master planning currently underway, should evaluate the cost/benefit and timing of replacing the sumps on a priority basis with a lined or conventional storm water conveyance system."*

With the adoption of this policy, the City's subsequent 1998 Storm Water Master Plan developed a plan to eventually abandon nearly all of the sumps in the City's system.

Since the completion of the 1998 Master Plan, progress on the recommended storm water improvements has been limited. In short, the replacement of sumps with a typical storm water system consisting of catch basins, detention basins, and conveyance pipelines has been more expensive than could be supported through the City's existing capital facilities budget. After experiencing such little progress over the last two decades towards the ultimate goal, the City has realized that a more measured approach is necessary. As a result, this master plan seeks to better balance the goal of reducing risk to the City's aquifer against the ultimate cost of storm water improvements.

To optimize the storm water approach for Orem City, BC&A considered two issues that affect the level of risk associated with sumps:

- ***Wellhead Protection Zones*** **–** As part of the State of Utah Drinking Water Source Protection (DWSP) Rule, the City is required to define wellhead protection zones for each of its wells. Wellhead protection zones are defined areas of an aquifer that have significant potential to influence water quality at a well. The protection zones are defined based on the time of travel for a particle of water to move from a specific point to the well. For example, Zone 4 (the largest protection zone regulated by the DWSP Rule) includes all areas within a 15-year groundwater travel time to the wellhead. Because the entire east bench area of the City is classified as a primary or principal recharge area for the aquifer system, sumps located within the defined wellhead protection zones pose the highest immediate risk to the current City wells.

- ***Soil Type –*** Soils vary throughout Orem City. Soils consisting mostly of gravels and sands tend to be more effective at infiltrating storm water to the groundwater system. Soils consisting of clays and other fine materials have poor infiltration rates and are inefficient for the use of sumps.

With these two issues in mind, BC&A overlaid Orem City's wellhead protection areas along with known soil types in the City as shown in Figure 5-1. From this figure a "Safe Sump Zone" was defined that represents the area of lowest risk associated with continued operation of future sumps. This zone includes those sumps that are located in areas with a coarse gravel soil type, but also outside existing wellhead protection zones.

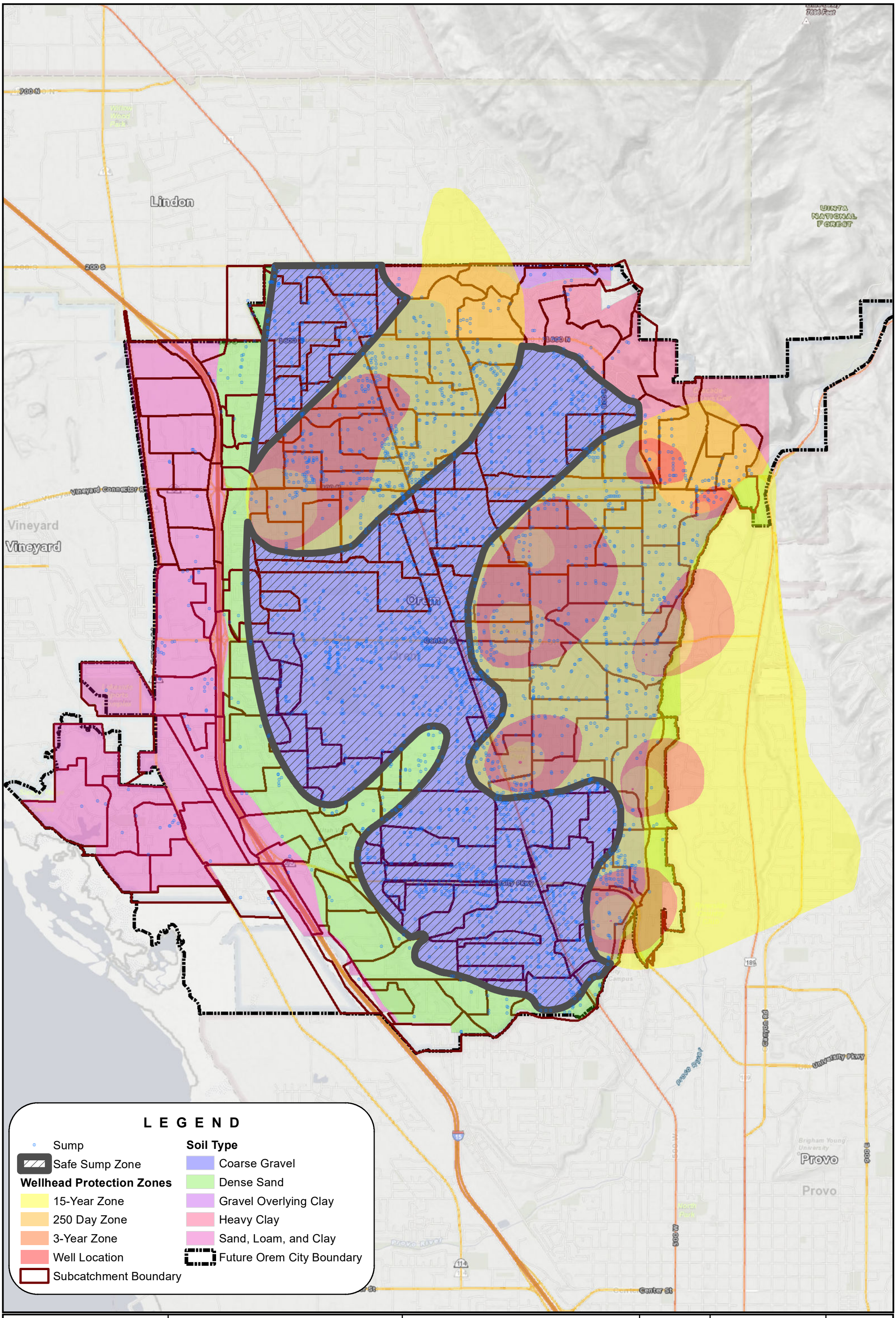
In this master plan, it has been assumed that the City will continue to use and maintain existing sumps shown in the "Safe Sump Zone". Due to the water quality, regulation, and maintenance concerns identified above, it has been assumed that sumps located outside of the "Safe Sump Zone" will be systematically removed and replaced with a storm water system consisting of catch basins and conveyance pipelines.

EXISTING CONVEYANCE SYSTEM ANALYSIS

Figures 5-2a and 5-2b show the model results for the storm water system under existing development conditions and the design criteria defined above. Model results identify where overtopping occurs in the storm water system during the design storm event. As can be seen from the figures, a significant number of both detention basins and pipe lines were found to be deficient. It should be noted that these results are based on the City's long-term plan to abandon sumps outside the Safe Sump Zone and assume that the sumps have already been decommissioned. This will obviously not occur immediately. As a result, many of the deficiencies shown in the figure are unlikely to be observed today. However, as the sumps lose capacity or are abandoned in the future, it is likely these deficiencies will become more prevalent without mitigating action.

FUTURE CONVEYANCE SYSTEM ANALYSIS

A few of the existing storm water collection trunks in Orem are undersized for ultimate development conditions in Orem. Additional trunks will need to be constructed. Also, there are several detention basins that need to be constructed/modified. Chapter 6 discusses conceptual improvements that will be needed to fix existing deficiencies, serve areas currently using sumps, and accommodate future growth.



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

SAFE SUMP ZONE

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 5-1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure5-1_Sump_Areas.mxd amckinnon 9/7/2017

LEGEND

Junction
- No Flooding
- Flooding

Detention Basin
- No Overtopping
- Overtopping
- Subcatchment
- Conduit

NORTH:

SCALE: 0 1,000 2,000 Feet

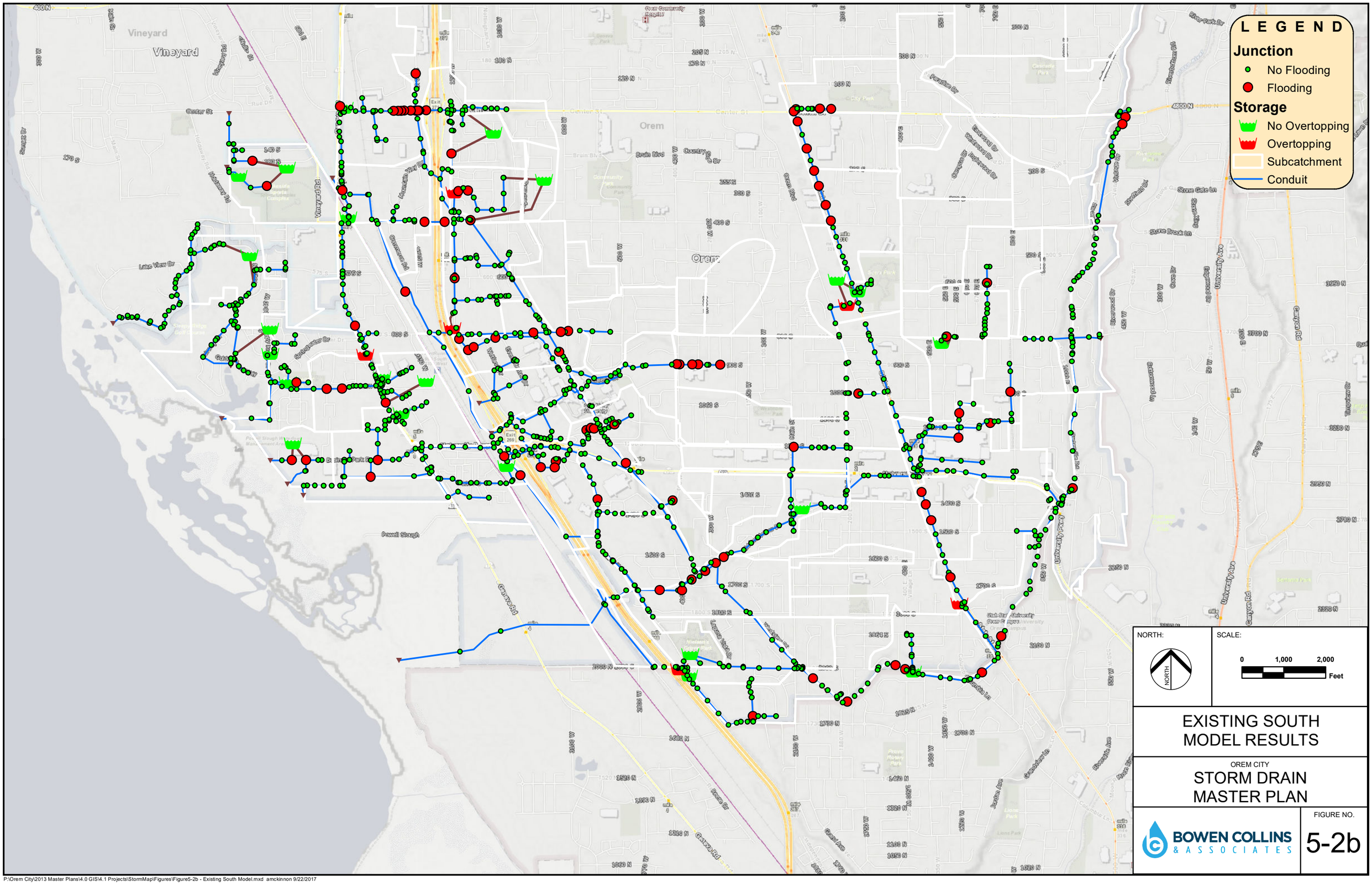
EXISTING NORTH MODEL RESULTS

OREM CITY
STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
5-2a

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure5-2a - Existing North Model.mxd amckinnon 9/22/2017



EXISTING SOUTH MODEL RESULTS

OREM CITY
STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
5-2b

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figures\Figure5-2b - Existing South Model.mxd amckinnon 9/22/2017

CHAPTER 6
RECOMMENDED SYSTEM IMPROVEMENTS

The InfoSWMM model was used to evaluate various alternatives for mitigating the identified storm water system deficiencies and for sizing future storm water facilities under projected future development conditions. The purpose of this chapter is to document recommended system improvements based on the model results.

TYPES OF RECOMMENDED IMPROVEMENTS

The recommended improvements identified in this master plan include only major storm water facilities. Local storm water facilities, typically associated with development projects, are not included in the storm water master plan. A brief description of the difference between local facilities and major facilities are found below.

- **Major Conveyance Facilities** – Major storm water conveyance facilities include pipelines or major channels that typically service multiple developments. Local facilities include smaller storm water conveyance facilities that typically only serve one small development, and are used to convey storm water runoff from the 10-yr design storm to the major conveyance facilities.
- **Regional Detention Facilities** – Major storm water detention facilities (also referred to as regional detention facilities) are those facilities that collect runoff from multiple developments and attenuate peak runoff to levels as necessary to support the master plan capacities of downstream facilities. In addition to regional detention facilities, Orem City requires all new development to provide local detention facilities to limit peak discharge from storm water runoff from the development. While the local detention facilities are important to the City's overall storm water system success, they are not individually considered here.

Improvement Approach

In accordance with instruction from City personnel, BC&A used the 1998 Master Plan's recommended improvements as a starting point for developing the recommended improvements outlined in this chapter. With the updated model results, BC&A and City personnel then modified the historic improvement plan to take advantage of opportunities to increase performance and minimize costs. This included considerable time identifying likely pipeline corridors and potential detention basin properties, and then balancing the cost of detention against the cost of conveyance.

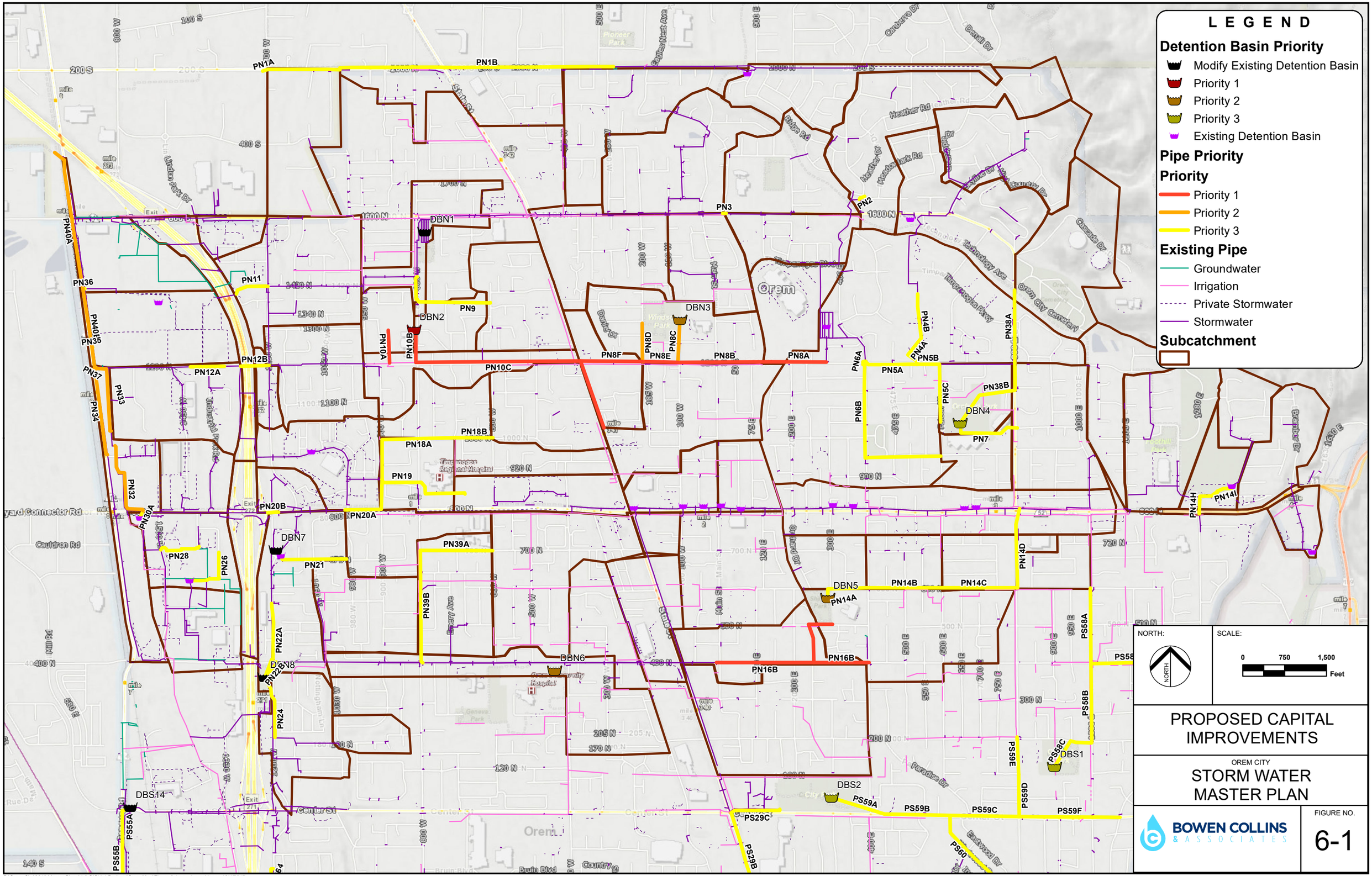
This chapter documents the most cost-effective approach to future improvements based on available information regarding likely detention basin properties and other system conditions. While this master plan will provide a good outline for planning and budgeting purposes, it is recommended that each project be examined in detail as part of final design. With the additional information available during detailed design, it is expected that the City will be able adjust some of the components of each project to further optimize overall system performance.

RECOMMENDED PIPELINE IMPROVEMENTS

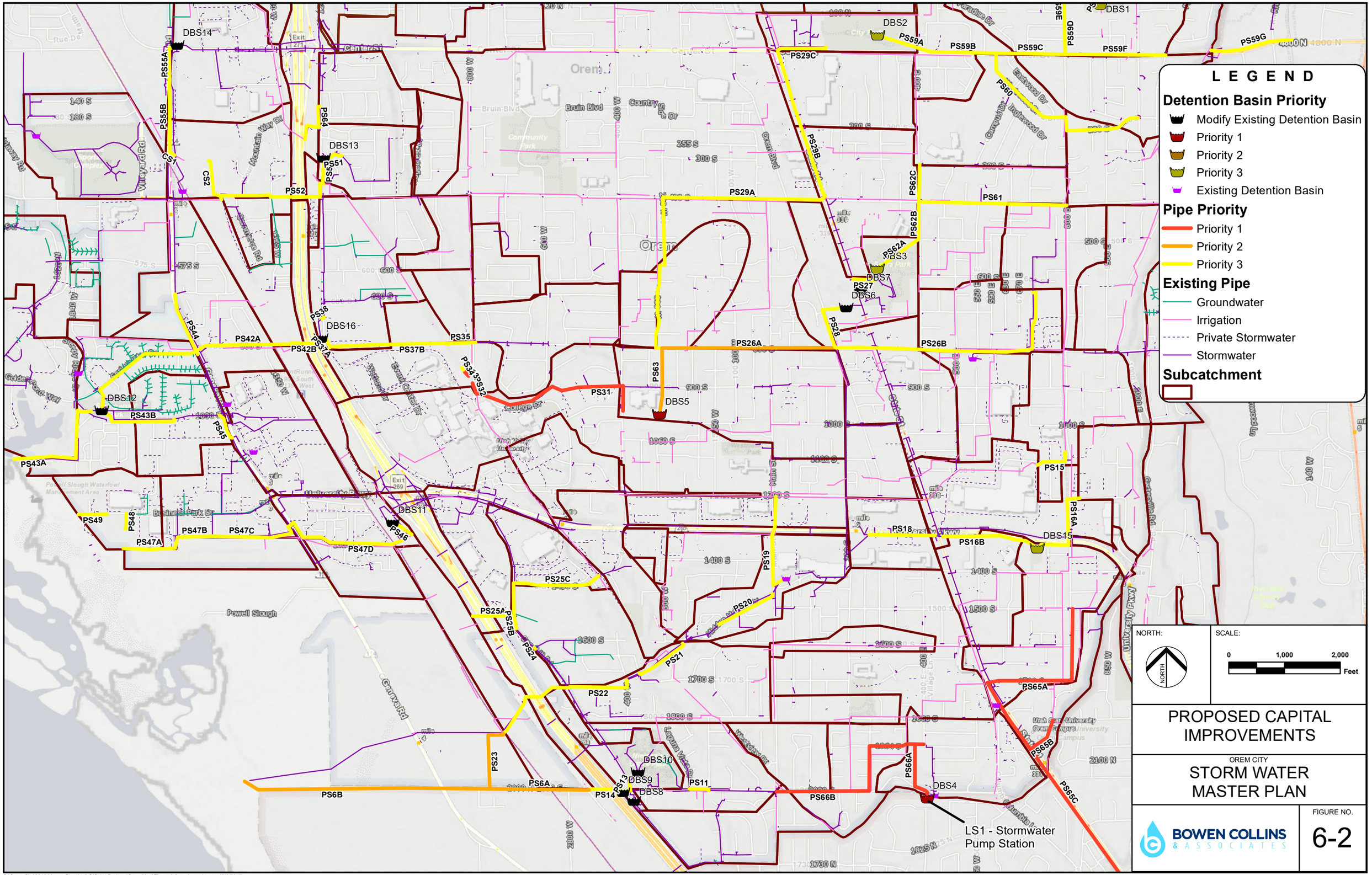
Figures 6-1 and 6-2 show the location of recommended storm water pipeline improvements. Basic information regarding each improvement is summarized in Table 6-1. Included in the table is the cost of the proposed pipe improvements in 2017 dollars. For more detailed mapping and model results associated with each pipeline project, see Appendix B. For a detailed cost estimate of each of the pipelines and all other types of recommended improvements, see Appendix C.

Table 6-1
Storm Water Trunkline Improvements

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)****	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PS65A	Well #1 Bypass Drain	3,270	30	$846,200	1	2017-2018	27.133	New
PN16B	250 E	3,864	24	$861,100	1	2018	11	New
PS32	Heat Plant Rd (A)	207	42	$70,900	1	2018	53	Upsize
PS33	Heat Plant Rd (B)	160	42	$55,700	1	2018	52	Upsize
PS65B	750 East Tailwater	675	24	$168,200	1	2018	11.021	New
PS31	900 S	3,240	18	$656,500	1	2018-2019	8	New/Upsize
PS65C	State Street, Columbia Ln & South	3,850	42	$1,646,200	1	2018-2020	95.318	Upsize
PN10C	1200 N (A)	4,230	42	$1,488,800	1	2019-2021	75	New
PS66B	2000 S (B)	3,450	24	$754,600	1	2020	10	New
PS66A	2000 S (A)	1,113	18	$222,800	1	2020-2021	4.613	New
PN10A	Bonneville School	590	18	$116,500	1	2021	4	New
PN10B	800 W	680	48	$274,400	1	2022	75	New
PN8A	1200 N (B)	990	24	$217,300	1	2022	17	New
PN8B	1200 N (C)	1,670	30	$433,200	1	2022	17	New
PN8E	1200 N (D)	690	18	$139,400	1	2022	5	New
PN8F	1200 N (E)	1,110	24	$240,200	1	2022	9	New
PS6B	2000 S (B)	4,450	36	$1,352,000	2	2023-2024	90	New
PS63	Lake Ridge Jr. High	2,400	36	$722,800	2	2023	148	New Parallel (2)
PS23	Taylor Drain Outlet	1,280	42	$451,900	2	2024	47	New
PN8D	200 W	700	18	$141,200	2	2025	4	New
PS26A	800 S (C)	3,130	42	$1,099,100	2	2025	74	New
PN34	Geneva Rd (B)	2,400	36	$722,800	2	2026	21	Upsize
PN40A	Geneva Rd (A)	90	36	$48,800	2	2026	137 (185)	Parallel



P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figure 6-1a.mxd amckinnon 12/4/2017



P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figure 6-2.mxd amckinnon 12/6/2017

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)****	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN40B	Geneva Rd (C)	1,070	66	$597,900	2	2026	123 (154)	Parallel
PN8C	100 W	770	24	$165,900	2	2026	12	New
PN33	1200 N (H)	1,370	42	$481,000	2	2026-2027	67 (145)	Parallel
PN32	800 N (C)	1,550	54	$706,500	2	2027	136	Upsize
PS6A	2000 S (A)	1,780	30	$458,600	3	2027	54	New
PN12A	1200 N (F)	620	36	$187,100	3	2027-2028	87	Upsize
PN11	1420 N	640	36	$192,500	3	2028+	95	Upsize
PN12B	1200 N (G)	520	24	$112,700	3	2028+	47	Upsize
PN14A	600 N (A)	860	30	$221,600	3	2028+	68	New
PN14B	600 N (B)	1,360	30	$352,100	3	2028+	54	New
PN14C	600 N (C)	1,350	30	$349,800	3	2028+	39	New
PN14D	800 E (A)	1,430	30	$368,300	3	2028+	30	New
PN14G	Foothill School	700	18	$141,200	3	2028+	6	Reroute
PN14H	Cascade Pkwy (A)	1,190	30	$303,300	3	2028+	26	Upsize
PN14I	Cascade Pkwy (B)	290	24	$59,300	3	2028+	14	Upsize
PN18A	1000 N (A)	2,040	42	$716,600	3	2028+	64	New
PN18B	1000 N (B)	670	36	$200,700	3	2028+	39	New
PN19	Timpanogas Hospital	1,700	30	$440,100	3	2028+	21	Upsize
PN1A	2000 N (A)	110	36	$33,800	3	2028+	94	Upsize
PN1B	2000 N (B)	3,450	30	$893,300	3	2028+	66	Upsize
PN1C	2000 N(C)	2,780	30	$719,600	3	2028+	42	Upsize
PN2	Moore Ln	120	30	$31,700	3	2028+	51	Upsize
PN20A	800 N (E)	1,160	42	$403,600	3	2028+	80	New/Parallel
PN20B	800 N (F)	400	30	$105,800	3	2028+	87	Parallel
PN21	675 N	1,240	18	$254,400	3	2028+	18	New
PN22A	1200 W (A)	340	36	$101,700	3	2028+	73	Upsize
PN22B	Orem Skate Park (A)	1,040	36	$310,500	3	2028+	56 (73)	Parallel
PN22C	Orem Skate Park (B)	350	30	$90,300	3	2028+	52 (76)	Parallel
PN24	1200 W (B)	1,130	36	$334,900	3	2028+	37	Upsize
PN26	1340 E	1,050	18	$211,800	3	2028+	15	Upsize
PN28	1370 W	800	24	$175,600	3	2028+	22	Upsize
PN3	1600 N	70	24	$17,300	3	2028+	14 (29)	Parallel
PN30A	800 N (B)	140	48	$56,500	3	2028+	136	Upsize
PN35	Geneva Rd (J)	20	60	$13,600	3	2028+	18	Connect Parallel Lines

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)****	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PN36	Geneva Rd (K)	40	60	$23,200	3	2028+	16	Connect Parallel Lines
PN37	Geneva Rd (L)	60	60	$32,800	3	2028+	21	Connect Parallel Lines
PN38A	800 E (B)	1,310	24	$287,900	3	2028+	15	New
PN38B	Orchard Park (A)	1,740	30	$449,300	3	2028+	14	New
PN39A	Orem Jr. High (A)	1,140	36	$337,600	3	2028+	26	New
PN39B	Orem Jr. High (B)	2,030	18	$411,300	3	2028+	4	New
PN4A	Research Way (A)	640	24	$141,100	3	2028+	13	Upsize
PN4B	Research Way (B)	800	24	$175,600	3	2028+	13	Upsize
PN5A	1200 N (I)	950	36	$286,100	3	2028+	27	Upsize
PN5B	1200 N (J)	410	30	$108,200	3	2028+	16	Upsize
PN5C	Falcon Way	1,030	18	$208,300	3	2028+	7	New
PN6A	400 E (A)	120	30	$31,700	3	2028+	18	New
PN6B	400 E (B)	3,040	24	$666,900	3	2028+	18	New
PN7	Orchard Park (B)	1,010	30	$261,800	3	2028+	25	New
PN9A	1360 N (A)	1,340	36	$401,300	3	2028+	41	New
PN9B	1360 N (B)	880	36	$261,600	3	2028+	50	Upsize
PS11	2000 S (C)	380	36	$112,500	3	2028+	36	Upsize
PS13	Nielson Grove Park	300	36	$90,800	3	2028+	43	Upsize
PS14	2000 S (D)	570	30	$145,100	3	2028+	18	Upsize
PS15	1100 S	690	36	$206,100	3	2028+	49	Upsize
PS16A	800 E (C)	1,660	36	$497,600	3	2028+	43	New
PS16B	University Pkwy (B)	1,680	30	$435,500	3	2028+	28	New
PS18	University Pkwy (C)	1,190	48	$475,400	3	2028+	96	Upsize
PS19	Main Str.	1,870	30	$484,900	3	2028+	11	Upsize
PS20	Hidden Hollow Dr. (A)	1,130	36	$334,900	3	2028+	17 (55)	Parallel
PS21	Hidden Hollow Dr. (B)	1,010	36	$302,400	3	2028+	60	Upsize
PS22A	400 W (A)	1,210	36	$366,100	3	2028+	77	Upsize
PS22B	400 W (B)	1,530	36	$458,400	3	2028+	62	Upsize
PS24	Sandhill Rd (B)	40	24	$11,600	3	2028+	4	Connect Parallel Lines
PS25A	I-15 & 1500 S	750	42	$261,500	3	2028+	67	Upsize
PS25B	Sandhill Rd (A)	240	36	$69,000	3	2028+	35	Upsize

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)****	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PS25C	1430 S, Canal outfall	2,200	36	$659,000	3	2028+	31.146	New
PS26B	800 S (D)	4,600	30	$1,192,900	3	2028+	24	New/Upsize
PS27	Scera Park (A)	390	24	$83,900	3	2028+	13	New
PS28	Orem Blvd	1,100	42	$384,200	3	2028+	39 (54)	Parallel
PS29A	400 S (A)	11,720	30	$3,041,400	3	2028+	64	New Parallel (2)
PS29B	State Str	4,360	36	$1,303,300	3	2028+	38	Parallel
PS29C	Center Str (A)	1,490	30	$382,100	3	2028+	36	Upsize
PS35	800 S (E)	540	30	$138,200	3	2028+	42	Upsize
PS37A	College Dr (A)	270	36	$77,200	3	2028+	105	Upsize
PS37B	800 S (F)	2,120	36	$637,300	3	2028+	72	Upsize
PS38	College Dr (B)	50	36	$17,500	3	2028+	61	Upsize
PS39	Union Canal (D)	820	48	$330,900	3	2028+	50	Upsize
PS41	Union Canal (E)	60	48	$26,500	3	2028+	49	Upsize
PS42A	800 S (A)	4,090	42	$1,438,000	3	2028+	105	New
PS42B	800 S (B)	510	42	$178,400	3	2028+	108	Upsize
PS43A	Sprinwater Park Out	2,250	54	$1,045,400	3	2028+	143	Upsize
PS43B	Sprinwater Park In	1,440	36	$428,400	3	2028+	39 (62)	Parallel
PS44	Geneva Rd (E)	1,180	36	$348,500	3	2028+	27	Upsize
PS45	Geneva Rd (F)	500	24	$108,800	3	2028+	17	Reroute
PS46	Kent Drain	410	60	$210,200	3	2028+	73	Reroute
PS47A	1330 S	940	60	$479,600	3	2028+	147	Upsize
PS47B	1300 S (A)	830	54	$378,000	3	2028+	137	Upsize
PS47C	1300 S (B)	1,460	48	$586,300	3	2028+	93.0	Upsize
PS47D	1300 S (C)	2360	36	$702,400	3	2028+	52	Upsize
PS48	Business Park Dr (A)	280	36	$79,900	3	2028+	24	Upsize
PS49	Business Park Dr (B)	520	24	$133,100	3	2028+	11	Upsize
PS51A	1200 W (C)	450	24	$99,300	3	2028+	28	Upsize
PS51B	1200 W (D)	360	24	$78,200	3	2028+	17	Upsize
PS52	400 S (B)	2,065	24	$450,900	3	2028+	12	Upsize
PS55A	Geneva Rd (G)	710	54	$322,700	3	2028+	96	Upsize
PS55B	Geneva Rd (H)	1,290	60	$677,500	3	2028+	111	Upsize
PS58A	1000 E (A)	1,350	36	$404,000	3	2028+	40	New
PS58B	1000 E (B)	2,820	36	$846,100	3	2028+	100	New Parallel (2)

Project Id	Project Name	Pipe Length (ft) ***	Diameter (in)****	Estimated Cost (Contingency, Engineering, Admin, and Legal Fees)	Priority Level	Build Year	Design Flow Rate (cfs)*	Status **
PS58C-1	Cascade Park	940	36	$283,400	3	2028+	52 (132)	New Parallel (PS58C-2)
PS58C-2	Cascade Park	940	42	$332,400	3	2028+	70 (132)	New Parallel (PS58C-1)
PS58D	400 N (B)	1,310	36	$393,200	3	2028+	45	New
PS59A	City Park In	2,000	42	$703,700	3	2028+	125	New Parallel (2)
PS59B	Center Str (D)	2,360	36	$702,400	3	2028+	107	New Parallel (2)
PS59C-1	Center Str (E)	1,250	30	$326,700	3	2028+	35 (85)	New Parallel (PS59C-2)
PS59C-2	Center Str (E)	1,250	36	$376,900	3	2028+	50 (85)	New Parallel (PS59C-1)
PS59D	800 E (D)	760	36	$225,100	3	2028+	37	New
PS59E	800 E (E)	670	30	$173,700	3	2028+	25	New
PS59F	Center Str (F)	1,810	24	$398,300	3	2028+	19	New
PS59G	Center Str (G) to Provo	1,477	24	$340,100	3	2028+	5	New
PS60	Westwood Dr	3,500	36	$1,045,600	3	2028+	25	New
PS61	400 S (C)	2,660	30	$686,300	3	2028+	24	New
PS62A	Scera Park (B)	1,840	36	$551,900	3	2028+	69	New Parallel (2)
PS62B	400 E (C)	1,360	30	$352,100	3	2028+	69	New Parallel (2)
PS62C	400 E (D)	680	24	$148,700	3	2028+	18.0	New

* First number is the design flow for the proposed parallel pipe. Value in Parenthesis is the total combined design flow.
** Values in Parentheses represents the number of new parallel pipes.
*** Lengths account for the total length of all barrels even when multiple barrels are present.
**** Diameters are approximate based on pipe slope estimated from existing topography. Actual size should be reevaluated at final design and may vary from the size shown depending on final pipe slope.

OPEN CHANNEL IMPROVEMENTS

The West Union Canal is the largest open channel in the City that is used by the City for storm water conveyance. The canal company is in the process of phasing out operation of the canal, especially in hazardous locations. As a result, the City needs to begin phasing out use of the canal for City storm water conveyance with priority on areas where there are maintenance or overtopping concerns. The City's long-term goal is to remove all public right-of-way drainage to the canal where possible.

All projects required to eliminate storm water concerns with the West Union Canal have been included as part of the overall list of pipeline improvements summarized in Table 6-1. Most projects associated with the decommissioning of the West Union Canal will include relatively minor pipe work to eliminate small, local drainage discharges to the canal. However, there are

several pipe projects listed in Table 6-1 that will be needed to eliminate larger drainage areas. Of special note are the following:

- Project PS65 will eliminate all connections to the canal between University Parkway and State Street (including the bypass for Well #1). A couple items should be noted about this project. First, costs for the reach of pipe between Columbia Lane and the Provo River have been estimated based on a pipeline sized to convey only Orem City storm water runoff. There may be an opportunity to reduce cost by partnering with UDOT. UDOT may also be interested in reducing its potential liability associated with discharging to the West Union Canal and choose to join with the City in building a combined pipeline along this reach. Second, detention options may be more cost effective than this pipeline if property or easements can be purchased to provide sufficient detention to keep stormwater runoff from this area at flows that are less than or equal to historical flows. This would completely eliminate the need to upsize existing pipes in State Street.

- Once the canal company phases out use of the canal, Orem City will also need to construct Project 66, a detention basin and storm water pump station to remove storm water from the canal at 424 East. The City has an existing detention basin at 424 East that discharges into the canal. Any detention basin discharge that currently flows to the canal will be redirected to a new detention facility and pump station south of the canal in Provo City (near 1500 West 1970 North, Provo). This detention basin and pump station will need to be sized to accommodate runoff from a 100-year storm event. Storm water pump stations are generally not ideal solutions for storm water conveyance due to the maintenance concerns and high capacities sometimes required. Alternatives to a storm water pump station at this location may include infiltrating storm water into the ground assuming there is sufficient detention area and soil conditions permit, or conveying flow through Provo City in existing ditch pipes (eventually connecting to Provo City storm drain pipes). For the purpose of this study, it was assumed a pump station will be needed due to uncertainty about the permeability of soil at the proposed detention site and the condition of existing ditch pipes in Provo City (including negotiations with Provo City for maintenance).

DETENTION BASIN IMPROVEMENTS

Figures 6-1 and 6-2 show the location of recommended detention basin improvements. Table 6-2 lists the recommended detention volumes, discharge rates, and costs for detention basin improvements in Orem City. Where applicable, property acquisition costs have been estimated between $150,000/acre and $200,000/acre and were included in the total cost estimate.

Table 6-2
Required Capacity at Detention Basins

Project Identifier	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Volume (acre-ft)	Discharge Rate (cfs)	Status*
DBN1	Bonneville Park	$20,400	0	8	Modify
DBN2	Bonneville School	$454,700	2.8	3.5	New
DBN3	Windsor Park	$513,600	3.2	7.5	New
DBN4	Orchard Park	$233,700	1.3	6.5	New
DBN5	Sharon Park	$618,200	3.91	19	New
DBN6	Orem Community Hospital	$425,100	2.6	5	New
DBN7	1200 W 675 N	$20,400	0	13.5	Modify
DBN8	Orem Skate Park	$20,400	0	42	Modify
DBS1	Cascade Park	$734,600	4.7	15.5	New
DBS2	City Park	$1,383,200	9.1	18	New
DBS3	Scera Park (A)	$572,500	3.6	9.5	New
DBS4	424 E West Union Canal	$423,500	1	4.4	New
DBS5	Lakeridge Jr. High	$970,500	6.3	6.5	New
DBS6	700 S & State Str.	$20,400	0	41	Upsize
DBS7	Scera Park (B)	$20,400	0	3	Upsize
DBS8	Ercanbrack East	$20,400	0	7	Modify
DBS9	Ercanbrack West	$20,400	0	54	Modify
DBS10	Nielson's Grove	$20,400	0	36	Modify
DBS11	Kent Drain	$20,400	0	61	Modify
DBS12	Springwater Park	$20,400	0	144	Modify
DBS13	12th West	$20,400	0	16.5	Modify
DBS14	Geneva Rd. & Center Str.	$20,400	0	47	Modify
DBS15	Hillcrest Park	$306,100	1.8	28	New
DBS16	8th S & 12th W	$20,400	0	110	Modify

* Where status is identified as “Modify”, the outlet works should be modified to match the discharge rate shown. Where status is identified as “Upsize”, the volume identified is the additional volume to be added at the existing basin.

STORM WATER PUMP STATION

A storm water pump station is proposed at 424 East, south of the existing West Union Canal as indicated in Figure 6-2. Table 6-3 summarizes characteristics for the pump station assuming the detention volume for the new DBS4 detention basin is 1 acre-ft and the basin is drained in approximately 12 hours.

Table 6-3
Pump Station Characteristics

Project Identifier	Project Location	Lift (ft)	Flow (cfs)	Power (HP)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
LS1	424 East West Union Canal	60	4.4	41.6	$363,000

CULVERT IMPROVEMENTS

Figures 6-1 and 6-2 show the location of recommended storm water culvert improvements. Table 6-4 lists the recommended culvert capacity and costs needed in Orem City.

Table 6-4
Required Capacity at Culverts

Project Identifier	Project Name	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)	Design Flow/ Discharge Rate (cfs)
CS1	Geneva Rd	$72,000	125
CS2	400 South, 1500 West	$681,700	59

ALTERNATIVE DETENTION IMPROVEMENTS

As noted previously, this chapter documents the most cost-effective approach to future improvements based on available information regarding likely detention basin properties and other system conditions. However, some additional project optimization may be possible if the City can secure additional properties for detention basins other than those initially identified. In order to evaluate this possibility, BC&A examined the potential costs savings associated with adding detention to some of the City's major storm water outfalls. The results of this analysis are contained in Appendix D.

CHAPTER 7
IMPLEMENTATION PLAN

In Chapter 6, a capital improvement plan was developed identifying and prioritizing all recommended improvements in the Orem City storm water system. The purpose of this chapter is to develop a 10-year implementation plan for the highest priority of these improvements. This plan will serve as a guideline for the budgeting and construction of recommended system improvements over the next 10 years. This will include a discussion of levels of funding for system maintenance, replacement, and capital improvement projects.

CAPITAL IMPROVEMENT PLAN SUMMARY

The recommended capital improvements for Orem's storm water system are summarized in Table 6-1 of the previous chapter in this report. Included in the table is a summary of each project, along with its estimated construction cost. The table includes improvements to the conveyance system, detention basins, removal of sumps, and other miscellaneous improvements.

As outlined in Chapter 6, there are several high priority projects related to existing conveyance deficiencies, sump removal, and deficiencies associated with future growth. Based on these high priority projects, City personnel identified problem areas which they plan to resolve in the next 10-years. It is estimated that an average annual cost of $1.7 million dollars will be required for construction of these capital improvement projects.

10-YEAR IMPLEMENTATION PLAN

While Table 6-1 displays all projects needed to serve the system through build-out, of particular interest is the development of a schedule for projects over the next 10 years. Table 7-1 and Figure 7-1 display a recommended 10-year implementation plan for the City's storm water system. Projects contained in the 10-year implementation plan were prioritized based on model results and through coordination with Orem City personnel. The projects have been organized to address the most important needs of the system first. A discussion of each of the major budget categories in the 10-year implementation plan is included below:

- **Major Conveyance –** This item includes large diameter pipelines intended to convey runoff towards outfalls located along the Provo River and Utah Lake. Although these improvements are driven by projected growth, there is some flexibility in when they can be completed. Flexibility stems from the unpredictable nature of storms and the fact that the City requires roadways to convey larger storm events. However, it is prudent to construct these projects in a timely manner to avoid collection of storm water in the streets and potential flooding damage to property.
    - **West Union Canal –** The first projects in the 10-year plan include major conveyance projects needed to remove storm water from open channel portions of the canal that could potentially overtop. The canal company itself has already discontinued use of these reaches of the canal, so these projects are considered highest priority.

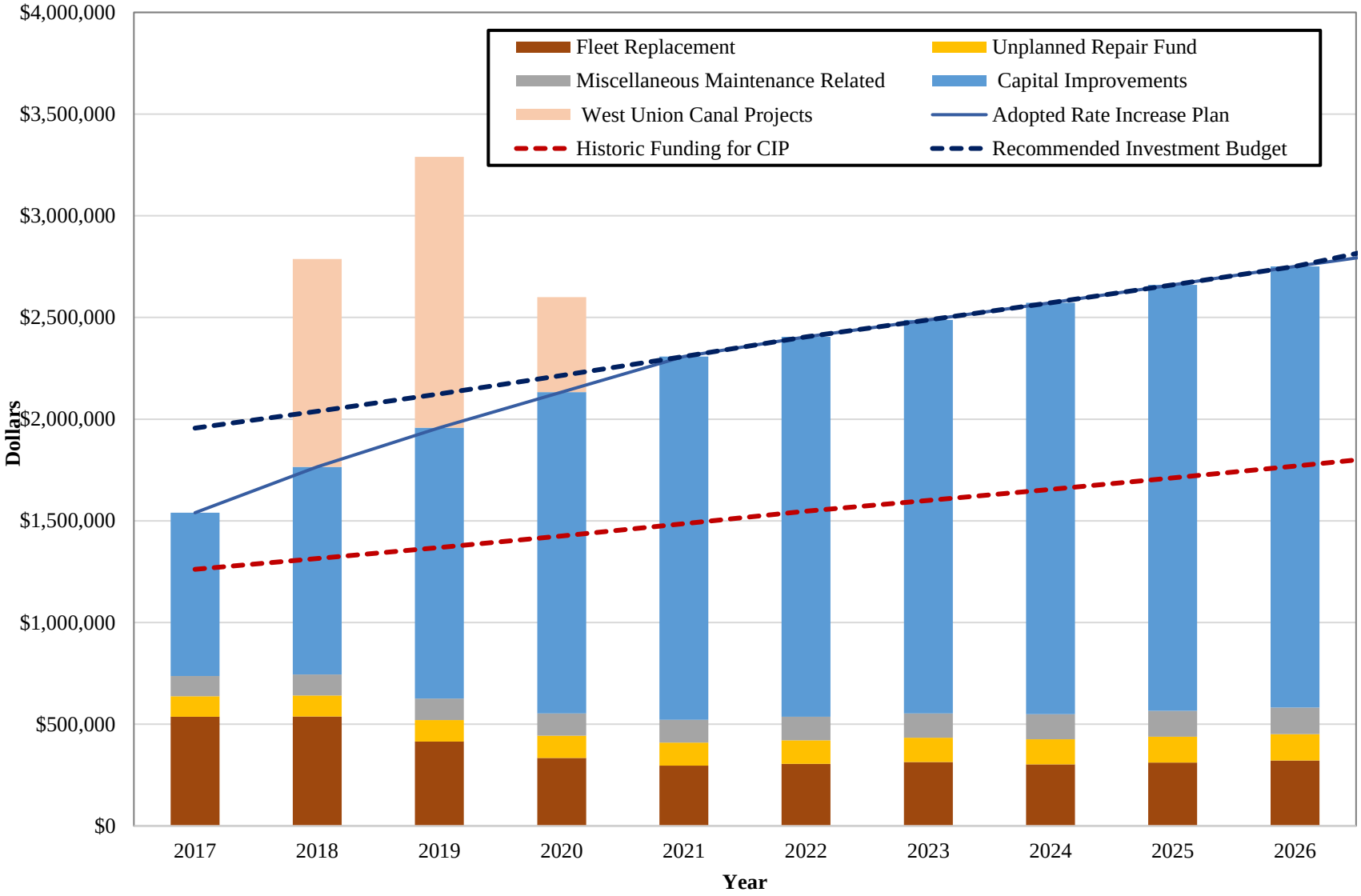
- **Detention/Infiltration Basins –** This budget item includes both improvements to existing detention facilities and construction of new detention facilities. Detention facilities are designed to detain flows in order to reduce downstream pipe sizes. When facilities are located in the "Safe Sump Zone" infiltration was accounted for to further reduce downstream flows.
- **Miscellaneous Maintenance and Replacement –** In addition to capital improvement projects, adequate funds must be set aside for regular system maintenance and replacement, otherwise the collection system will fall into a state of disrepair and be incapable of providing the level of service that Orem City customers expect. Based on conversations with Orem City personnel an annual budget of $150,000 (adjusted for inflation) has been established for maintenance and miscellaneous repairs based on historic costs. This will include regularly scheduled maintenance and repair on pipes, detention facilities, sumps, or other storm water facilities.
- **Unplanned Repairs** – In addition to the regularly scheduled maintenance items identified in the budget item above, Orem City will need to be prepared for unexpected system failures, such as pipe breaks. This budget category includes funds which should be reserved in order to cover the potential cost of these unplanned repairs. An annual budget of $100,000 (adjusted for inflation) has been established for this purpose based on historic costs as reported by City personnel.
- **Fleet Replacement** – City personnel have developed a schedule for vehicle replacement based on approximate use, depreciation, and reliability for maintenance vehicles in the City. Average expenditures under this category are expected to be approximately $370,000 per year. It should be noted that, due to lack of funding, the City has not been able to keep up with required fleet expenditures in recent years. As a result, it currently has a number of immediate needs to replace some of its service vehicles that are already beyond their useful service life. Correspondingly, the budget has been increased in the first several years to help the City address these needs. After few years of larger than average investment, it is expected that fleet expenditures will stabilize at approximately $300,000 (adjusted for inflation) as the City replaces vehicles at more regular intervals in the future.

Table 7-1
10-Year Capital Improvement Plan

Project type	Project Identifier	Project Name	Estimated Project Year	Estimated Cost (2017 Dollars)	Estimated Cost (Year of Construction)
Detention Facility	DBS4.1	424 East D.B. - Phase 1	2017	$228,000	$228,000
Major Conveyance	PS65A	Well #1 Bypass Drain	2017-2018	$846,200	$854,300
Major Conveyance	PS65B	750 East Tailwater	2018	$168,200	$173,200
Major Conveyance	PS65C	State Street, Columbia - River	2018-2020	$1,646,200	$2,367,100
Major Conveyance	PS66B	2000 South (B)	2020	$754,600	$824,600
Detention Facility	DBS4.2	424 East D.B.- Phase 2	2020	$195,500	$213,600
Major Conveyance	PS66A	2000 South (A)	2020-2021	$222,800	$250,800
Major Conveyance	LS1	424 E Pump Station	2021	$363,000	$408,600
Major Conveyance	PN16B	250 E	2018	$861,100	$886,900
Major Conveyance	PS33	Heat Plant Rd (B)	2018	$55,700	$57,400
Major Conveyance	PS32	Heat Plant Rd (A)	2018	$70,900	$73,000
Major Conveyance	PS31	900 S	2018-2019	$656,500	$696,500
Major Conveyance	PN10C	1200 N (A)	2019-2021	$1,488,800	$1,675,700
Detention Facility	DBN2	Bonneville School DB	2021	$454,700	$511,800
Major Conveyance	PN10A	Bonneville School	2021	$116,500	$120,000
Major Conveyance	PN10B	800 W	2022	$274,400	$318,100
Major Conveyance	PN8F	1200 N (E)	2022	$240,200	$278,500
Major Conveyance	PN8E	1200 N (D)	2022	$139,400	$161,600
Major Conveyance	PN8B	1200 N (C)	2022	$433,200	$502,200
Major Conveyance	PN8A	1200 N (B)	2022	$217,300	$251,900
Detention Facility	DBS5	Lakeridge Jr. High DB	2022-2023	$970,500	$1,158,800
Major Conveyance	PS63	Lakeridge Jr. High	2023	$722,800	$863,100
Major Conveyance	PS6B	2000 S (B) - Phase 1	2023-2024	$1,352,000	$1,662,800
Major Conveyance	PS23	Taylor Drain Outlet	2024	$451,900	$555,800
Major Conveyance	PS26A	800 S (C)	2025	$1,099,100	$1,392,300

Project type	Project Identifier	Project Name	Estimated Project Year	Estimated Cost (2017 Dollars)	Estimated Cost (Year of Construction)
Detention Facility	DBN3	Windsor Park DB	2025	$513,600	$650,600
Major Conveyance	PN8D	200 W	2025	$141,200	$125,200
Major Conveyance	PN8C	100 W	2026	$165,900	$216,500
Major Conveyance	PN40A	Geneva Rd (A)	2026	$48,800	$63,700
Major Conveyance	PN40B	Geneva Rd (C)	2026	$597,900	$780,100
Major Conveyance	PN34	Geneva Rd (B)	2026	$722,800	$943,100
Major Conveyance	PN33	1200 N (H)	2026-2027	$481,000	$646,400
Major Conveyance	PN32	800 N (C)	2027	$706,500	$949,500
Major Conveyance	PS6A	2000 S (A) - Phase 2	2027	$458,600	$616,300
Major Conveyance	PN12A	1200 N (F)	2027-2028	$187,100	$259,000
			Total	**$18,052,900**	**$21,737,000**

Figure 7-1
10-Year Storm Water Capital Improvement Budget

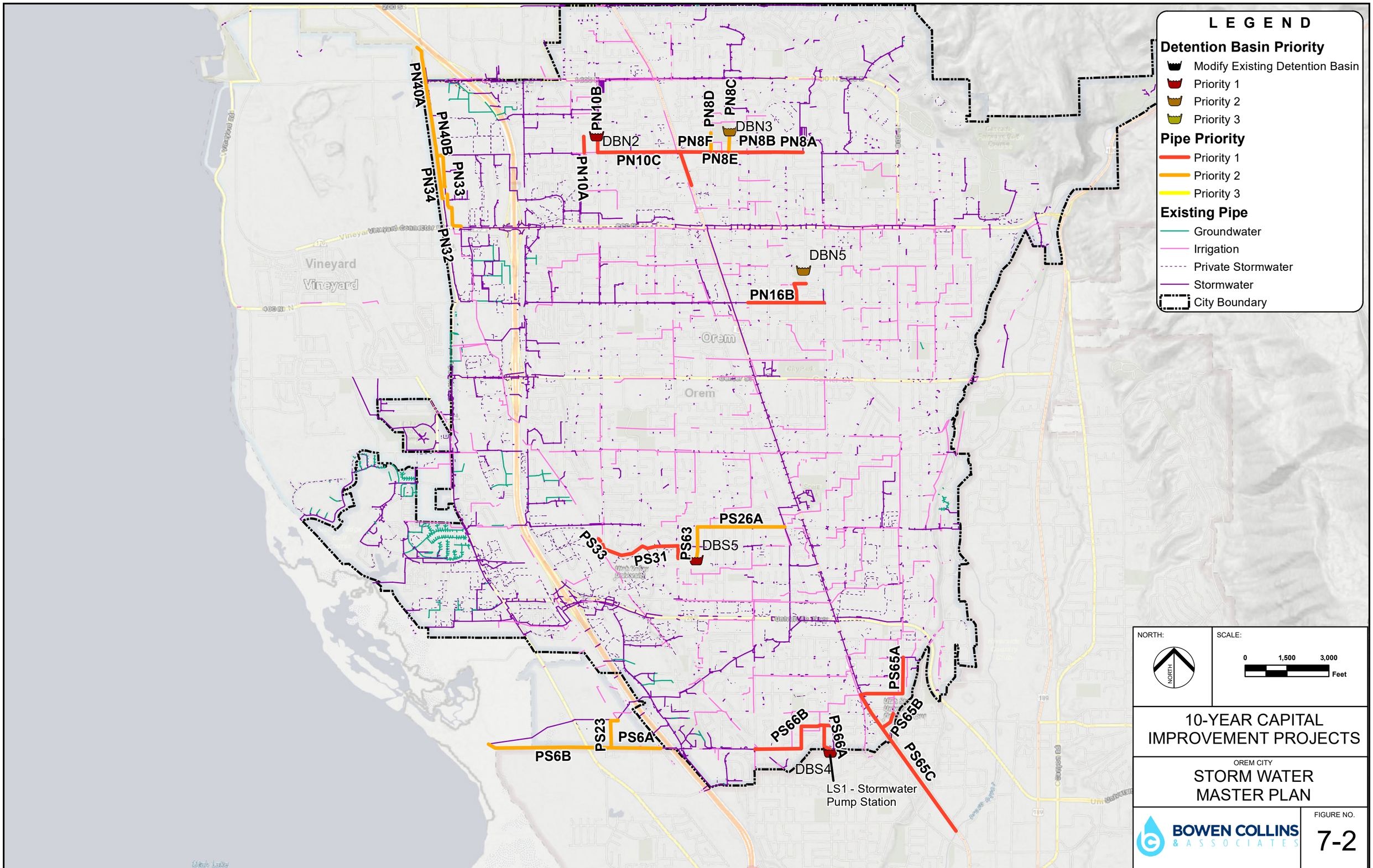


In addition to the budget categories described above, Figure 7-1 includes some additional information that may be useful as the City evaluate the recommended 10-year implementation plan:

- **Revenue for CIP Based on Historic Funding –** The red dashed line in Figure 7-1 shows the projected funding for capital improvement projects based on historic funding levels prior to 2016. This represents the revenue the City would have available for capital improvements if it continued with rates at the same level as 2016. It will be noted that this revenue increases gradually over time as additional users join the system. However, it is apparent from the figure that the projected revenue associated with historic rates would have been inadequate to implement many of the capital improvement projects identified in Table 7-1. Recognizing this, the City Council endorsed a five-year funding plan to adjust rates to more aggressively fund proposed capital improvement projects. Accordingly, it adjusted rates in FY2017 and FY2018. The City should continue to follow the recommended financing plan in order to ensure the plan is followed. These projects will help fix existing deficiencies, allow for runoff associated with future growth, and advance the City's goal of eliminating its higher risk sumps. Postponing the installation of these projects may leave areas of the City vulnerable to flows being conveyed in the streets and potential flooding.
- **Recommended CIP Funding Level –** In establishing a long-term capital improvements plan, it is important to consider how much funding should be set aside each year for capital improvements. One of the best ways to identify a recommended level of funding is to consider system service life. As with all utilities, each component of the storm drain system has a finite service life. If adequate funds are not set aside for regular system renewal, the system will fall into a state of disrepair and be incapable of providing the level of service that Orem City customers expect. To determine the target level of yearly spending on the system, the replacement value of the current system was evaluated. The total cost to replace all pipes, manholes, catch basins, and detention basin control facilities in the City would be approximately $100,000,000. Based on the assumption that most storm water system components have an average service life of about 70 years, the City should plan to spend about 1.5% of the total system value per year in order to prevent utilities from falling into disrepair. Based on this assumption, it is recommended that the City plan to spend $1,500,000 per year for the water system. If the average fleet investment rate of $370,000 per year is added to this total, the recommended long-term level of capital investment expenditures will be approximately $1.9 million in 2017 (and adjusted in future years for system growth and inflation).
- **Adopted Rate Increase Plan –** Compared to the historical storm water system investment, the recommended long-term level of CIP funding represents a significant increase in annual investment. Because of this dramatic difference, a gradual transition from existing to recommended funding was proposed to the City Council in 2016. After gathering feedback from the public and considering several different options, the City Council adopted a rate plan to transition to the recommended level of funding over a period of five years. Rate increases are revisited each year by the City Council, which has approved the first two recommended rate increases since the financing plan was adopted in 2016. This recommended plan will allow the City to construct all of the recommended projects in Table 7-1 within 10 years while still funding required maintenance and fleet projects.
- **West Union Canal Projects –** It should be noted that the proposed plan includes funding of projects in the early years of the plan at a higher level than might be justified by available rate revenue in those specific years. The City currently has a balance of capital improvement

project funds resulting from postponing some projects due to uncertainties related to the West Union Canal. The City will be reprioritizing use of capital funds to expedite projects to remove storm water from the West Union Canal. Approximately $3 million of projects will be funded using the available CIP balance. This will allow it to complete many of the required West Union projects without unduly postponing other system needs.

Figure 7-2 shows the location of projects listed in Table 7-1.



10-YEAR CAPITAL IMPROVEMENT PROJECTS

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
7-2

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Figure 7-2.mxd amckinnon 12/6/2017

APPENDIX A
HYDROLOGIC DATA

HYDROLOGIC SOIL GROUPS

Hydrologic soil groups have been developed to help engineers and scientists understand the impact rainfall will have on different soil types. This includes extensive rainfall, runoff, and infiltration data. Four major factors were considered when determining the hydrologic soil group. The first factor is the soils intake and transmission of water when thoroughly wet. Second, is whether the soil is frozen or not. Third, considers whether the soils are bare. Fourth, the maximum swelling of expansive clays is considered. Based on the results of these conditions the following four hydrologic soil groups were identified and are summarized below. For a more detailed description of the development of hydrologic soil groups and the four different groups please refer to National Engineering Handbook Part 630 Hydrology.

TYPE A

Type A soils have low runoff potential even when thoroughly wet. Soils typically consist of mostly sands and gravels which are well aggregated. Soils have high permeability and will infiltrate significant amounts of water. Impermeable layers must be at least 40 inches below the surface.

TYPE B

Type B soils have a medium to low runoff potential. Soils consist mostly of sands and gravels, but have more clays and loams than those of Type A. If soils are well aggregated they may contain more silts, clays, and loams. The majority of the soil will still consists of sands and gravels. Impermeable layers must be a minimum of 20 inches below the surface.

TYPE C

Type C soils have a medium to high runoff potential. Soils consist of more clays and silts with less than half of the material consisting of sands. If well aggregated larger amounts of clays may be present in the soil. Water transmission will be somewhat restricted through the soil. Impermeable layers must be a minimum of 20 inches from the surface.

TYPE D

Type D soil types have a high runoff potential. Soil types have large amounts of clays and less than 50 percent of the material is sands. The texture is clay like and water transmission will be restricted. All soils with an Impermeable surface less than 20 inches will be included in this group. Soils with high shrink-swell potential will also be considered a Type D soil. All soil with a water table less than 24 inches from the top are part of this group.

NOAA Atlas 14, Volume 1, Version 5
Location name: Orem, Utah, US*
Latitude: 40.2878°, Longitude: -111.6687°
Elevation: 4730 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.127** (0.111-0.150)	**0.163** (0.142-0.191)	**0.225** (0.195-0.264)	**0.281** (0.242-0.329)	**0.368** (0.308-0.433)	**0.445** (0.365-0.527)	**0.536** (0.428-0.638)	**0.640** (0.495-0.772)	**0.806** (0.595-0.989)	**0.953** (0.678-1.19)
10-min	**0.194** (0.170-0.228)	**0.248** (0.216-0.291)	**0.342** (0.297-0.402)	**0.428** (0.368-0.501)	**0.559** (0.469-0.658)	**0.677** (0.555-0.802)	**0.816** (0.652-0.970)	**0.975** (0.753-1.18)	**1.23** (0.905-1.50)	**1.45** (1.03-1.81)
15-min	**0.240** (0.210-0.282)	**0.307** (0.269-0.361)	**0.424** (0.368-0.498)	**0.531** (0.457-0.621)	**0.693** (0.581-0.816)	**0.840** (0.688-0.994)	**1.01** (0.808-1.20)	**1.21** (0.934-1.46)	**1.52** (1.12-1.86)	**1.80** (1.28-2.24)
30-min	**0.323** (0.283-0.380)	**0.414** (0.361-0.486)	**0.572** (0.495-0.670)	**0.715** (0.615-0.837)	**0.934** (0.782-1.10)	**1.13** (0.927-1.34)	**1.36** (1.09-1.62)	**1.63** (1.26-1.96)	**2.05** (1.51-2.51)	**2.42** (1.72-3.02)
60-min	**0.400** (0.350-0.470)	**0.512** (0.447-0.602)	**0.707** (0.613-0.830)	**0.884** (0.761-1.03)	**1.16** (0.968-1.36)	**1.40** (1.15-1.66)	**1.69** (1.35-2.00)	**2.01** (1.56-2.43)	**2.53** (1.87-3.11)	**3.00** (2.13-3.74)
2-hr	**0.499** (0.447-0.573)	**0.626** (0.556-0.713)	**0.828** (0.734-0.946)	**1.01** (0.887-1.15)	**1.30** (1.11-1.49)	**1.56** (1.31-1.80)	**1.86** (1.52-2.16)	**2.21** (1.75-2.60)	**2.76** (2.08-3.33)	**3.26** (2.37-4.00)
3-hr	**0.588** (0.531-0.664)	**0.732** (0.664-0.822)	**0.933** (0.842-1.05)	**1.12** (0.999-1.26)	**1.40** (1.23-1.58)	**1.65** (1.42-1.87)	**1.93** (1.62-2.21)	**2.26** (1.85-2.63)	**2.81** (2.21-3.34)	**3.31** (2.50-4.01)
6-hr	**0.770** (0.708-0.849)	**0.949** (0.869-1.04)	**1.17** (1.06-1.28)	**1.35** (1.24-1.49)	**1.63** (1.46-1.79)	**1.85** (1.64-2.06)	**2.11** (1.83-2.37)	**2.40** (2.04-2.72)	**2.93** (2.43-3.40)	**3.40** (2.75-4.04)
12-hr	**1.00** (0.920-1.10)	**1.23** (1.13-1.35)	**1.49** (1.36-1.63)	**1.70** (1.55-1.87)	**2.01** (1.81-2.21)	**2.25** (2.01-2.50)	**2.51** (2.21-2.80)	**2.79** (2.42-3.15)	**3.21** (2.73-3.70)	**3.57** (2.96-4.17)
24-hr	**1.21** (1.11-1.31)	**1.48** (1.36-1.61)	**1.78** (1.64-1.94)	**2.03** (1.87-2.21)	**2.36** (2.17-2.57)	**2.62** (2.39-2.85)	**2.88** (2.62-3.13)	**3.14** (2.85-3.42)	**3.50** (3.14-3.82)	**3.76** (3.36-4.21)
2-day	**1.42** (1.31-1.55)	**1.75** (1.61-1.90)	**2.10** (1.94-2.29)	**2.40** (2.21-2.62)	**2.81** (2.57-3.05)	**3.13** (2.85-3.40)	**3.45** (3.13-3.75)	**3.78** (3.41-4.12)	**4.23** (3.78-4.62)	**4.58** (4.06-5.02)
3-day	**1.59** (1.45-1.75)	**1.96** (1.79-2.16)	**2.37** (2.16-2.61)	**2.71** (2.47-2.98)	**3.19** (2.89-3.50)	**3.56** (3.22-3.92)	**3.95** (3.55-4.35)	**4.35** (3.88-4.80)	**4.89** (4.32-5.42)	**5.32** (4.66-5.91)
4-day	**1.76** (1.60-1.96)	**2.17** (1.97-2.41)	**2.63** (2.39-2.93)	**3.02** (2.73-3.35)	**3.57** (3.21-3.96)	**4.00** (3.58-4.44)	**4.45** (3.97-4.95)	**4.91** (4.36-5.48)	**5.55** (4.87-6.21)	**6.06** (5.26-6.80)
7-day	**2.07** (1.87-2.30)	**2.55** (2.30-2.83)	**3.08** (2.78-3.42)	**3.52** (3.17-3.90)	**4.12** (3.70-4.56)	**4.58** (4.11-5.08)	**5.06** (4.51-5.61)	**5.54** (4.92-6.15)	**6.20** (5.45-6.89)	**6.70** (5.85-7.48)
10-day	**2.36** (2.14-2.60)	**2.90** (2.63-3.20)	**3.49** (3.15-3.85)	**3.96** (3.57-4.36)	**4.59** (4.13-5.05)	**5.07** (4.55-5.58)	**5.55** (4.97-6.12)	**6.03** (5.38-6.66)	**6.66** (5.91-7.37)	**7.13** (6.28-7.91)
20-day	**3.16** (2.85-3.50)	**3.89** (3.51-4.30)	**4.64** (4.18-5.13)	**5.22** (4.70-5.78)	**5.98** (5.37-6.61)	**6.54** (5.87-7.23)	**7.08** (6.34-7.83)	**7.61** (6.80-8.42)	**8.27** (7.37-9.18)	**8.75** (7.77-9.74)
30-day	**3.80** (3.46-4.18)	**4.68** (4.26-5.14)	**5.58** (5.07-6.13)	**6.29** (5.71-6.91)	**7.22** (6.55-7.94)	**7.92** (7.17-8.71)	**8.61** (7.77-9.47)	**9.28** (8.35-10.2)	**10.2** (9.07-11.2)	**10.8** (9.60-12.0)
45-day	**4.74** (4.31-5.21)	**5.82** (5.29-6.39)	**6.89** (6.25-7.57)	**7.72** (7.00-8.48)	**8.79** (7.96-9.65)	**9.57** (8.65-10.5)	**10.3** (9.31-11.3)	**11.1** (9.94-12.2)	**12.0** (10.7-13.2)	**12.6** (11.3-13.9)
60-day	**5.64** (5.14-6.18)	**6.93** (6.31-7.58)	**8.18** (7.44-8.95)	**9.14** (8.30-9.99)	**10.3** (9.38-11.3)	**11.2** (10.2-12.3)	**12.1** (10.9-13.2)	**12.8** (11.5-14.1)	**13.8** (12.4-15.1)	**14.5** (13.0-15.9)

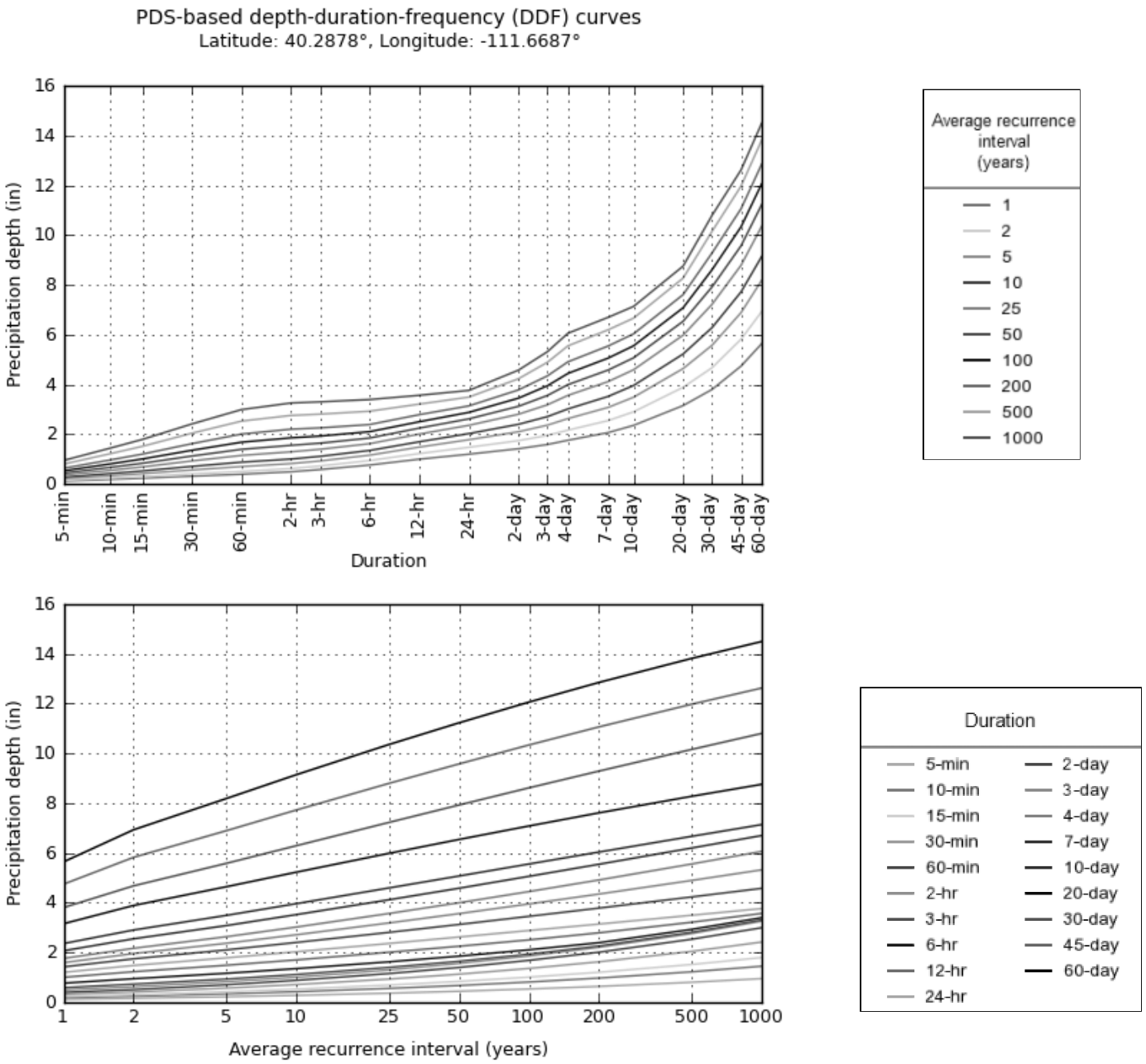
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



NOAA Atlas 14, Volume 1, Version 5

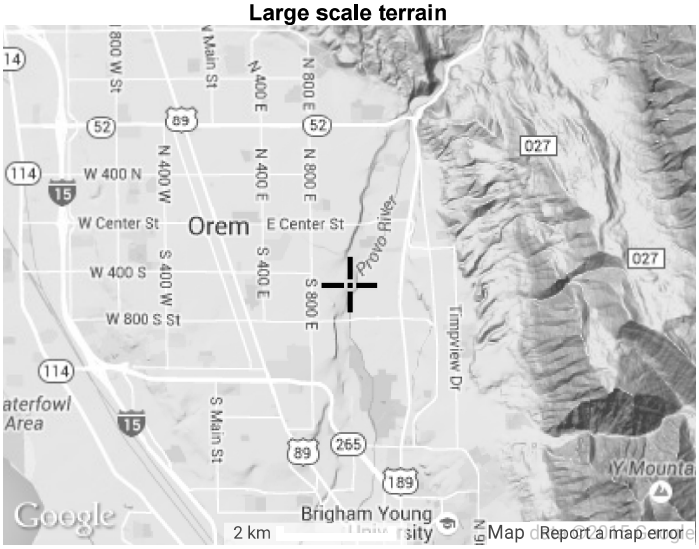
Created (GMT): Wed Jul 22 13:59:42 2015

Back to Top

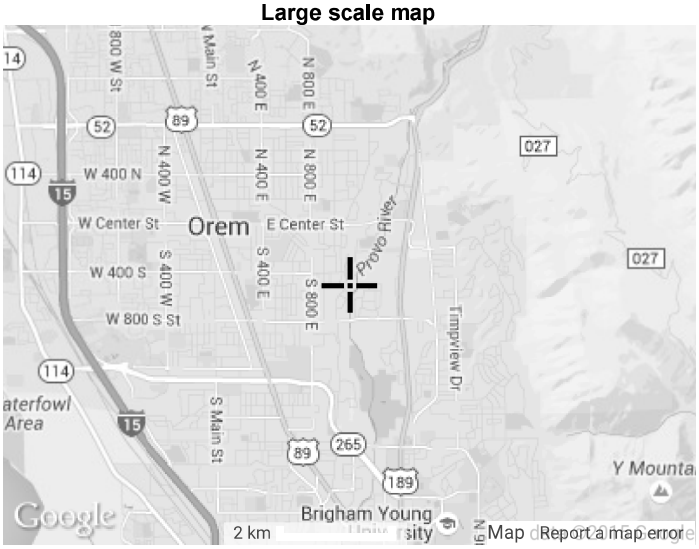
Maps & aerials

Small scale terrain

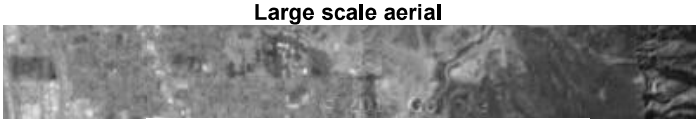
Large scale terrain



Large scale map



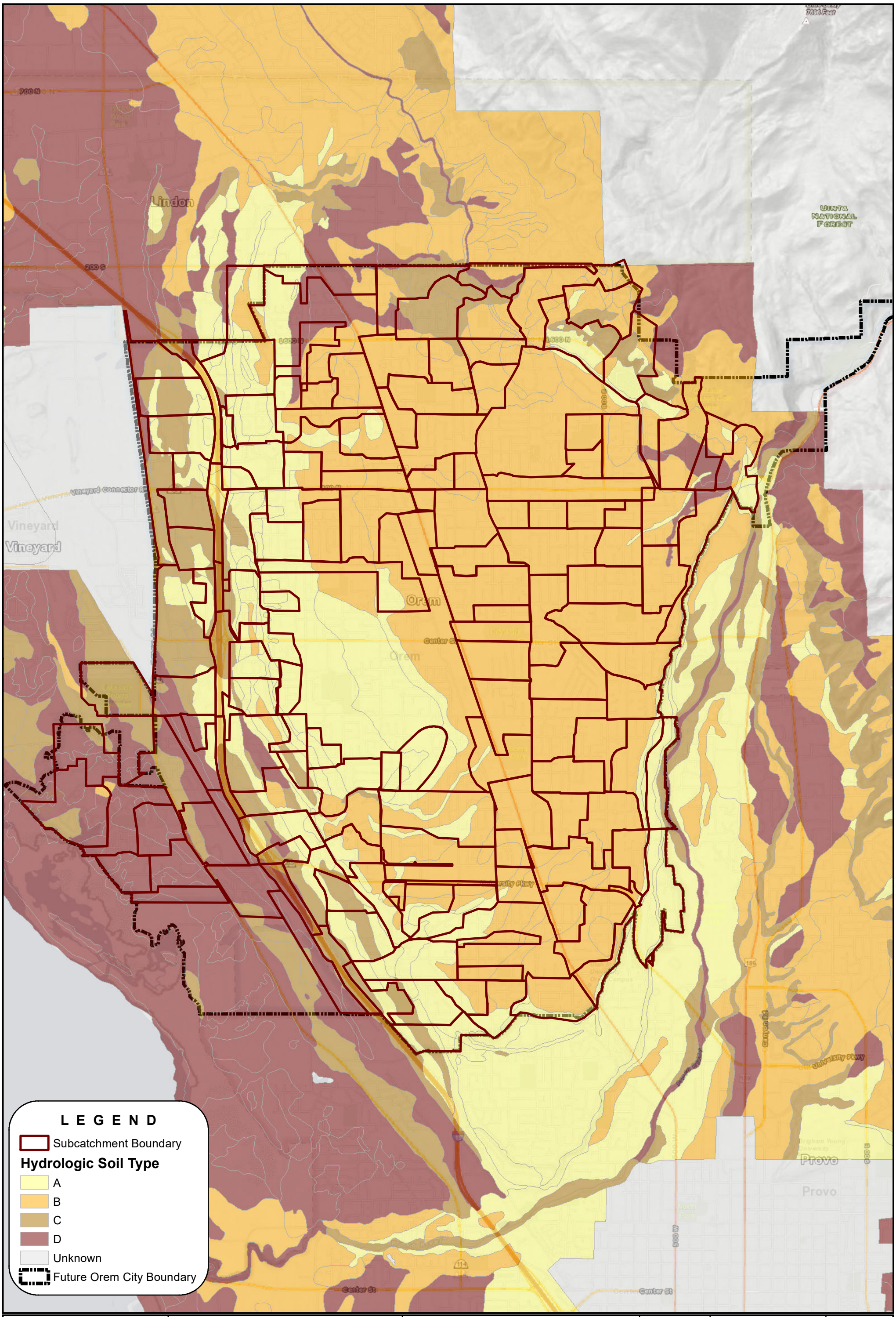
Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

HYDROLOGIC SOIL GROUP

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. A-1

P:\Orem City\2013 Master Plans\6.0 Reports and Memos\6.3 Final Report\Appendices\Appendix A Hyrologic Data\FigureA-1_Soils_Map.mxd amckinnon 9/22/2017

APPENDIX B
MODEL OUTPUT

L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

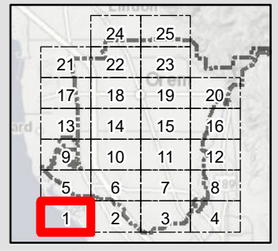
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE:

0 225 450
Feet

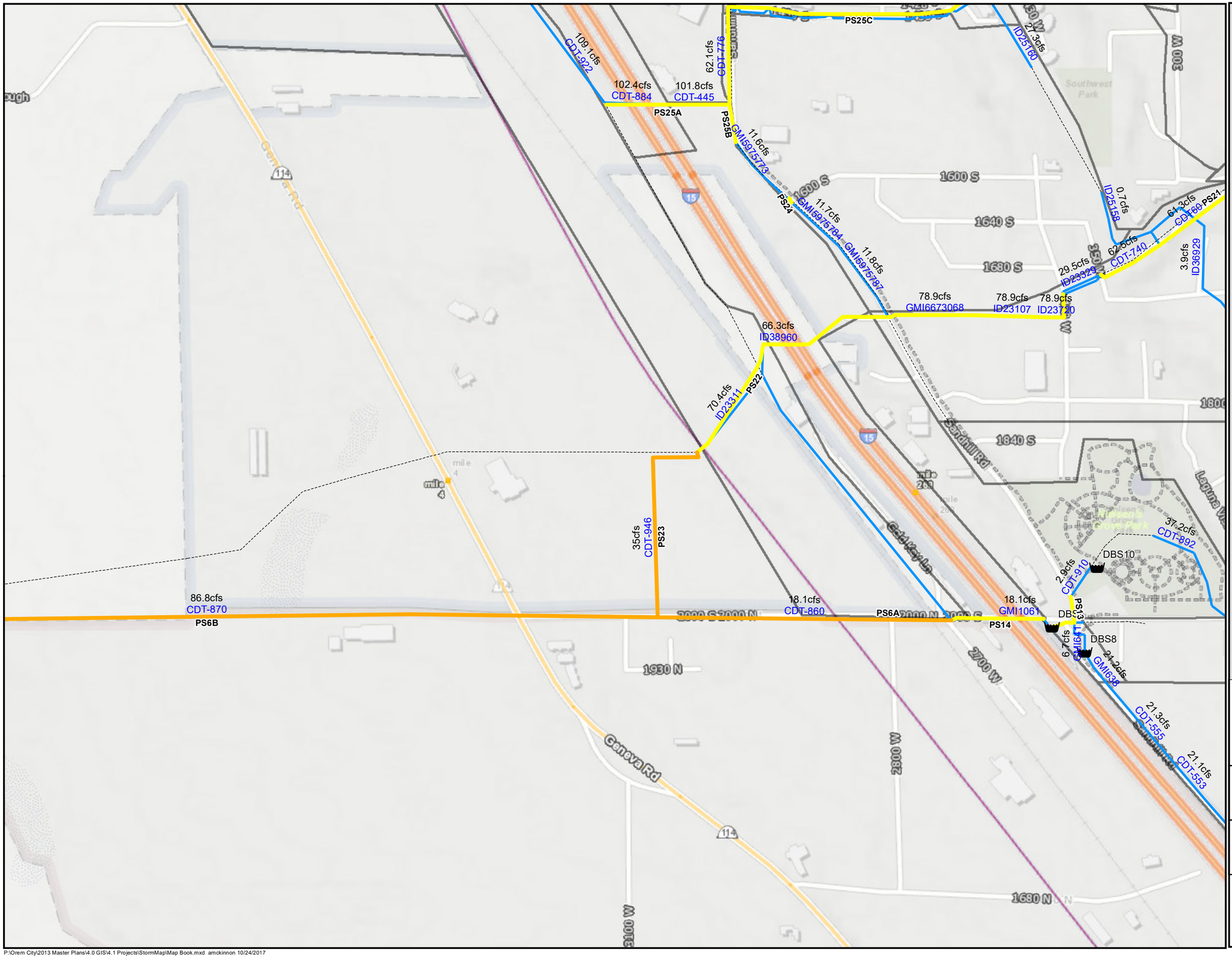
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
1

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

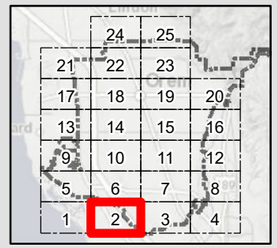
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

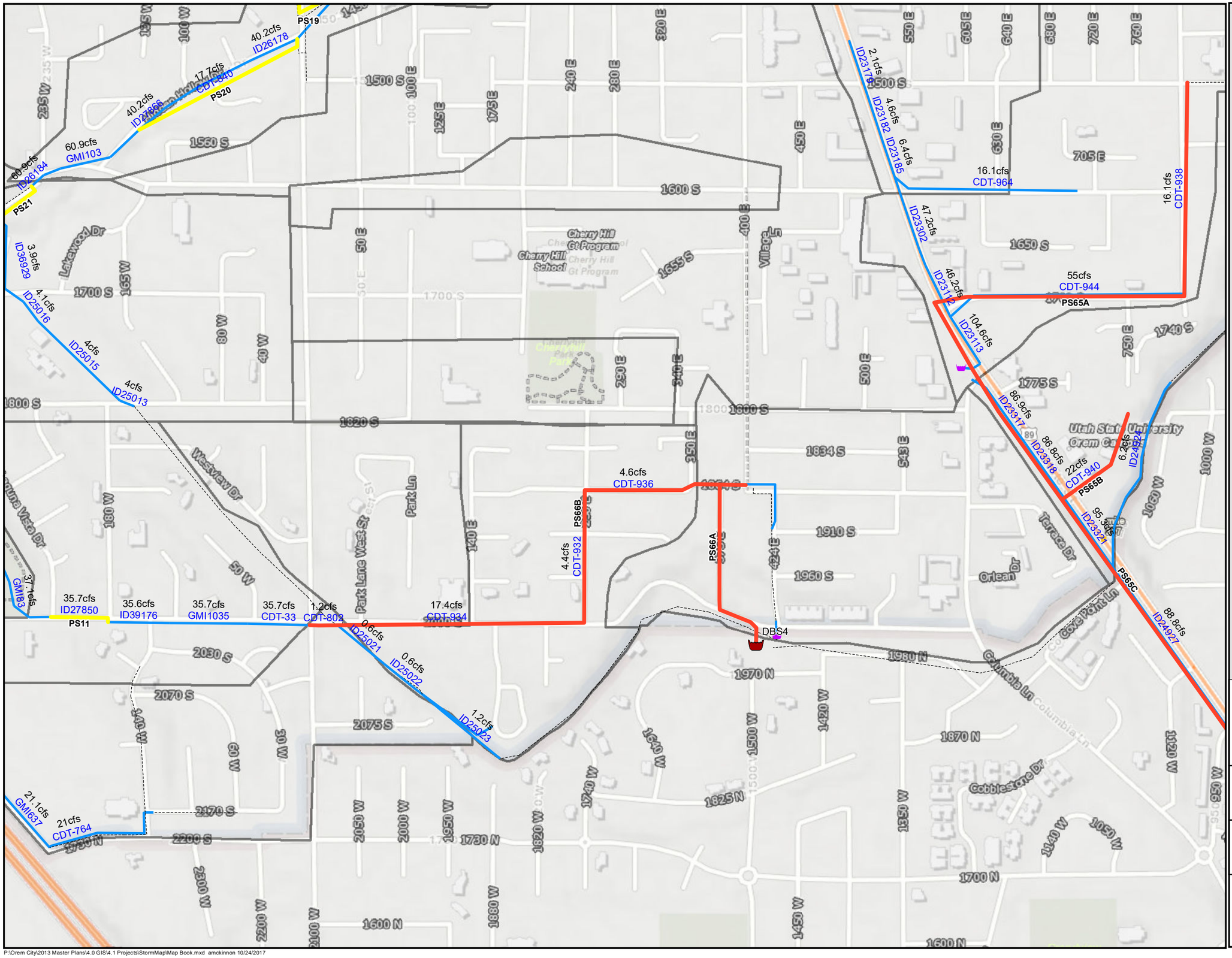
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 2

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

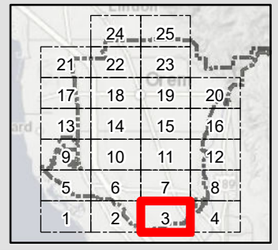
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

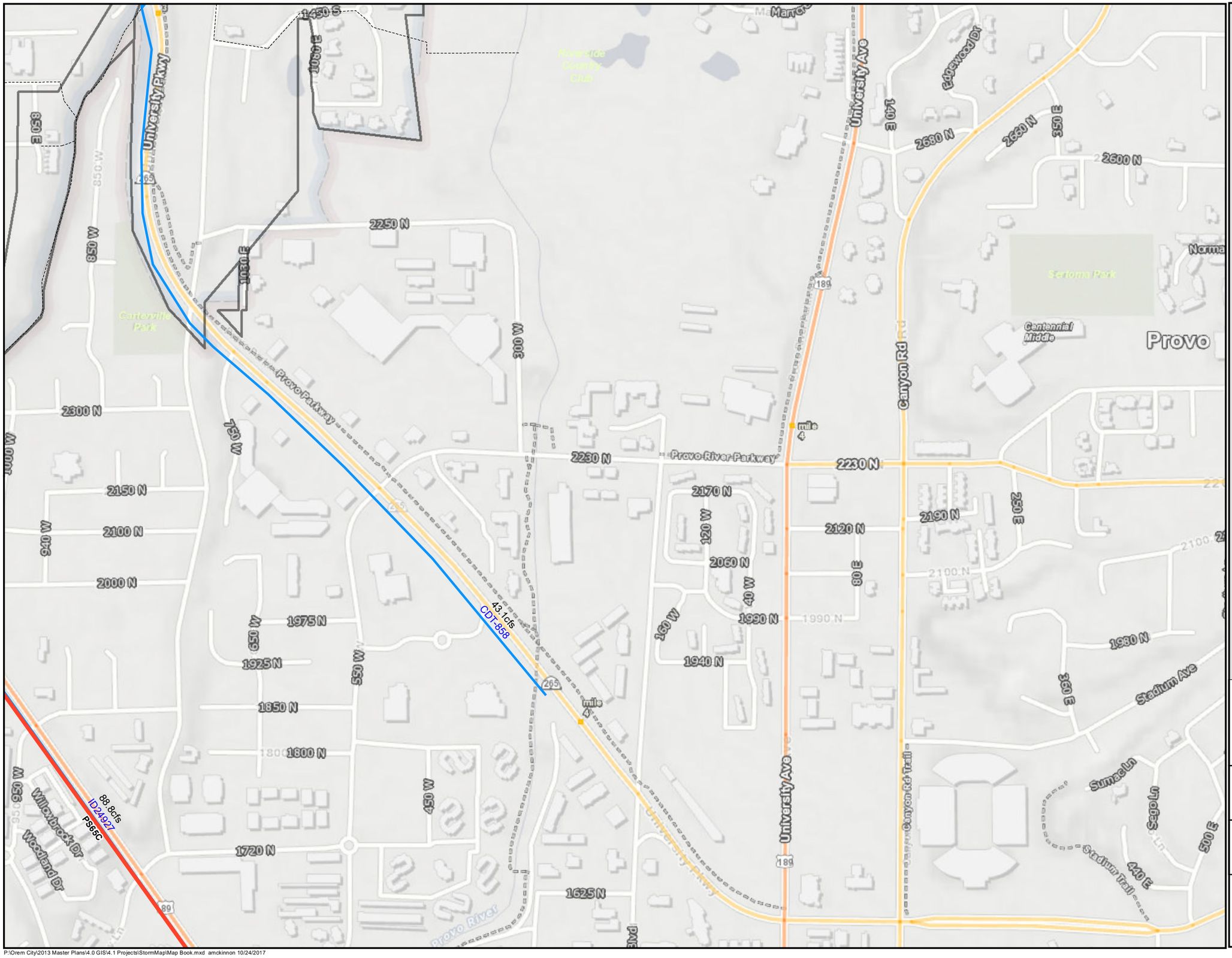
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 3

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

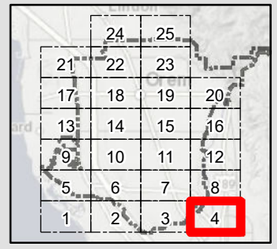
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

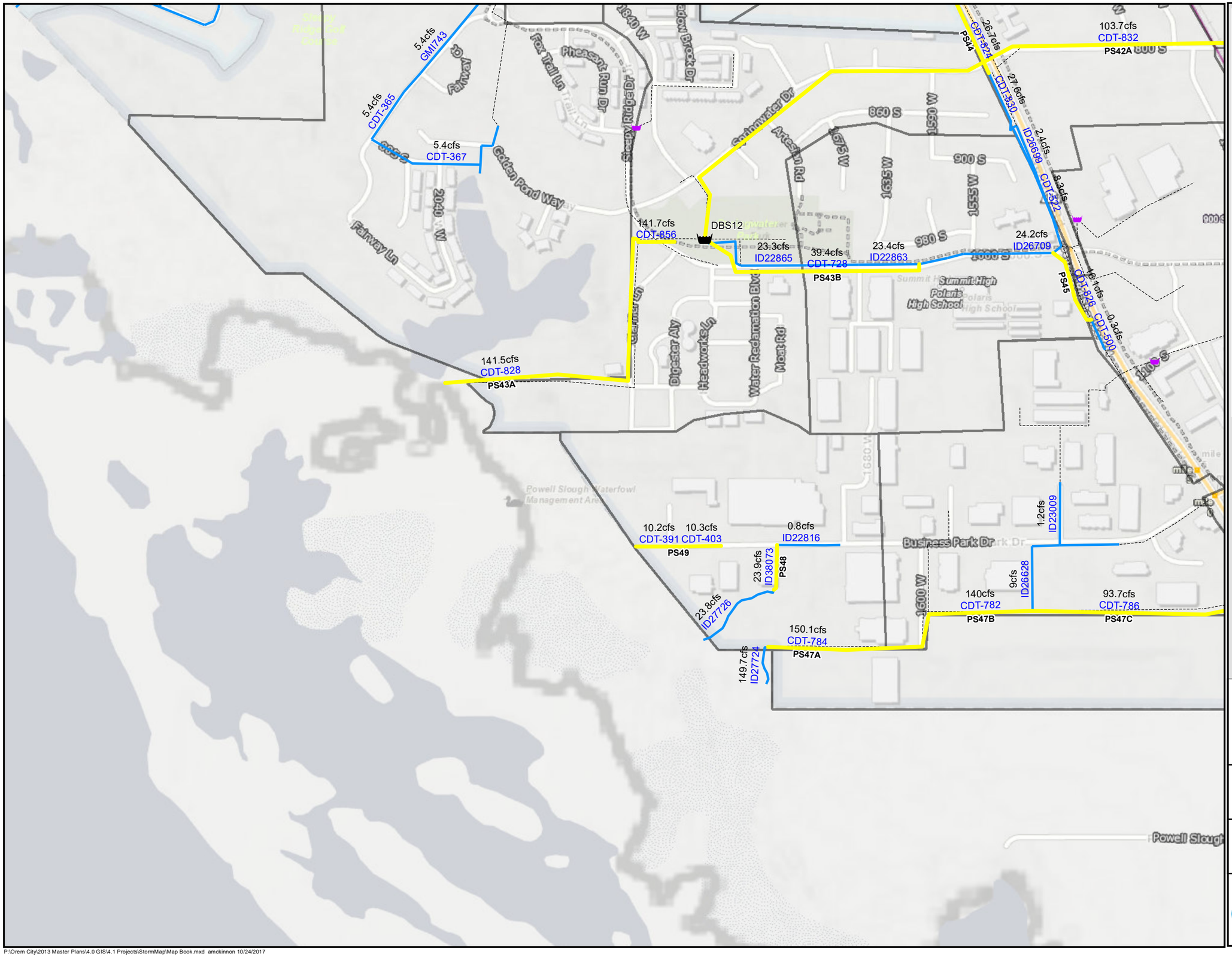
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 4

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

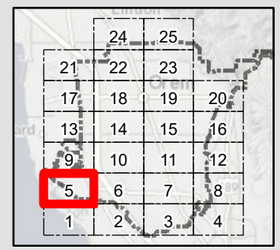
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

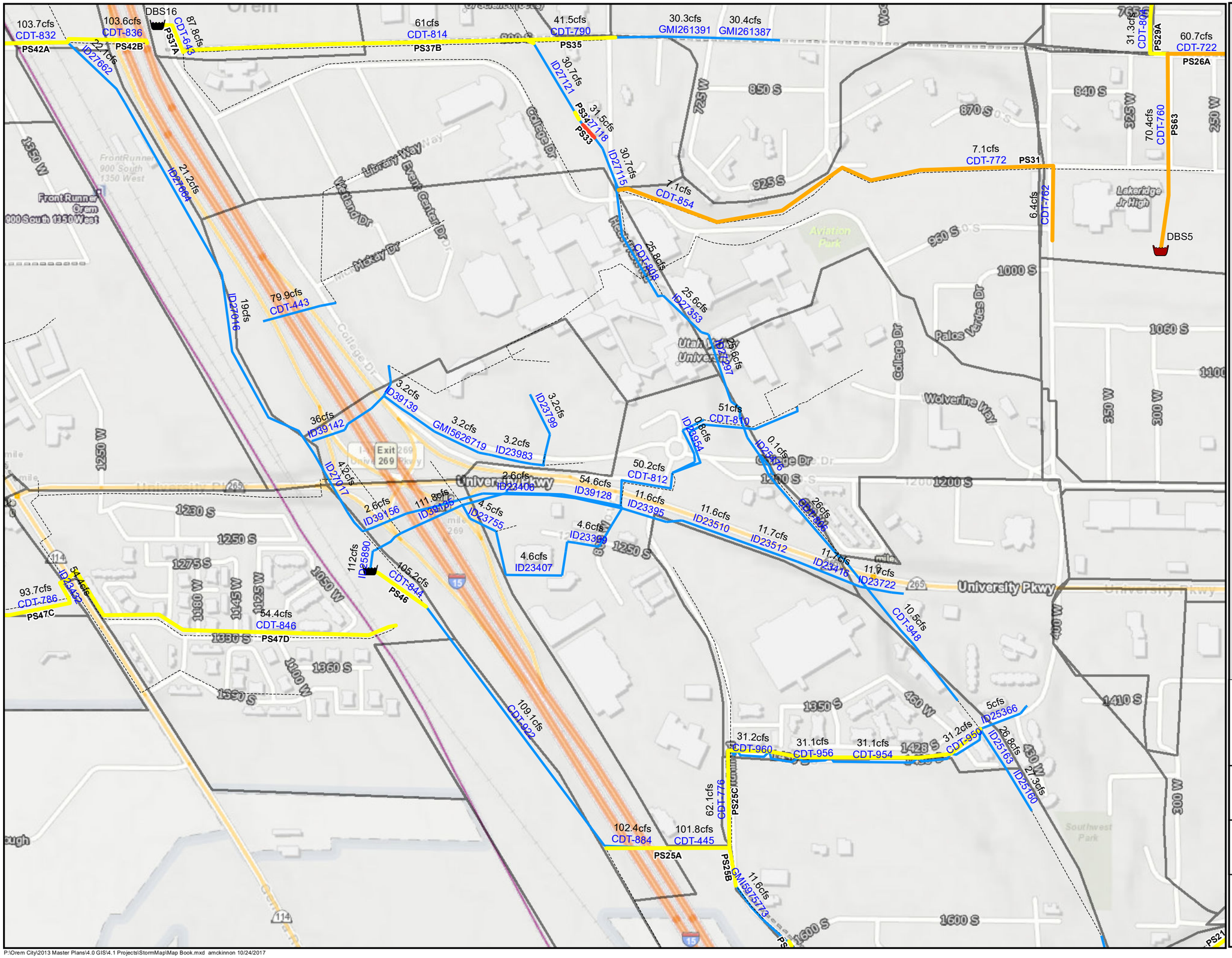
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

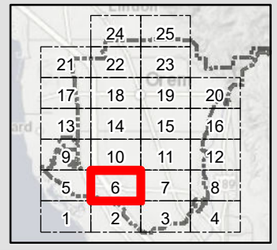
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

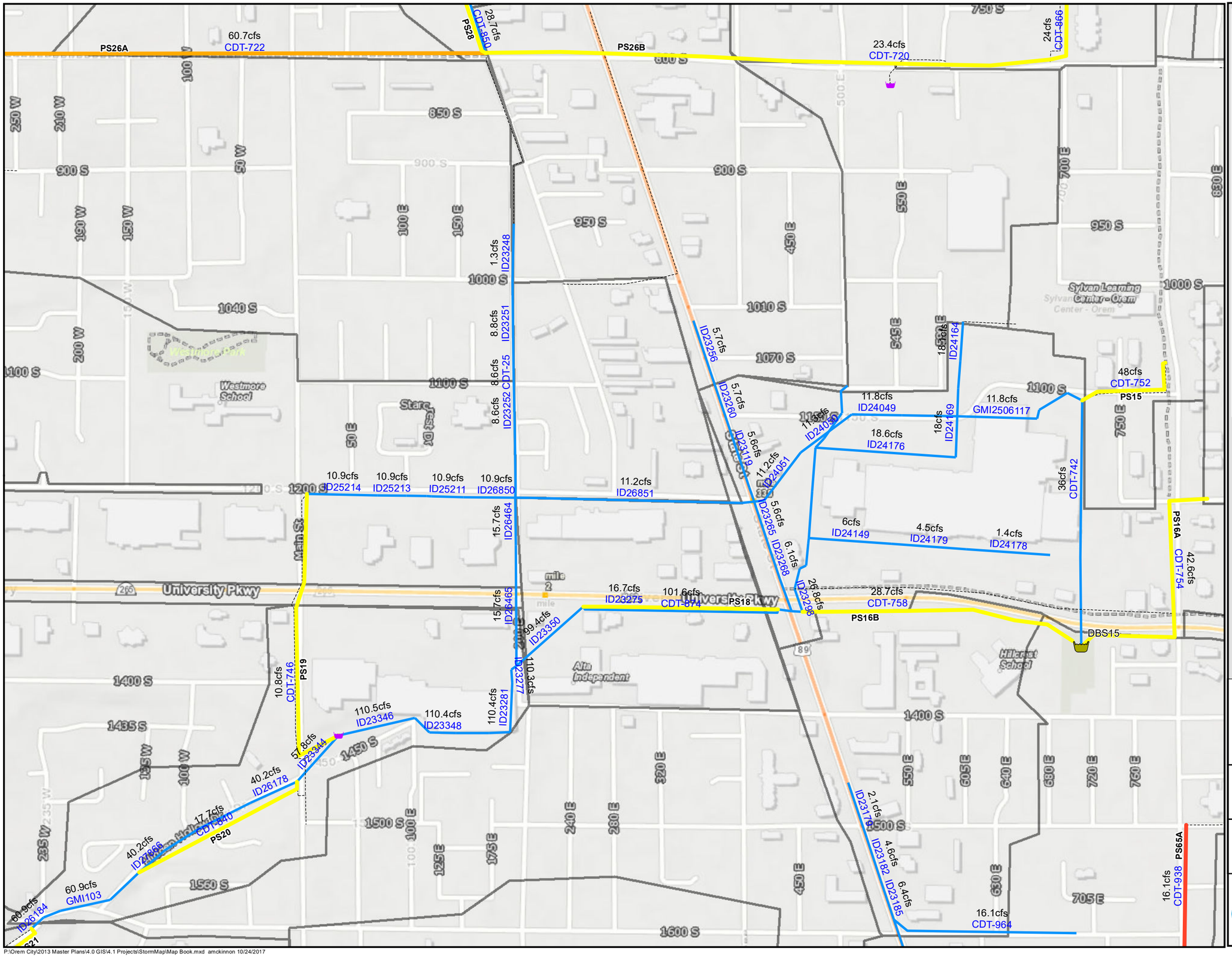
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 6

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

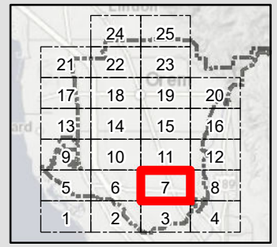
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

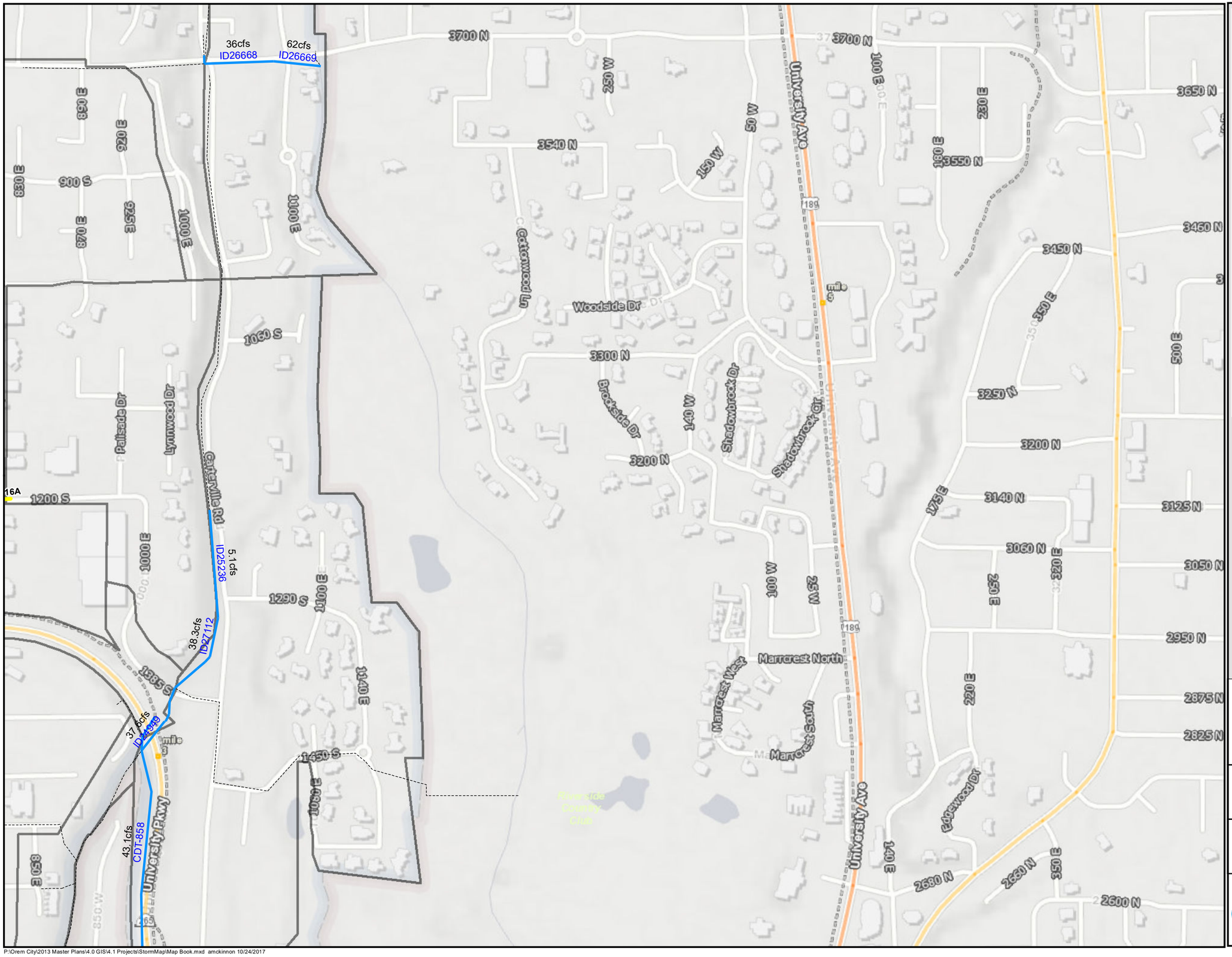
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 7

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

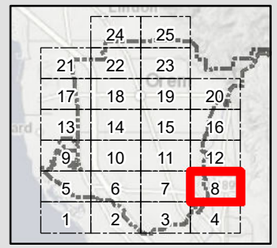
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

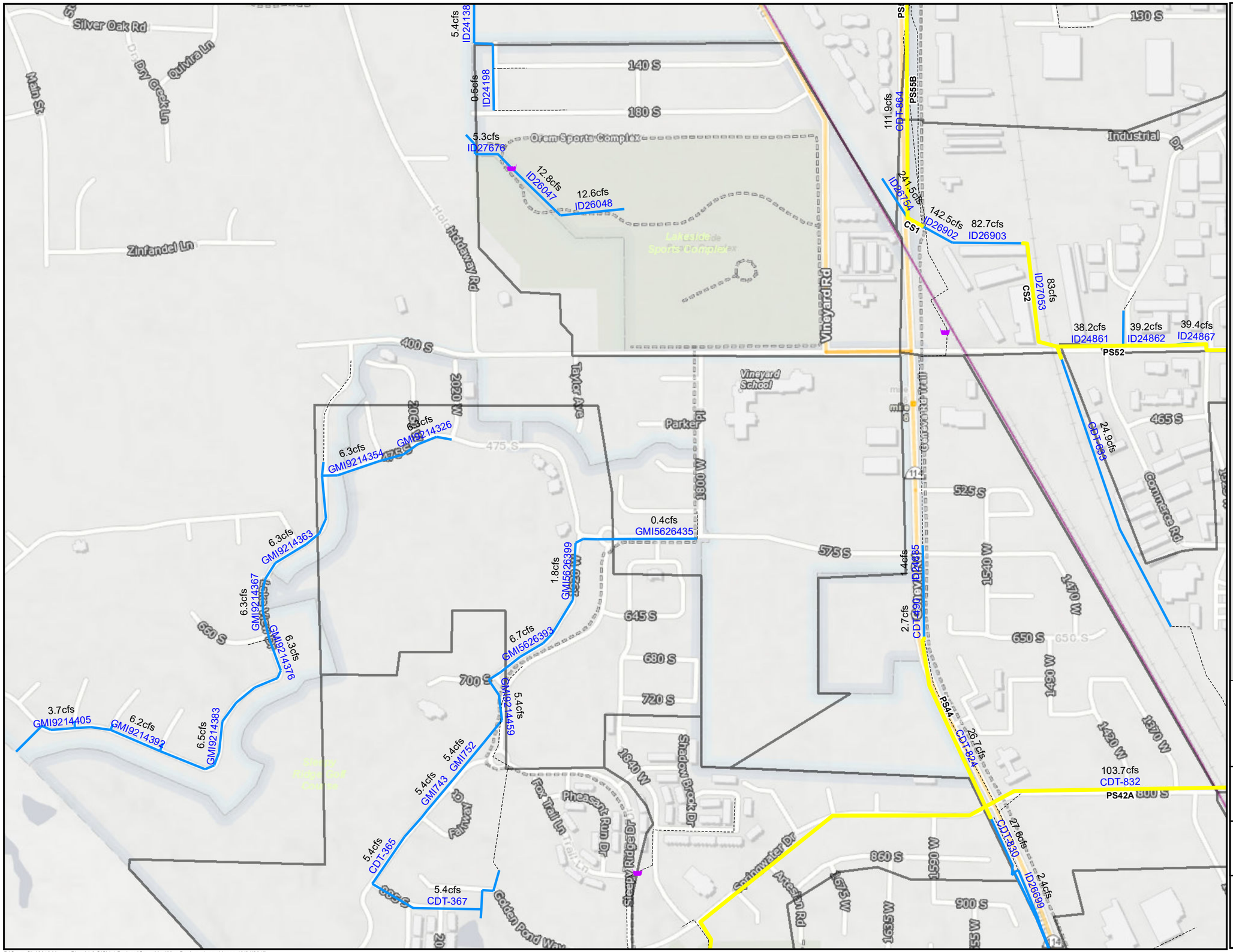
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 8

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

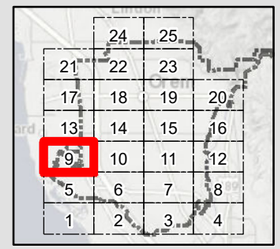
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

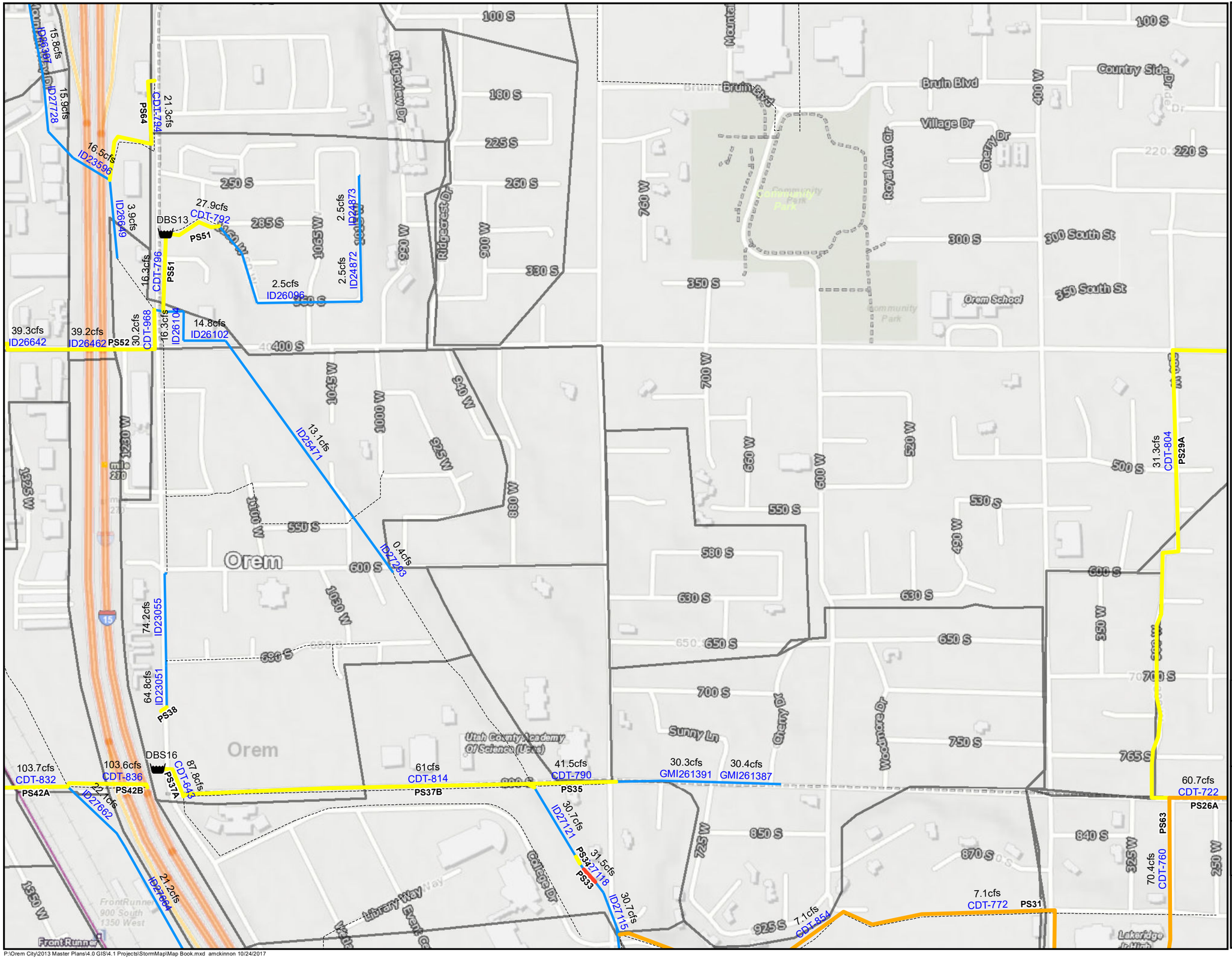
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 9

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

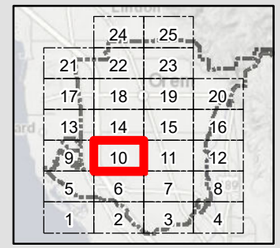
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

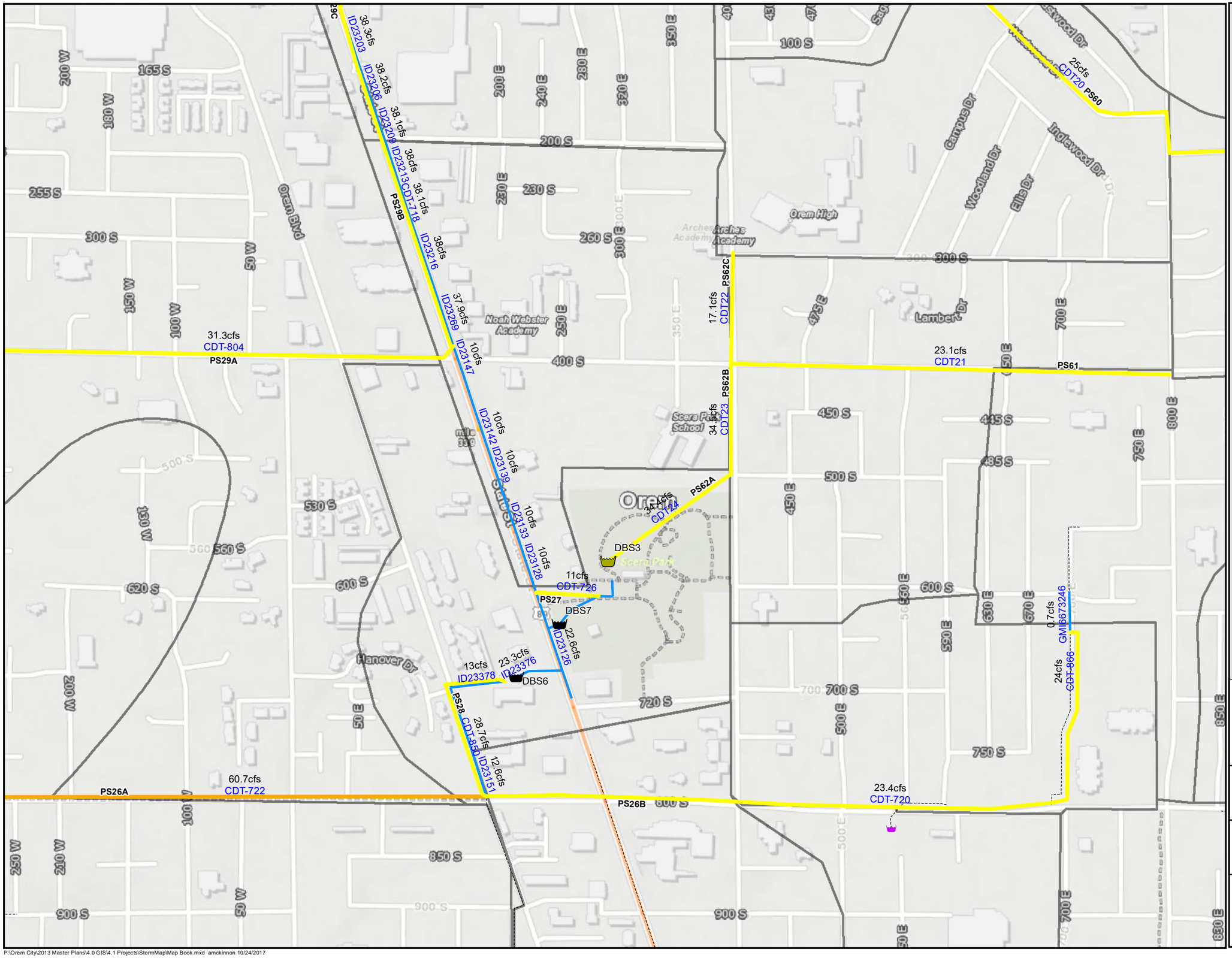
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 10

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

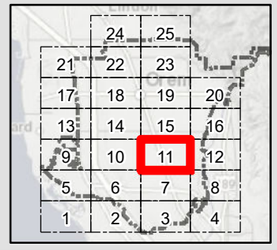
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

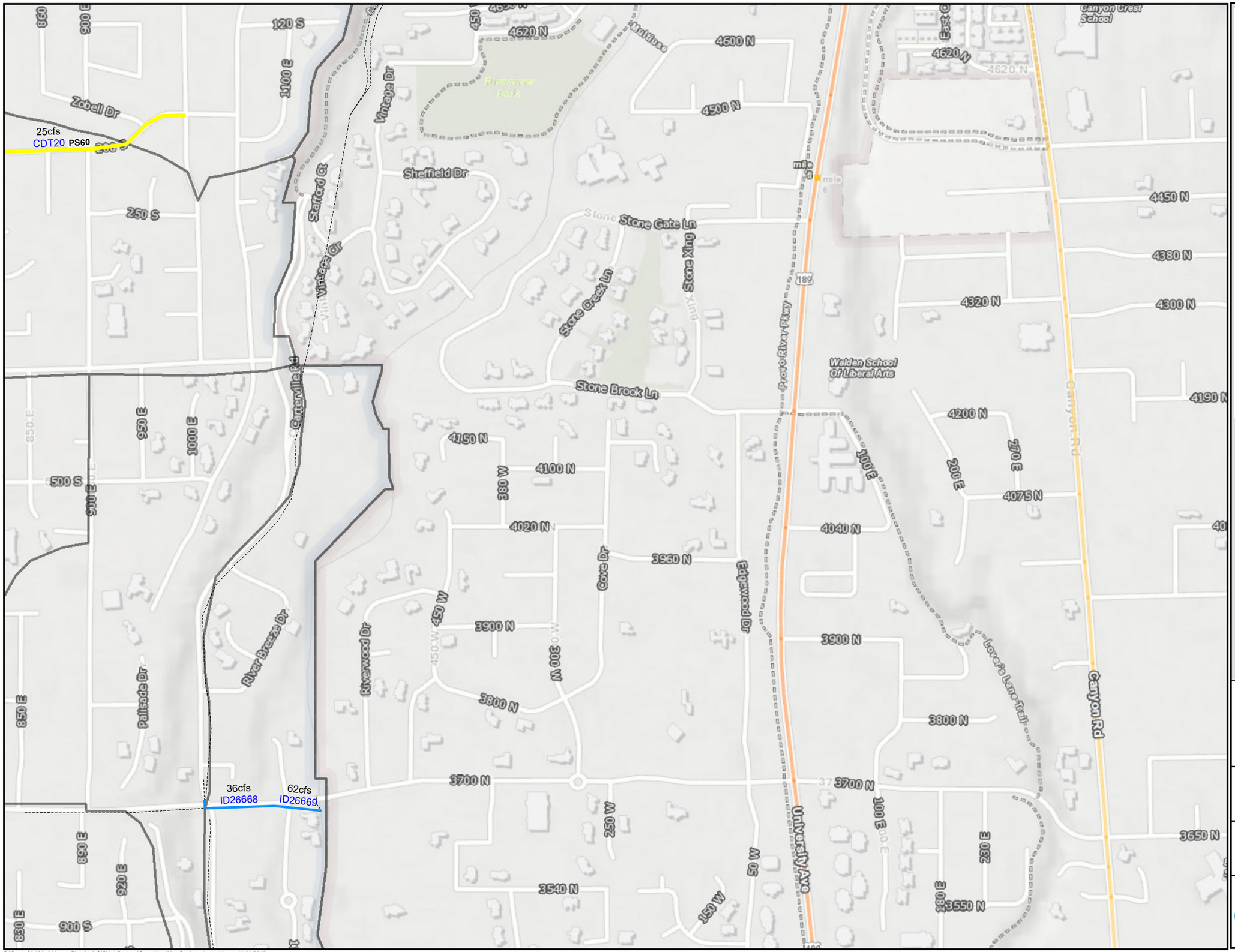
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 11

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

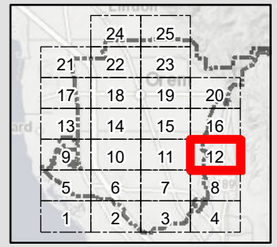
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE:

0 225 450
Feet

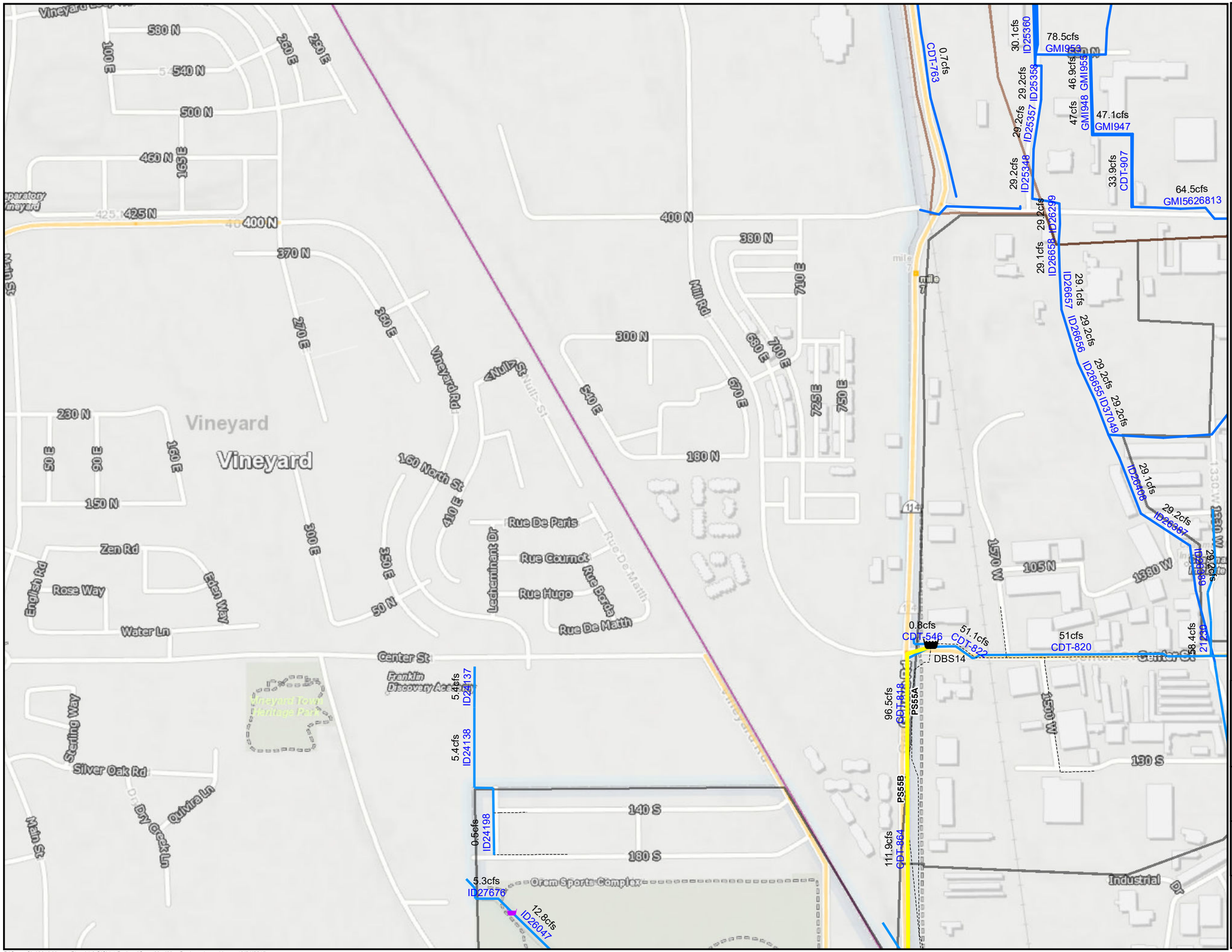
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.
12

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

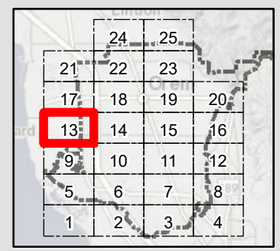
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 13

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017

LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

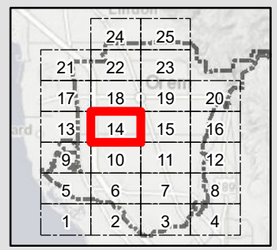
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

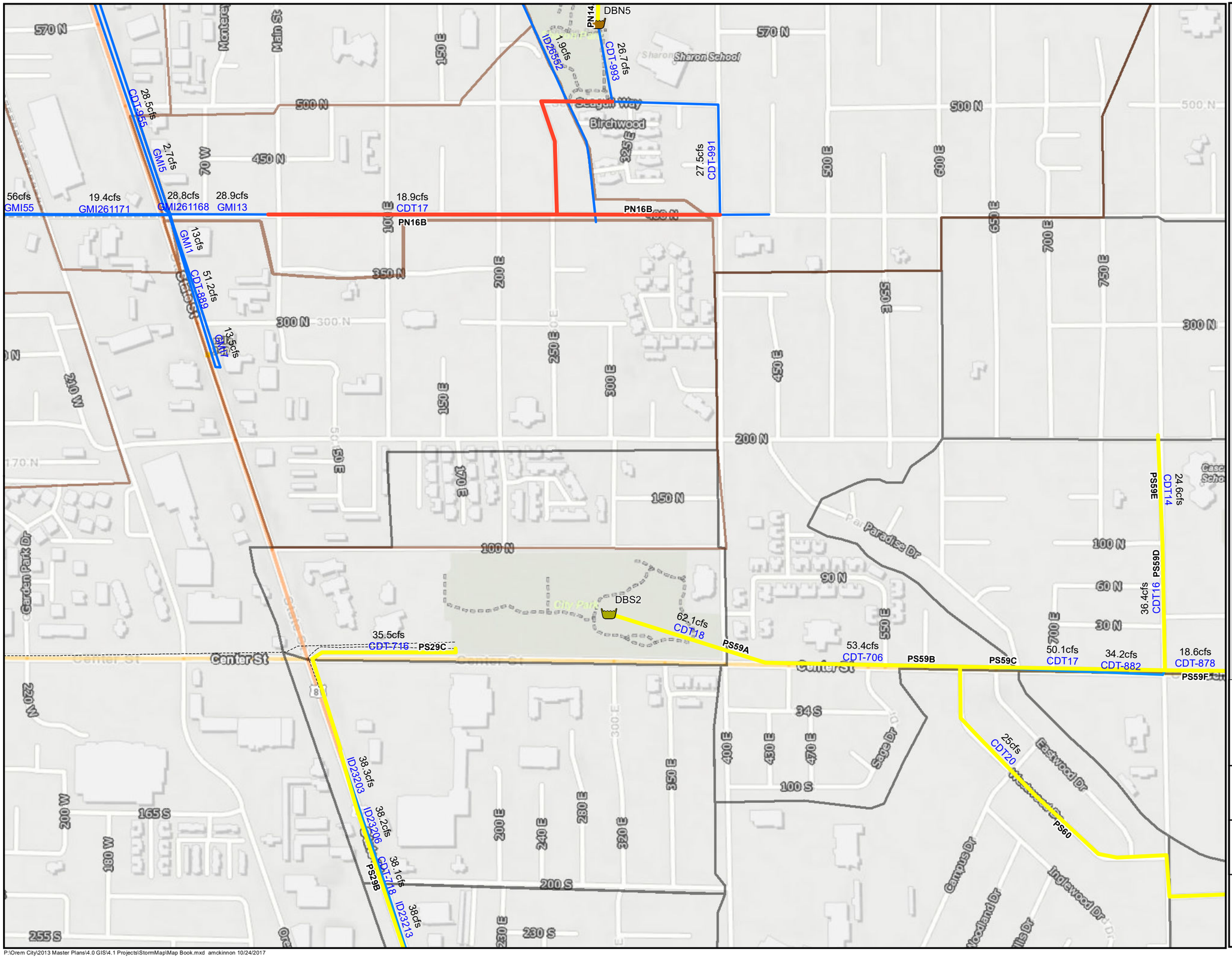
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 14

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

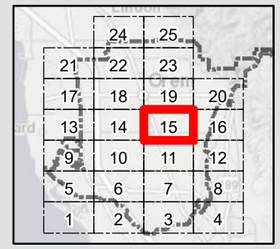
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

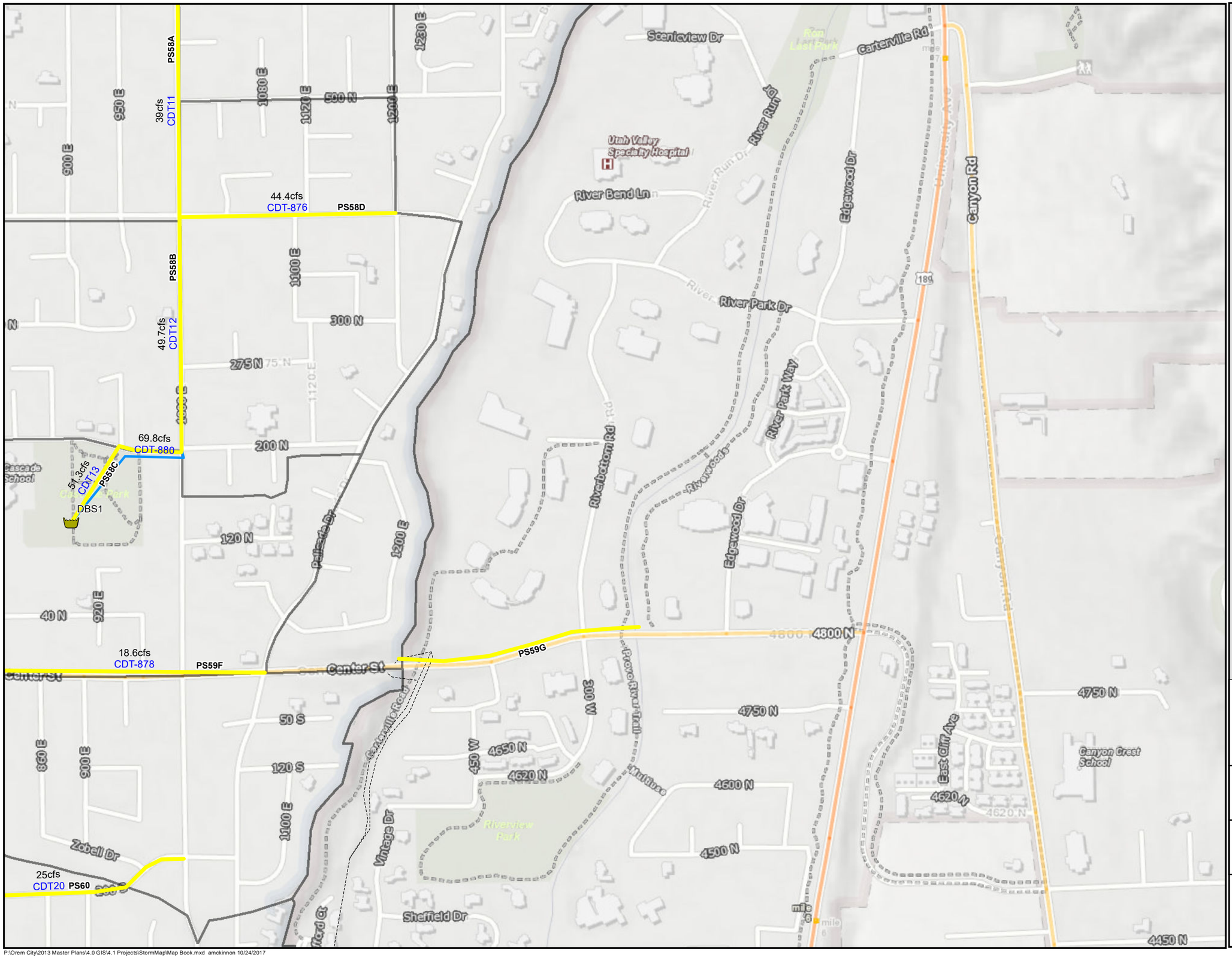
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 15

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

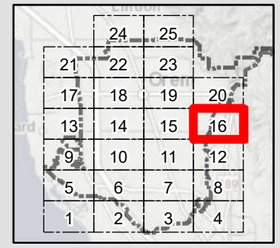
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

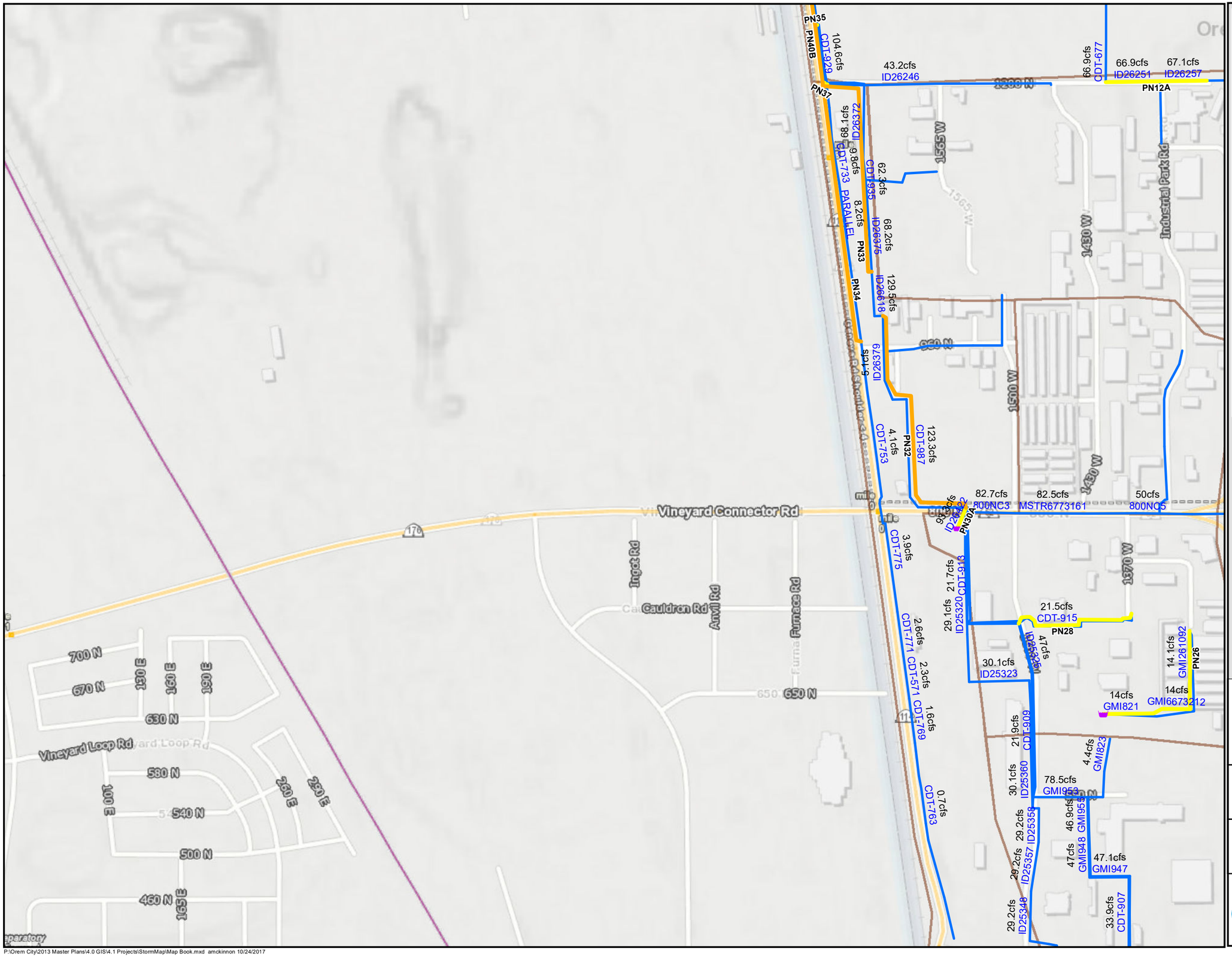
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 16

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

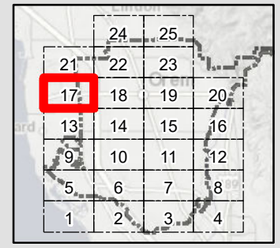
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 17

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017

LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

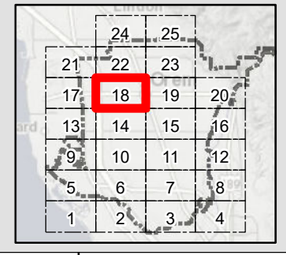
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

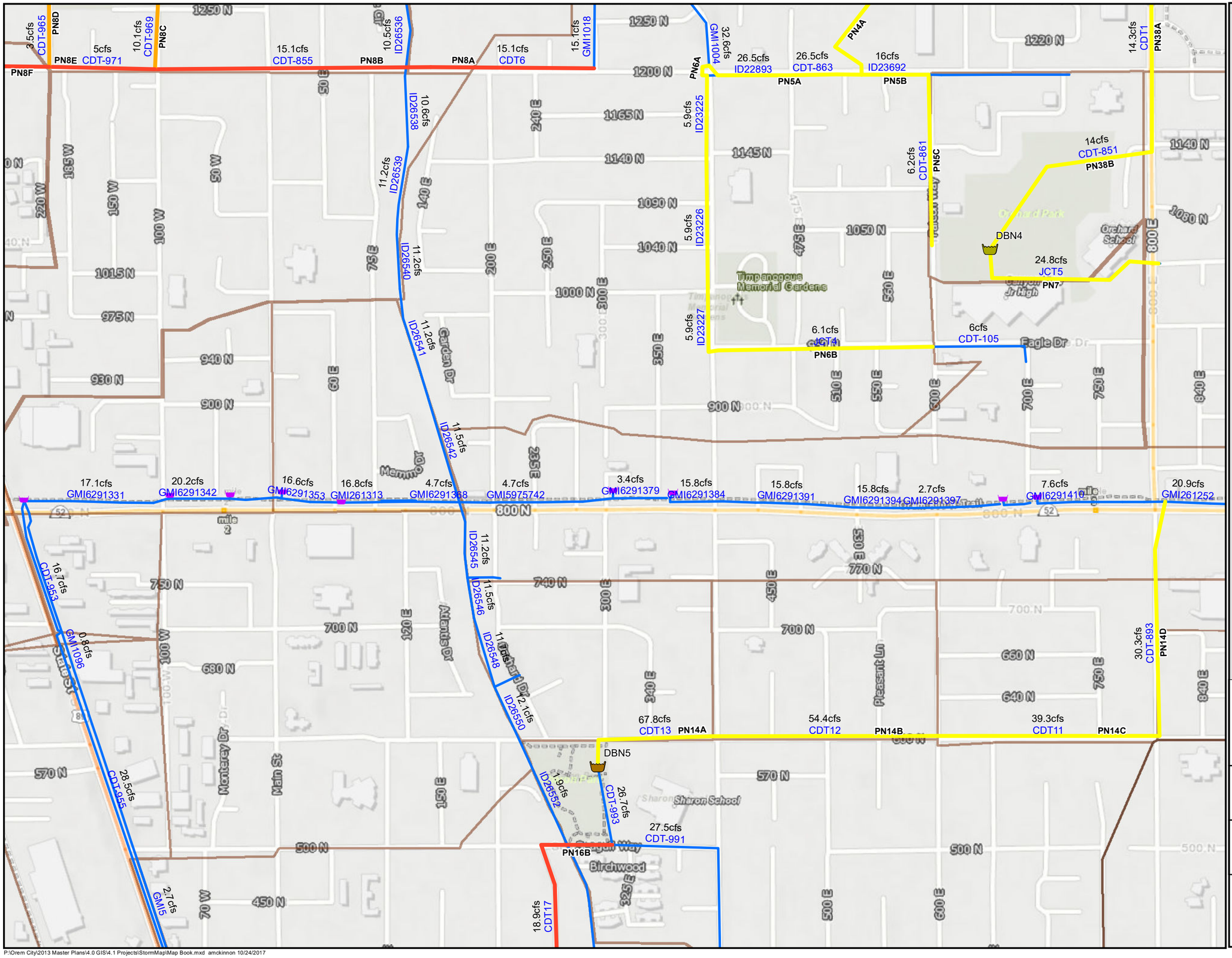
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 18

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

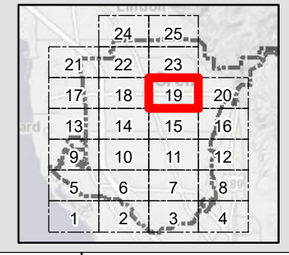
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

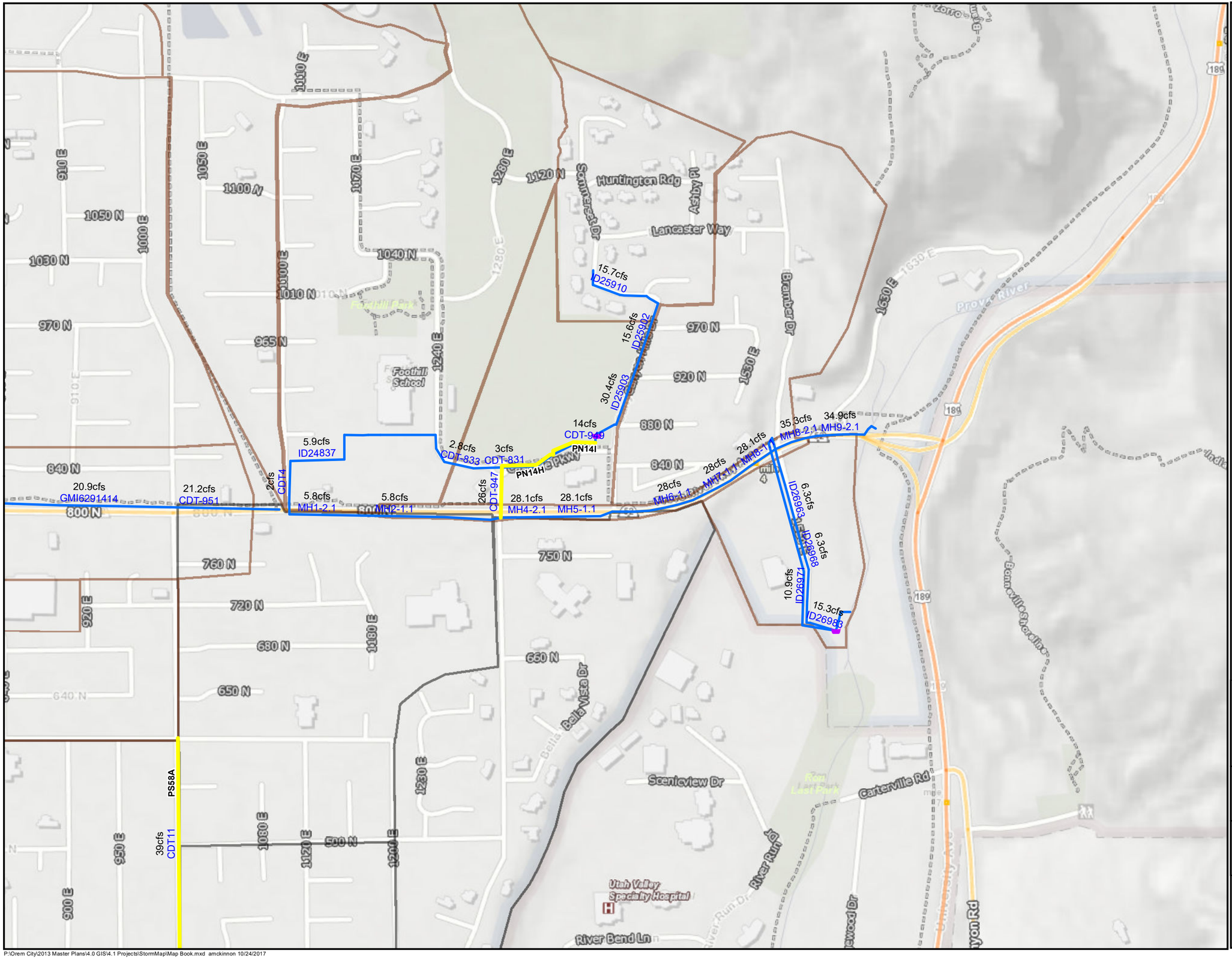
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 19

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

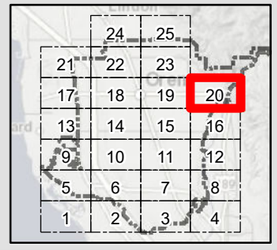
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

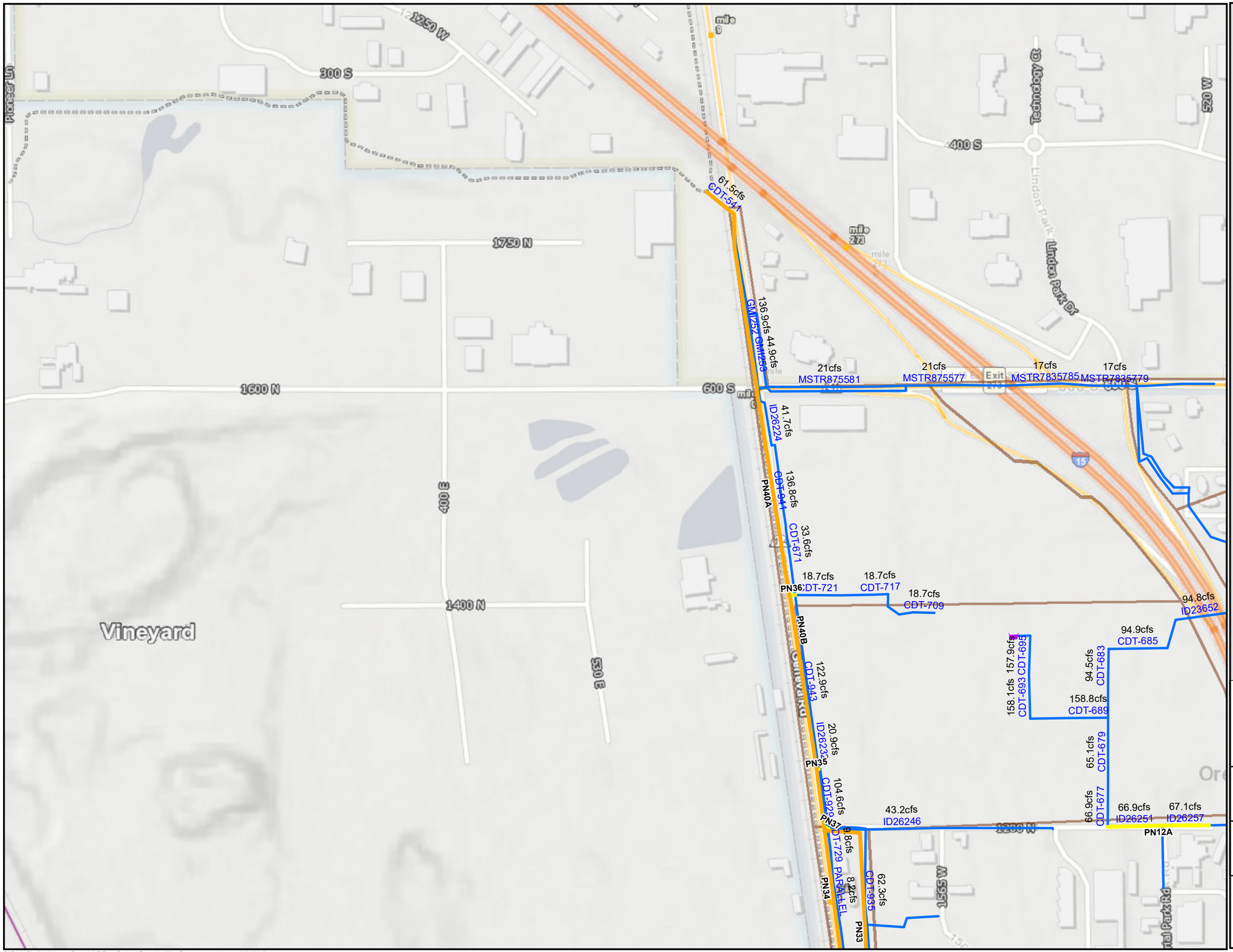
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 20

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

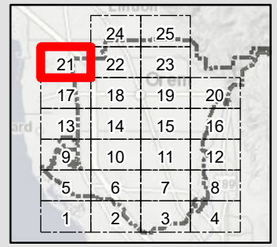
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

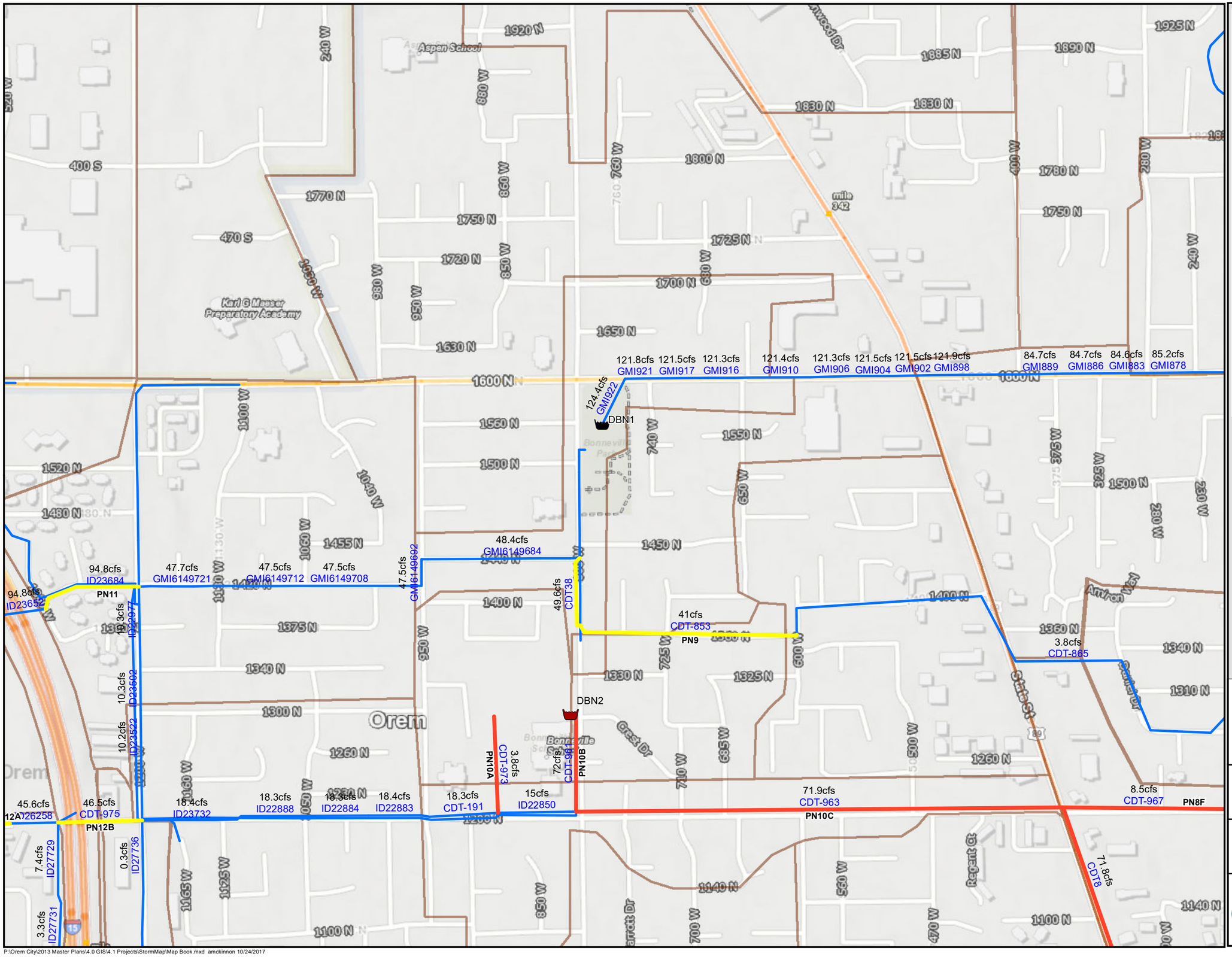
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 21

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

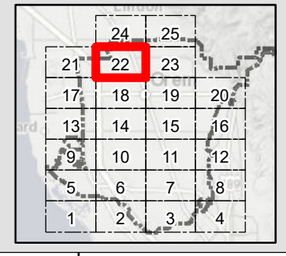
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 22

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017

LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

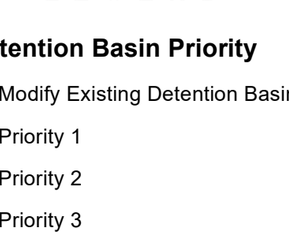
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

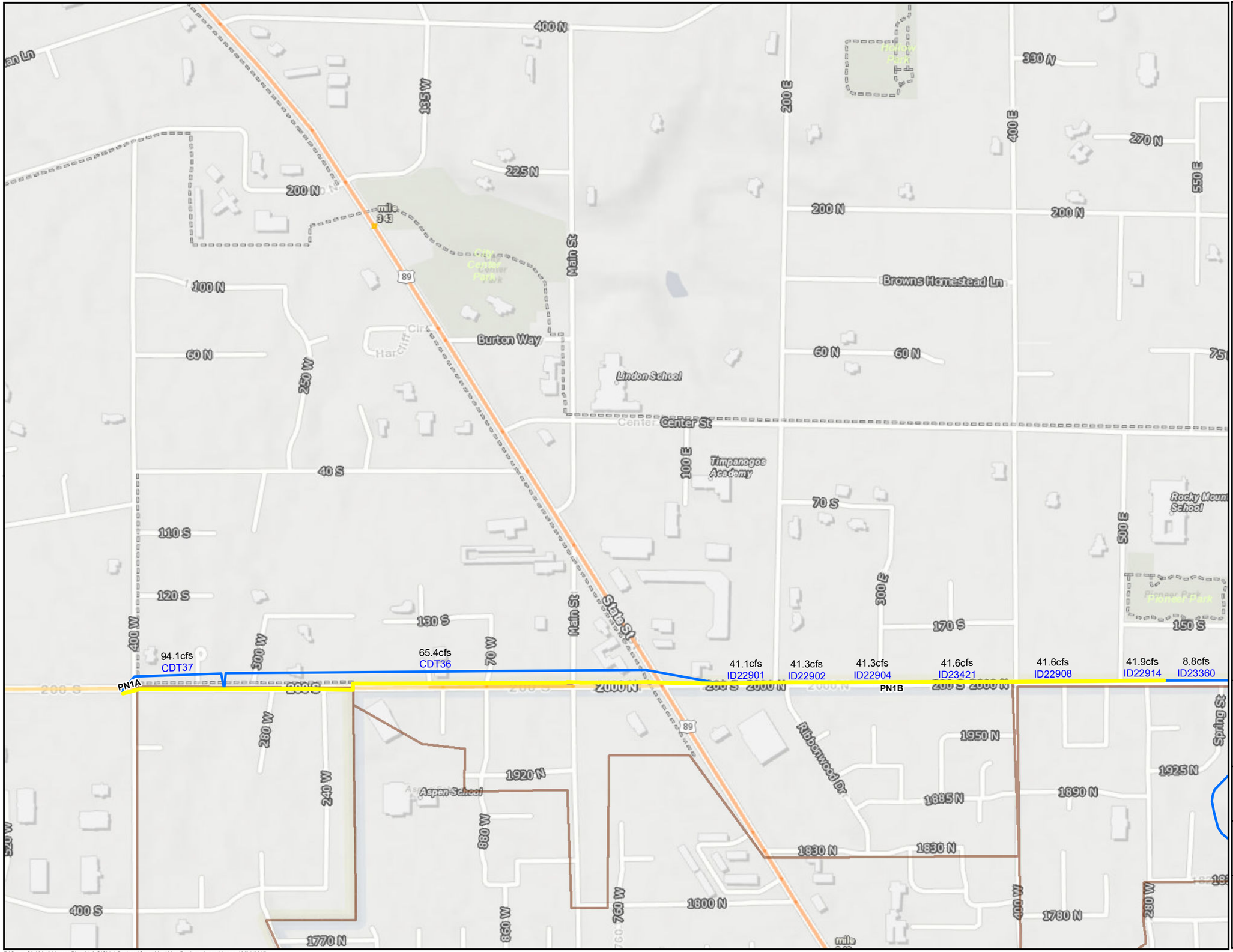
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 23

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



L E G E N D

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

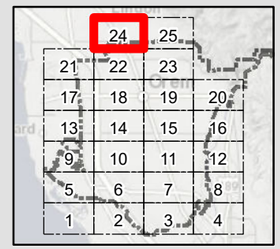
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

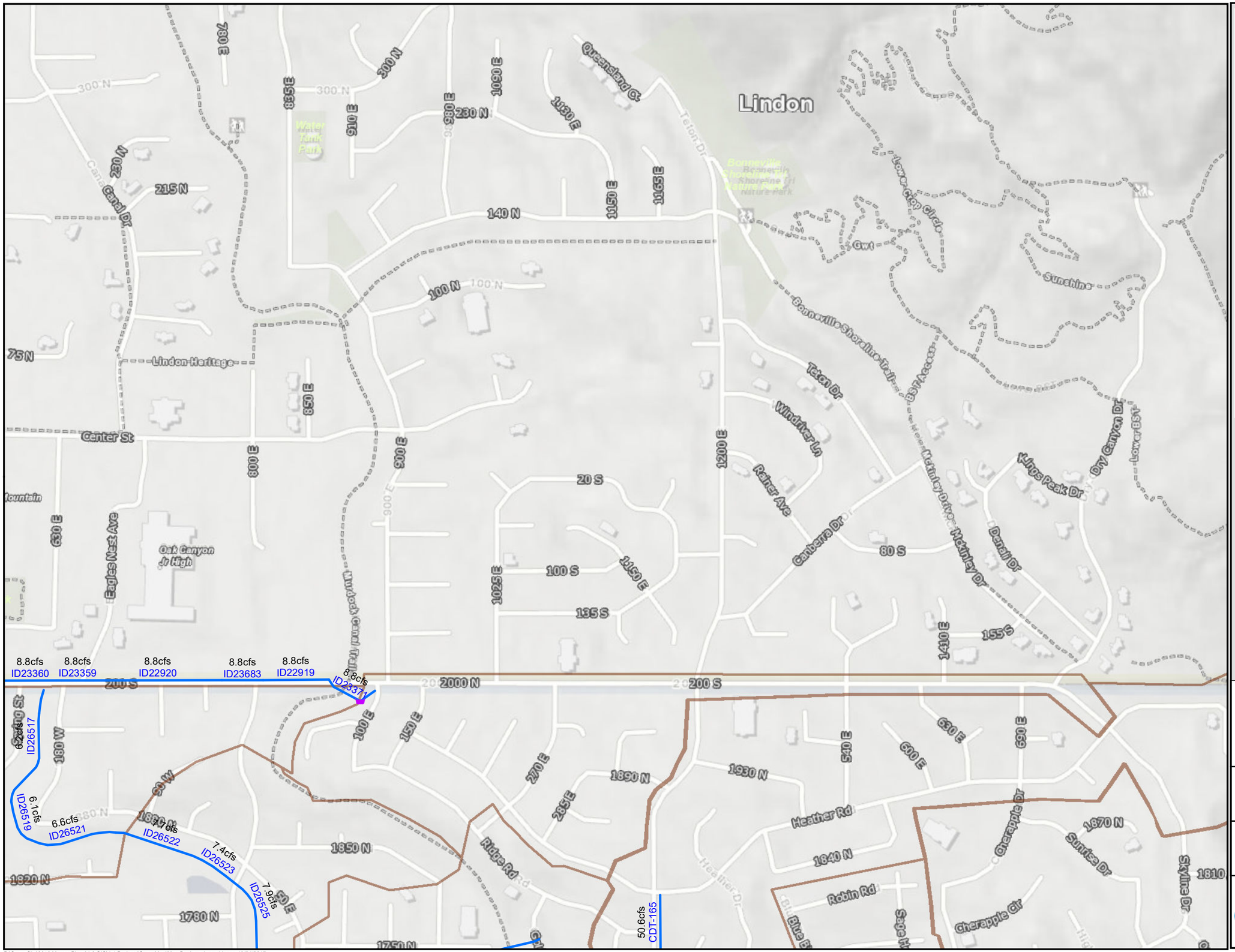
BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 24

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017



LEGEND

Detention Basin Priority

- Modify Existing Detention Basin
- Priority 1
- Priority 2
- Priority 3
- Existing Detention Basin

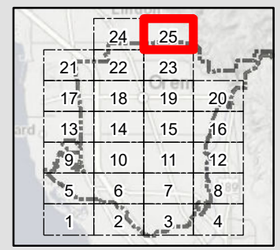
Pipe Priority

- Priority 1
- Priority 2
- Priority 3
- Future / Major Pipe or Channel
- Existing / Minor Pipe or Channel

Subcatchment

- Active

20 cfs ← Peak Runoff, 10-yr Storm Event
ID23219 ← Pipe ID



NORTH:

SCALE: 0 225 450 Feet

BUILDOUT PROPOSED FLOW RATES

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 25

P:\Orem City\2013 Master Plans\4.0 GIS\4.1 Projects\StormMap\Map Book.mxd amckinnon 10/24/2017

Table B-1
Model Output Data

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
21077	280	0.55	24	12	17		CDT-55	99	1.32	18	0	12
21078	161	0.32	24	12	13		CDT-553	399	0.95	30	21	40
21079	237	0.95	24	12	22		CDT-555	383	1.16	30	21	44
21080	396	1.22	24	12	25		CDT-557	147	3.16	30	21	73
21082	404	0.31	24	12	12		CDT-563	161	3.45	21	3	38
21084	401	1.52	24	12	28		CDT-566	37	2.60	18	0	22
21086	389	0.18	24	12	10		CDT-568	192	0.52	18	0	10
21090	196	2.46	24	12	35		CDT-570	36	15.73	18	0	54
21092	94	1.31	24	12	26		CDT-578	254	0.49	18	0	10
21093	397	0.66	24	12	18		CDT-580	87	0.50	18	0	10
21095	400	0.25	24	12	11		CDT-586	140	3.21	18	14	24
21097	355	1.48	24	12	28		CDT-588	146	5.70	18	14	33
21100	85	2.25	24	12	34		CDT-590	302	1.64	18	14	17
60	49	2.73	60	131	430		CDT-592	181	2.71	18	14	22
800NC2	152	0.76	36	29	58		CDT-594	85	1.64	24	17	38
800NC3	331	2.99	48	83	248		CDT-596	69	3.88	24	17	58
800NC5	137	8.35	42	50	291		CDT-598	223	6.65	24	28	76
AFSD	51	0.48	84	30	440		CDT-599	165	3.82	24	36	44
CDT-1003	70	1.52	18	6	13		CDT-600	46	8.73	24	28	87
CDT-105	315	2.94	18	6	18		CDT-601	155	4.91	24	51	50
CDT-165	1137	4.09	36	51	135		CDT-602	85	14.04	24	28	110
CDT-17	259	0.08	36	0	19		CDT-604	181	1.74	24	33	39
CDT-19	101	0.24	36	0	33		CDT-605	78	2.06	24	0	32
CDT-191	273	1.87	24	18	31		CDT-606	333	3.03	24	29	51
CDT-21	198	0.97	36	0	66		CDT-607	104	2.36	24	0	35
CDT-495	143	2.80	18	6	18		CDT-608	112	0.48	24	36	20
CDT-541	29	10.48	36	185	216		CDT-609	78	2.38	24	0	35
CDT-569	256	0.94	18	0	10		CDT-61	32	1.24	18	0	12
CDT-571	259	0.16	18	2	4		CDT-610	65	0.49	24	36	21
CDT-573	28	1.68	18	4	14		CDT-611	227	1.74	24	0	30
CDT-593	352	3.02	24	0	39		CDT-612	35	2.83	24	36	50
CDT-627	192	0.26	24	0	12		CDT-613	129	0.72	30	0	35
CDT-635	53	0.10	24	17	7		CDT-615	53	1.21	30	0	45
CDT-647	5	0.02	24	15	3		CDT-617	233	0.63	30	0	33
CDT-649	76	3.47	48	82	268		CDT-622	101	1.27	18	0	15
CDT-665	11	4.87	42	42	222		CDT-624	110	2.01	18	0	19
CDT-667	133	0.16	42	42	40		CDT-626	184	0.35	18	0	8
CDT-669	231	0.11	42	34	33		CDT-628	70	4.37	24	0	61
CDT-671	167	0.48	42	34	69		CDT-630	70	0.00	24	1	1
CDT-673	52	1.10	42	34	106		CDT-631	1891	0.01	72	0	44
CDT-675	20	0.28	42	34	53		CDT-632	222	12.99	18	14	49
CDT-677	248	2.73	48	67	237		CDT-633	1761	0.07	30	25	198
CDT-679	412	1.07	48	65	149		CDT-634	30	0.00	18	0	1
CDT-681	213	2.65	48	95	234		CDT-643	176	2.72	36	107	110
CDT-683	203	0.23	48	95	70		CDT-645	88	3.69	36	107	128
CDT-685	355	1.95	48	95	201		CDT-664	251	0.69	24	0	24
CDT-687	178	5.63	48	95	341		CDT-666	222	0.76	24	0	26
CDT-689	236	2.07	48	159	207		CDT-668	227	1.14	15	0	9
CDT-691	235	0.61	48	159	112		CDT-67	70	0.72	18	0	9
CDT-693	264	2.14	48	158	210		CDT-670	162	0.19	24	0	13
CDT-695	238	2.80	48	158	240		CDT-672	232	0.97	24	0	22
CDT-697	99	0.58	48	158	109		CDT-674	56	0.71	24	0	25
CDT-709	129	4.64	30	19	88		CDT-676	175	3.70	24	0	57
CDT-711	86	4.64	30	19	88		CDT-678	87	0.41	24	0	19
CDT-713	83	0.39	30	19	26		CDT-680	282	2.50	24	0	46
CDT-715	74	1.12	30	19	43		CDT-682	92	0.13	18	0	5

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
CDT-717	91	2.70	30	19	67		CDT-684	194	0.14	24	0	11
CDT-719	194	0.10	30	19	13		CDT-686	23	12.42	24	0	104
CDT-721	278	0.04	30	19	8		CDT-688	12	23.01	28	0	213
CDT-723	278	0.13	30	21	15		CDT-69	124	0.40	18	0	7
CDT-725	30	2.26	30	22	62		CDT-690	12	1.49	24	16	36
CDT-729	116	0.17	24	10	9		CDT-694	533	1.13	24	0	31
CDT-731	185	0.05	30	10	9		CDT-698	145	0.13	42	4	39
CDT-733	50	1.98	30	10	58		CDT-706	1178	0.85	36	107	61
CDT-739	124	0.20	30	10	18		CDT-71	128	1.41	18	0	12
CDT-741	270	0.05	30	11	9		CDT-716	1481	0.83	30	36	37
CDT-743	272	0.11	30	11	14		CDT-718	1834	0.35	36	38	40
CDT-745	197	0.96	30	11	40		CDT-720	3426	0.60	30	23	32
CDT-747	90	0.66	24	5	18		CDT-722	3125	0.68	42	61	83
CDT-749	224	0.43	24	5	15		CDT-724	1387	0.82	12	0	3
CDT-751	198	0.10	24	4	7		CDT-726	384	0.27	24	11	12
CDT-753	235	0.14	24	4	8		CDT-728	1439	0.63	36	39	53
CDT-755	63	1.02	24	4	23		CDT-73	211	1.47	18	0	13
CDT-757	298	0.39	18	0	7		CDT-738	42	6.62	24	33	58
CDT-759	62	0.44	18	0	7		CDT-740	417	4.01	36	63	134
CDT-761	102	0.26	18	0	5		CDT-742	1133	0.89	36	36	63
CDT-763	214	0.09	18	1	3		CDT-746	1640	1.27	30	11	46
CDT-765	79	0.18	24	1	10		CDT-752	684	0.53	36	48	49
CDT-767	199	0.12	18	1	4		CDT-754	1652	0.61	36	43	52
CDT-769	160	0.20	18	2	5		CDT-758	1676	0.57	30	29	31
CDT-771	273	0.15	18	3	4		CDT-760	1194	1.68	36	141	86
CDT-773	242	0.15	18	4	4		CDT-762	434	1.73	18	6	14
CDT-775	342	0.12	18	4	4		CDT-764	724	1.03	24	21	23
CDT-777	139	0.12	24	4	8		CDT-768	0	0.20	18	0	5
CDT-779	15	1.11	24	4	24		CDT-770	0	0.29	30	0	22
CDT-781	108	2.01	18	4	15		CDT-772	1317	0.83	18	7	10
CDT-783	20	10.25	24	4	72		CDT-776	607	3.99	30	31	82
CDT-785	22	0.01	24	4	2		CDT-782	829	0.44	54	138	130
CDT-787	85	2.90	18	0	18		CDT-784	933	0.22	60	148	122
CDT-789	174	2.33	18	0	16		CDT-786	1455	0.62	48	92	113
CDT-791	61	1.30	24	0	26		CDT-790	539	4.26	30	42	85
CDT-793	284	1.55	24	0	28		CDT-792	355	3.69	24	28	43
CDT-795	322	1.51	24	0	28		CDT-794	897	1.55	24	21	28
CDT-797	14	7.10	24	0	60		CDT-796	402	0.71	24	16	19
CDT-799	43	2.24	24	0	34		CDT-802	115	12.98	36	17	240
CDT-801	53	1.82	24	0	30		CDT-804	5853	0.53	30	63	30
CDT-803	114	1.36	30	6	48		CDT-806	731	0.56	48	50	107
CDT-805	277	0.21	30	18	19		CDT-808	781	0.44	42	48	67
CDT-807	9	0.01	30	18	4		CDT-814	2083	2.13	36	95	97
CDT-809	88	2.35	30	10	63		CDT-816	36	7.66	36	69	185
CDT-811	49	0.20	30	9	19		CDT-818	703	0.21	54	96	91
CDT-813	82	0.17	42	42	41		CDT-820	1166	1.48	36	51	81
CDT-815	21	5.49	12	2	8		CDT-822	292	0.49	42	51	71
CDT-827	110	0.15	24	3	9		CDT-824	1172	0.30	36	27	36
CDT-831	380	0.19	36	3	29		CDT-826	494	1.93	24	16	31
CDT-833	181	1.25	36	3	75		CDT-828	2009	0.50	54	142	139
CDT-835	94	3.31	36	0	121		CDT-83	76	2.42	18	0	16
CDT-837	82	2.32	36	0	102		CDT-830	380	0.30	48	28	78
CDT-841	188	0.02	24	14	4		CDT-832	4081	1.00	42	105	100
CDT-843	29	6.03	24	14	56		CDT-836	509	1.62	42	110	128
CDT-845	468	4.32	24	5	47		CDT-840	928	1.01	24	18	23
CDT-847	403	3.58	15	5	12		CDT-844	406	1.72	60	87	444
CDT-849	328	8.79	15	5	19		CDT-846	2211	1.16	36	52	72
CDT-851	1742	0.52	30	14	29		CDT-85	261	3.53	18	0	20

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
CDT-853	1339	0.85	36	41	61		CDT-850	1092	0.13	42	29	36
CDT-855	1669	0.42	30	17	27		CDT-854	1480	4.65	18	24	23
CDT-859	42	3.56	30	32	77		CDT-856	236	1.47	54	143	238
CDT-861	1033	0.45	18	6	7		CDT-858	5112	1.67	36	43	86
CDT-863	285	0.24	36	27	32		CDT-860	1778	1.00	30	18	41
CDT-865	3960	0.86	24	5	21		CDT-864	1289	0.21	60	112	120
CDT-881	741	0.88	36	55	63		CDT-866	1166	0.58	30	24	31
CDT-883	347	3.98	30	49	82		CDT-868	2128	1.08	36	70	69
CDT-885	226	1.62	24	0	29		CDT-870	4442	0.71	30	18	35
CDT-887	11	23.40	24	12	109		CDT-874	1207	0.42	48	102	93
CDT-889	994	0.58	36	51	94		CDT-876	1309	0.76	36	44	58
CDT-891	1121	0.59	36	37	51		CDT-878	1802	0.67	24	19	18
CDT-893	1426	0.58	36	30	51		CDT-880	923	0.76	42	70	88
CDT-897	1297	0.58	30	26	31		CDT-882	1258	0.64	30	34	33
CDT-899	2028	0.36	18	4	6		CDT-884	320	1.43	42	71	120
CDT-901	526	0.59	30	22	31		CDT-890	249	0.17	42	38	41
CDT-903	14	2.97	24	12	39		CDT-892	227	0.43	42	38	66
CDT-907	1173	0.60	36	34	52		CDT-896	234	6.38	18	0	27
CDT-909	1017	0.61	30	22	32		CDT-898	38	7.30	18	0	28
CDT-913	611	0.27	30	22	21		CDT-900	6	1.82	12	0	5
CDT-915	796	2.93	24	21	39		CDT-902	68	4.80	18	0	23
CDT-917	35	2.89	60	16	442		CDT-904	31	0.81	36	18	60
CDT-921	56	0.18	60	13	110		CDT-908	14	4.46	36	18	14
CDT-923	14	7.33	60	18	705		CDT-91	309	3.14	30	0	994
CDT-925	38	4.72	60	21	566		CDT-910	225	5.36	15	3	15
CDT-929	358	0.20	54	105	88		CDT-914	25	0.16	42	1	43
CDT-935	1369	0.64	42	62	80		CDT-920	345	0.15	24	0	10
CDT-941	1270	0.24	60	137	128		CDT-922	1804	0.06	30	83	132
CDT-943	1067	0.15	60	123	102		CDT-926	140	0.28	24	0	12
CDT-947	640	1.17	30	26	44		CDT-928	108	0.22	30	0	25
CDT-949	288	0.26	24	14	12		CDT-932	803	0.30	18	0	6
CDT-951	985	1.11	30	21	43		CDT-934	1662	3.70	18	0	20
CDT-953	843	0.12	36	17	23		CDT-936	1437	0.27	18	0	5
CDT-955	2110	0.32	36	29	38		CDT-938	1284	0.37	36	47	41
CDT-961	602	0.27	42	75	53		CDT-940	672	1.39	30	45	63
CDT-963	2952	0.91	42	75	96		CDT-942	0	1.17	24	6	32
CDT-965	695	1.01	18	4	11		CDT11	1348	0.74	36	39	57
CDT-967	1107	0.72	24	9	19		CDT12	1354	0.64	36	99	53
CDT-969	762	0.53	24	12	16		CDT13	859	0.74	36	51	58
CDT-971	640	1.88	18	5	14		CDT14	667	1.05	30	25	42
CDT-973	585	0.10	18	4	3		CDT16	757	0.40	36	36	42
CDT-975	510	4.75	24	47	49		CDT17	2712	0.65	36	50	54
CDT-979	228	1.53	48	55	177		CDT18	1645	0.43	42	124	66
CDT-981	1191	0.67	30	21	34		CDT20	3500	0.20	36	25	30
CDT-983	68	3.76	36	10	129		CDT21	2658	0.75	30	23	36
CDT-985	4	26.21	24	10	116		CDT22	673	0.59	24	17	17
CDT-987	1534	0.41	54	123	126		CDT23	673	1.19	30	69	45
CDT-991	1605	0.56	30	28	31		CDT24	912	0.55	36	69	49
CDT-993	150	1.33	24	27	26		CDT45	823	1.75	36	23	88
CDT-995	1400	0.37	30	18	25		CDT60	584	6.78	36	61	174
CDT-997	269	0.28	42	64	53		GMI103	308	4.04	36	61	134
CDT-999	1677	0.56	18	5	8		GMI1035	475	4.20	36	36	137
CDT1	1305	0.84	24	14	21		GMI104	109	2.69	36	61	109
CDT10	1233	6.10	18	18	26		GMI1051	163	2.51	18	3	17
CDT11	1348	0.74	36	39	57		GMI1052	64	1.50	36	7	82
CDT12	1354	0.96	36	54	65		GMI1053	71	0.14	36	7	25
CDT13	859	1.40	36	68	79		GMI1054	60	1.19	36	10	73
CDT17	2712	0.72	24	19	19		GMI1055	18	1.38	36	10	78

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
CDT36	2706	2.64	30	65	67		GMI1056	64	0.31	36	11	37
CDT37	745	5.00	36	94	149		GMI1061	298	0.82	24	18	21
CDT38	439	0.66	36	50	54		GMI1067	56	4.35	18	1	22
CDT4	351	1.01	24	6	23		GMI1101	0	3.93	2	0	0
CDT45	823	2.60	36	0	108		GMI1102	116	1.90	24	0	31
CDT47	1858	0.82	30	0	37		GMI1103	118	28.70	24	0	121
CDT48	917	1.82	42	15	136		GMI125	60	0.00	24	2	1
CDT55	1147	0.58	30	18	31		GMI132	184	0.09	24	2	7
CDT6	989	0.91	24	17	22		GMI133	85	0.24	24	9	11
CDT8	1268	0.47	42	72	69		GMI170	37	1.89	12	0	5
CDT9	670	0.64	36	39	53		GMI171	120	0.49	12	0	2
GMI1	133	1.34	24	13	26		GMI172	89	62.69	12	0	28
GMI10	185	0.07	24	13	6		GMI2506002	93	1.82	36	66	90
GMI1004	259	0.82	36	32	60		GMI2506114	379	0.39	24	13	14
GMI1005	203	0.58	36	32	51		GMI2506115	418	0.39	24	13	14
GMI1006	172	0.50	36	32	47		GMI2506116	216	0.39	24	12	14
GMI1008	269	0.42	36	32	43		GMI2506117	219	0.39	24	12	14
GMI1009	38	0.96	36	51	65		GMI2506118	76	0.39	24	12	13
GMI1018	272	1.04	18	17	11		GMI2506160	112	6.23	24	5	56
GMI1094	158	0.11	36	3	22		GMI2506161	159	3.03	24	5	39
GMI1095	320	0.59	36	3	51		GMI261387	425	4.57	24	30	48
GMI1096	246	0.39	36	1	42		GMI261391	300	6.76	24	30	59
GMI1097	188	0.51	36	0	48		GMI261394	272	9.13	24	30	68
GMI1098	152	0.47	36	0	46		GMI328	48	0.69	24	0	19
GMI1099	148	1.86	36	0	91		GMI370	50	0.70	24	0	19
GMI1100	349	0.18	36	0	28		GMI371	39	0.39	24	0	14
GMI116	276	5.48	30	72	96		GMI372	329	0.75	24	0	20
GMI117	150	6.41	30	72	104		GMI373	84	0.17	24	0	9
GMI13	431	1.28	24	29	26		GMI374	147	0.18	24	0	9
GMI149	60	0.46	24	13	15		GMI5626232	123	0.38	36	24	41
GMI16	52	1.33	24	13	26		GMI5626233	100	0.47	36	24	46
GMI17	371	0.61	48	21	112		GMI5626236	69	1.41	36	24	79
GMI18	372	0.72	24	7	19		GMI5626237	101	0.45	36	24	45
GMI20	6	4.75	24	4	49		GMI5626242	71	1.45	36	24	80
GMI22	5	2.64	24	5	37		GMI5626274	5	24.00	24	0	111
GMI23	389	0.64	24	3	18		GMI5626275	24	3.99	24	4	45
GMI24	387	0.45	48	22	97		GMI5626276	101	2.69	24	4	37
GMI252	806	0.32	60	137	147		GMI5626277	264	0.19	24	4	10
GMI253	800	0.41	36	45	43		GMI5626380	175	0.48	24	5	16
GMI255	178	0.11	42	48	33		GMI5626381	256	0.77	12	0	3
GMI26	6	15.87	24	6	90		GMI5626382	151	0.53	12	0	3
GMI261056	117	0.41	15	0	4		GMI5626392	152	1.91	18	6	15
GMI261092	252	0.72	24	14	19		GMI5626393	162	0.59	18	7	8
GMI261093	180	0.23	24	7	11		GMI5626394	77	0.46	18	7	7
GMI261103	16	19.46	12	0	16		GMI5626397	243	0.59	18	6	8
GMI261104	15	4.46	48	56	303		GMI5626399	345	1.10	18	2	11
GMI261105	308	0.21	48	56	66		GMI5626404	51	6.79	18	2	27
GMI261129	8	104.20	12	0	36		GMI5626406	206	0.15	24	1	9
GMI261134	110	0.00	24	2	1		GMI5626435	397	0.22	24	0	11
GMI261135	310	0.85	24	17	21		GMI5626440	37	0.76	12	0	3
GMI261143	295	0.66	24	0	18		GMI5626573	221	0.20	12	4	2
GMI261165	196	0.53	36	55	48		GMI5626628	128	7.43	24	27	62
GMI261166	282	0.57	36	57	50		GMI5626632	116	1.40	24	27	27
GMI261167	255	0.57	36	56	50		GMI5626643	153	0.34	30	5	24
GMI261168	161	3.36	36	29	122		GMI5626669	107	0.23	12	0	2
GMI261169	5	1.76	24	18	30		GMI5626719	298	0.82	12	0	3
GMI261170	255	0.56	24	20	17		GMI5626720	174	0.13	12	0	1
GMI261171	283	0.43	24	19	15		GMI5626760	239	0.66	12	0	3

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
GMI261174	7	0.89	12	3	3		GMI5626761	45	0.86	12	0	3
GMI261175	6	5.31	12	2	8		GMI581	37	0.32	12	0	2
GMI261176	68	1.34	24	13	26		GMI582	37	2.19	12	0	5
GMI261177	32	4.82	36	12	146		GMI583	200	13.75	24	0	84
GMI261178	193	0.20	36	9	30		GMI5975768	155	0.82	36	40	60
GMI261179	285	0.66	24	21	18		GMI5975770	78	0.72	36	40	57
GMI261180	381	0.59	36	19	51		GMI5975773	160	2.38	24	5	35
GMI261181	374	0.35	24	10	13		GMI5975774	103	0.21	24	5	10
GMI261182	6	11.39	24	10	76		GMI5975776	487	0.86	21	6	15
GMI261187	344	0.65	36	34	54		GMI5975777	232	0.25	24	5	11
GMI261188	168	0.76	36	34	58		GMI5975782	392	0.18	15	0	3
GMI261191	50	3.87	36	40	131		GMI5975784	390	0.25	24	12	11
GMI261205	186	0.39	24	3	14		GMI5975787	383	0.28	24	12	12
GMI261232	295	1.19	30	0	45		GMI5975788	400	0.18	15	0	3
GMI261252	272	1.38	24	21	27		GMI5975790	140	0.32	24	12	13
GMI261307	131	3.16	24	17	40		GMI5975791	123	0.15	15	0	3
GMI261309	28	1.00	24	13	23		GMI5975799	11	1.74	15	0	9
GMI261312	54	0.94	24	10	22		GMI5975800	258	0.67	12	0	3
GMI261313	191	1.03	24	17	23		GMI5975802	56	1.14	12	0	4
GMI261318	351	2.47	24	0	36		GMI5975811	160	1.05	12	0	4
GMI261319	98	2.51	24	0	36		GMI603	138	4.87	12	0	8
GMI261320A	48	10.06	24	0	72		GMI604	125	4.89	12	0	8
GMI261334	33	22.41	24	15	107		GMI606	50	2.52	12	0	6
GMI27	258	0.52	24	9	16		GMI607	448	1.37	12	0	4
GMI28	258	0.91	48	15	137		GMI6150321	500	0.11	36	23	22
GMI31	5	2.84	24	4	38		GMI6150322	500	0.06	36	23	16
GMI35	316	0.65	48	11	116		GMI6150323	500	0.02	36	23	10
GMI36	315	0.70	24	10	19		GMI6150325	500	0.21	36	25	31
GMI37	6	0.02	24	6	3		GMI6150340	500	0.00	12	5	0
GMI38	317	0.44	48	5	96		GMI6150352	274	2.55	36	68	107
GMI39	317	0.52	24	16	16		GMI6150354	500	0.10	12	0	1
GMI40	7	3.42	24	51	42		GMI6150355	500	0.45	12	0	2
GMI43	377	1.08	48	56	149		GMI6150361	115	15.85	12	0	14
GMI44	377	1.09	24	19	24		GMI637	366	1.24	30	21	46
GMI45	6	3.87	24	3	44		GMI638	138	1.49	30	21	50
GMI46	329	0.54	48	58	106		GMI641	108	0.98	15	7	6
GMI47	328	0.50	24	17	16		GMI650	242	4.82	12	0	8
GMI4721158	180	0.23	24	7	11		GMI6673068	510	3.48	36	79	124
GMI4721166	70	4.09	24	2	46		GMI6673069	23	0.27	36	79	35
GMI4721217	49	2.15	24	0	33		GMI6673194	159	0.82	24	18	20
GMI4721233	6	5.31	24	4	52		GMI6673195	59	0.83	24	18	21
GMI4754200	12	3.08	12	0	6		GMI6673196	23	4.61	24	18	49
GMI4754201	206	1.92	12	0	5		GMI6673236	67	0.87	12	0	3
GMI4754202	47	6.54	12	0	9		GMI6673237	387	0.66	12	0	3
GMI4754203	33	1.26	24	0	25		GMI6673239	28	3.00	12	0	6
GMI4754204	285	1.39	12	0	4		GMI6673246	222	0.20	12	1	2
GMI4754205	32	11.09	12	0	12		GMI671	141	0.62	24	0	18
GMI4754212	492	6.15	24	0	56		GMI672	463	0.71	24	0	19
GMI4754217	77	3.89	24	0	45		GMI682	34	0.45	24	9	15
GMI48	6	1.63	24	5	29		GMI684	186	2.89	12	5	6
GMI5	211	0.99	36	3	66		GMI742	56	1.02	24	5	23
GMI51	232	1.30	48	53	164		GMI743	241	0.89	24	5	21
GMI52	233	1.29	24	23	26		GMI746	111	0.21	12	0	2
GMI53	6	1.33	24	4	26		GMI752	292	0.62	24	5	18
GMI55	365	0.84	48	56	132		GMI756	78	0.98	12	0	4
GMI554	65	1.85	24	13	31		GMI757	114	0.21	12	0	2
GMI56	366	0.92	24	20	22		GMI758	29	2.30	24	0	34
GMI5626793	363	0.42	12	3	2		GMI761	68	1.40	24	27	27

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
GMI5626794	436	0.40	12	3	2		GMI78	40	1.13	12	0	4
GMI5626796	50	6.07	24	2	56		GMI796	135	2.60	42	40	162
GMI5626800	51	4.99	12	2	8		GMI797	128	0.28	42	38	53
GMI5626811	25	1.73	48	64	189		GMI80	190	0.55	12	0	3
GMI5626812	127	3.20	48	64	257		GMI83	159	0.26	42	38	51
GMI5626813	153	1.47	48	64	174		GMI9214306	128	0.72	12	0	3
GMI5626910	36	7.12	12	0	10		GMI9214314	89	0.34	18	1	6
GMI57	5	7.04	24	4	60		GMI9214325	93	0.40	24	6	14
GMI5975681	51	0.78	24	4	20		GMI9214326	124	1.32	24	6	26
GMI5975682	77	0.78	24	4	20		GMI9214327	104	0.85	24	6	21
GMI5975683	11	17.37	24	5	94		GMI9214340	97	3.64	24	0	43
GMI5975685	199	0.29	24	17	12		GMI9214341	109	0.61	24	0	18
GMI5975688	152	0.42	12	0	2		GMI9214342	84	0.09	24	0	7
GMI5975689	244	2.38	12	0	5		GMI9214344	90	0.87	24	0	21
GMI5975731	121	3.90	12	0	7		GMI9214347	284	0.40	24	0	14
GMI5975738	24	0.00	12	1	0		GMI9214351	152	0.23	24	6	11
GMI5975739	145	3.17	24	10	40		GMI9214354	268	1.29	24	6	26
GMI5975741	53	1.23	24	10	25		GMI9214355	93	1.14	24	6	24
GMI5975742	212	1.84	24	10	31		GMI9214356	82	0.58	24	0	17
GMI5975744	44	0.99	24	10	23		GMI9214359	261	0.58	36	6	51
GMI5975745	202	1.20	24	10	25		GMI9214360	99	0.54	36	6	49
GMI5975747	52	0.21	24	10	10		GMI9214362	102	0.42	36	6	43
GMI5975748	184	0.08	24	10	6		GMI9214363	218	0.45	36	6	45
GMI5975756	130	4.28	24	0	47		GMI9214364	113	0.57	36	6	50
GMI60	90	0.98	48	55	142		GMI9214366	79	0.57	36	6	50
GMI6149660	41	0.54	24	0	17		GMI9214367	123	0.53	36	6	48
GMI6149662	96	0.47	24	0	16		GMI9214372	133	1.77	12	0	5
GMI6149664	387	0.51	24	0	16		GMI9214373	169	0.71	36	6	56
GMI6149666	91	0.61	24	1	18		GMI9214376	202	0.73	36	6	57
GMI6149669	41	3.22	24	1	41		GMI9214377	50	0.59	36	6	51
GMI6149670	60	1.38	36	49	78		GMI9214378	148	0.59	36	6	51
GMI6149672	176	0.77	36	49	59		GMI9214379	146	0.62	36	6	53
GMI6149683	92	0.26	30	10	21		GMI9214380	141	0.46	36	6	45
GMI6149684	342	0.64	36	48	53		GMI9214383	191	0.40	36	6	42
GMI6149687	341	0.57	36	48	50		GMI9214384	83	0.54	36	6	49
GMI6149688	41	0.31	36	48	37		GMI9214385	61	0.48	36	6	46
GMI6149692	160	0.67	36	48	55		GMI9214386	294	0.48	36	7	46
GMI6149698	38	0.97	36	48	66		GMI9214390	54	4.10	12	0	7
GMI6149701	251	1.72	36	48	87		GMI9214392	324	0.25	36	6	33
GMI6149707	35	0.57	36	48	50		GMI9214395	41	7.42	12	0	10
GMI6149708	347	1.41	36	48	79		GMI9214398	45	7.01	12	0	9
GMI6149709	87	1.20	36	48	73		GMI9214402	121	0.24	12	4	2
GMI6149712	256	1.50	36	48	82		GMI9214403	97	1.68	12	4	5
GMI6149714	208	5.91	36	48	162		GMI9214405	145	0.14	12	4	1
GMI6149717	46	4.68	36	48	144		GMI9214406	59	1.58	12	4	4
GMI6149720	115	4.58	36	48	143		GMI9214457	84	0.30	24	5	12
GMI6149721	136	10.58	36	48	217		GMI9214458	138	0.21	24	5	10
GMI6149722	125	8.65	36	48	196		GMI9214459	152	0.45	24	5	15
GMI6149723	71	5.95	36	48	163		GMI9214495	14	0.52	12	0	3
GMI6291330	284	0.20	24	17	10		GMI9214496	71	2.97	12	0	6
GMI6291331	300	0.26	24	17	12		GMI9214498	158	0.36	36	0	40
GMI6291335	77	0.09	24	17	7		GMI9214499	60	0.32	36	0	37
GMI6291340	23	1.45	24	17	27		GMI9214500	4	0.38	12	0	2
GMI6291341	26	14.40	24	5	86		GMI9214513	156	1.87	24	3	31
GMI6291342	223	1.30	24	20	26		GMI9214584	152	0.53	12	3	3
GMI6291347	96	2.27	24	25	34		GMI9214586	332	8.92	12	0	11
GMI6291348	144	0.59	24	20	17		GMI9214587	306	0.23	12	0	2
GMI6291349	29	11.42	24	6	76		GMI9214588	98	1.02	36	0	67

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
GMI6291350	137	0.06	24	13	6		GMI9214589	44	1.49	24	0	28
GMI6291351	52	1.45	24	13	27		ID-23850	100	1.00	24	0	23
GMI6291352	45	7.57	24	5	62		ID22816	291	0.54	12	1	3
GMI6291353	174	0.73	24	17	19		ID22823	91	0.43	12	0	2
GMI6291357	8	2.46	24	3	35		ID22838	65	5.62	12	0	8
GMI6291361	185	0.14	12	0	1		ID22863	366	0.27	36	23	35
GMI6291363	8	29.16	24	4	122		ID22864	318	0.25	36	23	34
GMI6291364	183	0.33	24	10	13		ID22865	397	0.23	36	23	32
GMI6291368	326	0.64	24	10	18		ID23005	33	7.26	36	52	180
GMI6291378	51	0.97	24	5	22		ID23006	240	5.97	24	0	55
GMI6291379	214	1.05	24	8	23		ID23007	224	0.67	24	0	19
GMI6291380	114	1.02	24	8	23		ID23008	151	0.40	24	0	14
GMI6291382	42	0.40	24	13	14		ID23009	383	0.47	24	0	16
GMI6291383	24	12.31	24	16	79		ID23050	44	5.72	36	63	160
GMI6291384	323	0.89	24	16	21		ID23051	249	0.88	30	80	526
GMI6291385	194	0.81	24	16	20		ID23055	559	1.40	30	74	662
GMI6291388	56	6.32	24	16	57		ID23057	76	1.71	12	0	5
GMI6291391	260	0.70	24	16	19		ID23058	349	1.57	12	0	4
GMI6291392	137	0.67	24	16	19		ID23060	101	1.59	12	0	4
GMI6291393	135	0.61	24	16	18		ID23061	34	0.64	24	16	18
GMI6291394	246	1.03	24	16	23		ID23090	24	0.68	12	0	3
GMI6291396	145	0.66	24	16	18		ID23091	109	0.18	24	0	10
GMI6291397	185	0.68	24	3	19		ID23092	107	0.65	24	0	18
GMI6291398	174	0.37	24	3	14		ID23093	174	1.69	24	0	29
GMI6291399	144	0.37	24	3	14		ID23096	108	0.26	24	0	11
GMI6291401	43	0.30	24	2	12		ID23106	156	0.76	36	63	58
GMI6291404	120	0.96	24	4	22		ID23107	431	2.79	36	79	111
GMI6291408	40	0.68	24	4	19		ID23108	118	0.17	48	32	59
GMI6291409	44	0.79	24	5	20		ID23112	349	0.12	54	32	67
GMI6291410	221	0.24	24	8	11		ID23113	336	0.27	54	82	102
GMI6291411	286	0.63	24	21	18		ID23114	58	1.90	54	91	271
GMI6291414	356	1.34	24	21	26		ID23115	100	0.50	36	71	47
GMI6673019	29	3.41	48	75	265		ID23118	26	12.45	54	85	694
GMI6673020	281	0.27	48	74	75		ID23119	351	0.11	36	6	22
GMI6673045	150	2.32	30	15	62		ID23125	179	1.12	24	0	24
GMI6673046	74	1.54	30	15	51		ID23126	269	0.22	36	23	32
GMI6673047	154	1.58	30	15	52		ID23127	225	0.22	36	20	31
GMI6673048	153	3.21	30	15	74		ID23128	374	0.46	36	10	45
GMI6673051	115	2.64	30	15	67		ID23133	154	0.33	36	10	38
GMI6673052	133	1.03	30	38	42		ID23136	155	0.10	36	10	21
GMI6673058	42	3.02	24	3	39		ID23139	246	0.10	36	10	21
GMI6673184	91	2.19	12	0	5		ID23142	246	0.77	36	10	59
GMI6673185	172	0.90	12	0	3		ID23145	231	0.29	36	10	36
GMI6673191	445	0.84	36	53	61		ID23147	173	0.29	36	10	36
GMI6673192	365	0.91	36	50	64		ID23150	36	2.24	36	4	100
GMI6673193	50	0.46	36	51	45		ID23151	290	0.17	36	13	28
GMI6673197	14	0.60	24	29	17		ID23168	184	0.38	48	33	89
GMI6673198	370	1.96	24	29	32		ID23179	352	0.26	36	1	34
GMI6673199	202	1.47	24	29	27		ID23182	276	0.15	36	2	25
GMI6673200	340	0.02	24	30	3		ID23185	246	0.16	36	3	27
GMI6673201	527	1.30	24	29	26		ID23187	112	1.16	48	11	155
GMI6673206	57	1.02	24	18	23		ID23203	351	0.34	36	38	39
GMI6673211	43	0.23	24	14	11		ID23206	294	0.27	36	38	35
GMI6673212	172	1.75	24	14	30		ID23209	261	0.27	36	38	35
GMI7	241	0.53	24	13	17		ID23213	383	0.31	36	38	37
GMI8	84	0.62	24	13	18		ID23216	481	0.29	36	38	36
GMI817464	267	1.74	12	0	5		ID23248	358	0.20	24	1	10
GMI817465	331	2.50	12	0	6		ID23249	356	0.37	24	0	14

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
GMI818	59	1.59	24	14	29		ID23250	60	0.01	24	0	2
GMI819	85	1.90	24	14	31		ID23251	597	0.15	24	9	9
GMI821	219	2.86	24	14	38		ID23252	349	0.12	24	9	8
GMI823	201	1.16	12	4	4		ID23253	300	0.20	24	9	10
GMI827	156	0.68	12	4	3		ID23256	324	0.34	24	6	13
GMI829	148	9.11	24	36	68		ID23260	391	0.64	36	6	53
GMI830	127	0.62	24	36	18		ID23264	49	0.41	36	6	43
GMI831	96	0.49	24	36	16		ID23265	299	0.47	36	6	46
GMI832	93	2.54	24	36	36		ID23268	235	0.47	36	6	46
GMI833	19	1.00	24	36	23		ID23269	398	0.29	36	38	36
GMI842	39	6.08	12	0	9		ID23275	287	0.35	48	17	85
GMI844	233	3.26	24	0	41		ID23276	37	0.38	48	110	89
GMI845	303	2.30	24	0	34		ID23277	80	0.32	48	110	81
GMI849	443	2.22	24	29	34		ID23281	299	0.60	48	110	112
GMI850	95	1.90	24	29	31		ID23292	650	0.21	36	0	31
GMI852	85	4.96	24	29	50		ID23298	147	2.38	36	26	103
GMI855	65	0.48	24	29	16		ID23299	131	0.00	48	105	4
GMI856	298	1.64	24	28	29		ID23300	241	2.33	24	7	35
GMI857	132	1.52	24	28	28		ID23302	261	0.15	48	33	56
GMI862	283	1.73	24	28	30		ID23311	620	2.02	36	70	95
GMI863	252	1.87	24	28	31		ID23315	318	0.37	24	0	14
GMI865	48	5.42	24	40	53		ID23317	415	1.54	36	71	83
GMI868	67	1.79	36	88	89		ID23318	404	3.17	36	86	119
GMI869	205	1.53	48	88	178		ID23321	513	3.91	36	87	132
GMI871	277	1.32	48	88	165		ID23329	213	6.96	21	29	42
GMI875	246	1.06	48	89	148		ID23336	12	28.09	12	3	19
GMI878	293	0.47	48	85	98		ID23337	52	16.51	12	3	14
GMI883	211	0.71	48	85	121		ID23344	206	4.07	27	58	62
GMI886	284	0.53	48	85	104		ID23346	296	0.11	48	110	48
GMI889	268	0.39	48	85	90		ID23347	124	0.08	48	110	40
GMI892	83	0.34	48	85	84		ID23348	160	0.44	48	110	95
GMI895	208	0.81	48	122	129		ID23349	129	0.90	48	110	136
GMI898	222	0.33	48	122	83		ID23350	541	1.06	48	99	148
GMI9	209	0.22	24	13	11		ID23354	1473	0.59	36	62	51
GMI902	247	1.04	48	122	147		ID23355	1131	1.14	36	62	71
GMI904	242	0.59	60	121	200		ID23369	45	3.14	12	3	6
GMI906	257	0.49	60	121	181		ID23375	205	0.53	48	23	105
GMI910	362	0.53	60	121	190		ID23376	17	2.44	48	23	224
GMI913	100	0.68	60	121	214		ID23378	333	0.24	24	13	11
GMI916	160	0.50	60	121	185		ID23379	404	0.02	36	13	10
GMI917	376	1.17	60	121	282		ID23383	443	1.38	12	0	4
GMI921	127	1.08	60	122	270		ID23384	21	0.46	12	0	2
GMI9214533	52	1.86	24	0	31		ID23389	#N/A	0.71	24	3	19
GMI922	66	10.41	60	124	840		ID23390	28	3.20	24	3	40
GMI941	37	8.11	24	0	64		ID23391	46	20.41	24	3	102
GMI946	232	0.19	42	31	43		ID23395	282	3.24	24	12	41
GMI947	239	1.33	42	47	116		ID23399	143	1.96	24	5	32
GMI948	265	0.62	42	47	79		ID23400	145	0.34	24	5	13
GMI953	335	0.99	42	79	100		ID23404	94	8.95	24	12	68
GMI955	215	0.51	42	47	72		ID23406	398	2.41	24	3	35
GMI956	89	1.22	48	5	158		ID23407	339	0.18	24	5	10
GMI986	277	2.32	36	36	102		ID23408	270	0.33	24	5	13
GMI987	176	2.18	36	36	99		ID23409	325	0.89	18	0	10
GMI990	157	2.38	36	36	103		ID23410	194	0.10	18	0	3
ID22850	472	0.48	24	15	16		ID23411	332	0.72	18	0	9
ID22851	77	0.63	36	0	53		ID23414	43	0.70	18	0	9
ID22852	116	0.13	36	0	24		ID23416	410	2.88	24	12	38
ID22876	471	3.04	24	0	39		ID23418	74	18.82	24	12	98

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID22879	215	3.08	24	0	40		ID23432	107	1.12	36	52	71
ID22880	79	4.23	24	0	47		ID23455	268	0.80	12	0	3
ID22883	319	0.00	24	18	0		ID23485	359	0.70	24	0	19
ID22884	334	1.32	24	18	26		ID23510	349	3.15	24	12	40
ID22888	416	0.00	24	18	0		ID23512	392	3.89	24	12	45
ID22889	110	5.01	12	0	8		ID23556	53	9.75	24	5	71
ID22890	50	0.01	30	32	4		ID23557	63	1.42	24	5	27
ID22891	28	4.66	30	32	89		ID23588	225	3.24	24	3	41
ID22893	434	0.12	36	27	24		ID23590	176	0.42	36	3	43
ID22894	154	0.24	36	27	32		ID23596	249	0.16	48	30	58
ID22895	144	0.51	36	0	47		ID23627	4	18.16	24	0	96
ID22896	146	0.47	36	0	45		ID23628	44	66.08	24	0	184
ID22901	309	0.45	36	41	45		ID23650	141	5.29	24	9	52
ID22902	423	0.62	36	41	52		ID23653	13	63.68	15	0	52
ID22904	372	0.46	36	41	45		ID23654	57	15.72	24	0	90
ID22908	498	0.91	36	42	64		ID23712	14	3.49	24	0	42
ID22914	257	1.08	36	42	69		ID23716	94	0.80	48	4	128
ID22918	52	3.66	15	9	12		ID23718	105	0.89	48	22	135
ID22919	398	2.54	15	9	10		ID23719	199	0.87	48	110	134
ID22920	775	4.50	15	9	14		ID23720	94	3.17	36	79	119
ID22921	137	6.87	36	0	175		ID23722	127	2.66	24	12	37
ID22922	199	2.42	36	0	104		ID23724	169	0.85	24	5	21
ID22953	166	11.88	24	38	78		ID23725	97	2.22	12	0	5
ID22954	259	8.98	24	22	68		ID23726	244	0.14	24	0	9
ID22957	82	3.92	24	38	45		ID23738	583	0.71	12	0	3
ID22961	39	5.11	24	13	51		ID23739	39	0.80	12	0	3
ID22962	50	5.03	24	13	51		ID23750	7	2.50	24	16	36
ID22963	7	4.59	24	38	48		ID23755	23	15.43	24	5	89
ID22964	298	3.96	24	38	45		ID23760	253	4.83	12	0	8
ID22965	129	0.70	24	13	19		ID23795	60	0.28	24	0	12
ID22966	134	2.09	24	13	33		ID23796	63	0.27	24	0	12
ID22967	426	1.76	24	13	30		ID23797	125	2.27	24	0	34
ID22968	426	2.19	24	13	33		ID23799	270	0.86	24	0	21
ID22969	81	8.98	36	95	200		ID23800	309	0.72	24	0	19
ID22970	184	3.76	36	95	129		ID23801	54	9.39	12	0	11
ID22971	53	0.57	24	3	17		ID23809	422	1.97	24	0	32
ID22973	227	0.88	24	0	21		ID23810	410	2.06	24	0	32
ID22974	108	0.81	24	10	20		ID23811	10	2.90	24	0	39
ID22976	26	0.48	24	20	16		ID23812	50	2.77	24	0	38
ID22977	177	0.21	24	10	10		ID23821	344	2.74	24	0	37
ID22978	301	0.87	24	0	21		ID23823	220	2.47	24	0	36
ID22979	136	0.81	24	0	20		ID23824	238	2.28	24	0	34
ID22980	396	1.09	24	0	24		ID23825	367	1.41	24	0	27
ID22983	58	1.19	24	0	25		ID23827	359	0.58	24	0	17
ID22985	332	8.80	24	0	67		ID23838	56	1.79	24	0	30
ID22988	252	2.62	24	0	37		ID23839	48	2.44	24	0	35
ID23014	138	0.94	24	17	22		ID23849	68	3.66	24	0	43
ID23017	95	0.41	24	14	14		ID23851	514	2.34	24	0	35
ID23019	227	0.35	24	14	13		ID23857	361	0.66	24	0	18
ID23020	112	0.09	24	14	7		ID23858	324	0.44	24	0	15
ID23022	51	0.20	24	14	10		ID23861	244	0.44	24	0	15
ID23062	45	2.89	12	0	6		ID23862	29	1.53	24	0	28
ID23063	238	0.71	24	0	19		ID23863	49	4.64	24	0	49
ID23066	226	0.88	24	0	21		ID23872	70	3.71	12	0	7
ID23070	253	0.59	24	0	17		ID23873	72	6.52	12	0	9
ID23074	160	0.62	24	1	18		ID23876	96	4.15	24	0	46
ID23077	115	0.35	24	17	13		ID23880	268	0.78	24	0	20
ID23078	100	0.49	24	17	16		ID23883	119	3.90	24	0	45

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID23079	96	0.52	24	17	16		ID23884	86	0.14	24	0	9
ID23080	253	0.47	24	17	16		ID23885	464	2.69	12	0	6
ID23087	197	7.90	36	71	188		ID23889	330	0.78	12	0	3
ID23219	371	1.00	12	0	4		ID23890	82	0.10	12	0	1
ID23220	77	0.52	15	1	5		ID23904	143	15.03	24	0	88
ID23221	404	1.04	15	0	7		ID23906	454	5.08	12	0	8
ID23225	467	0.56	24	6	17		ID23909	339	3.78	12	0	7
ID23226	906	0.18	24	6	10		ID23920	55	8.82	12	0	11
ID23227	299	0.04	24	6	5		ID23921	52	14.87	12	0	14
ID23228	61	0.39	24	6	14		ID23926	20	10.04	24	6	72
ID23322	975	5.56	24	56	53		ID23927	#N/A	1.39	24	27	27
ID23359	194	5.40	15	9	15		ID23928	74	13.06	24	27	82
ID23360	562	4.97	24	9	50		ID23934	78	3.24	24	0	41
ID23363	71	2.69	30	50	67		ID23935	78	2.16	24	0	33
ID23364	15	28.97	30	50	221		ID23942	153	1.67	24	3	29
ID23370	70	1.31	24	1	26		ID23943	104	1.05	24	27	23
ID23371	190	1.31	15	9	7		ID23944	41	3.24	24	27	41
ID23421	652	0.57	36	42	50		ID23946	223	9.30	24	27	69
ID23451	35	7.77	24	14	63		ID23947	77	4.14	24	26	46
ID23466	61	0.83	30	24	37		ID23949	72	0.82	24	22	20
ID23468	116	11.08	30	23	137		ID23950	47	1.97	24	22	32
ID23472	55	21.99	24	18	106		ID23951	26	0.33	24	4	13
ID23479	164	0.55	24	13	17		ID23952	62	1.11	12	3	4
ID23480	34	0.86	24	13	21		ID23953	46	1.04	12	3	4
ID23481	225	1.20	24	13	25		ID23954	100	2.01	12	3	5
ID23497	198	0.30	24	10	12		ID23957	20	1.44	24	0	27
ID23498	32	6.86	24	18	59		ID23958	59	0.84	24	0	21
ID23499	139	3.41	24	18	42		ID23961	28	6.83	12	0	9
ID23500	32	17.24	12	0	15		ID23982	90	2.46	36	0	105
ID23501	169	7.25	24	18	61		ID23983	86	2.42	36	0	104
ID23502	268	0.60	24	10	17		ID23984	71	3.09	36	0	117
ID23504	37	5.44	36	0	156		ID23985	81	5.88	48	0	348
ID23522	320	0.60	24	10	18		ID24048	313	0.12	24	12	7
ID23523	345	1.49	24	10	28		ID24049	305	0.20	24	12	9
ID23524	135	8.82	24	38	67		ID24050	385	0.25	24	11	11
ID23525	14	4.09	24	38	46		ID24051	367	0.25	24	11	10
ID23576	103	7.20	42	0	270		ID24094	4	10.91	12	5	12
ID23577	306	7.08	36	0	177		ID24137	246	0.47	24	5	16
ID23581	135	2.44	36	0	104		ID24138	485	0.22	24	5	11
ID23584	197	7.76	36	0	186		ID24139	109	0.25	24	5	11
ID23609	275	2.61	36	0	108		ID24140	4	4.65	24	5	49
ID23610	35	4.82	12	0	8		ID24142	152	0.02	24	5	3
ID23613	178	1.40	12	0	4		ID24143	38	4.40	12	0	7
ID23614	212	1.08	12	0	4		ID24145	161	1.08	12	0	4
ID23652	346	2.86	36	95	113		ID24149	500	0.32	24	6	13
ID23664	65	0.39	24	27	14		ID24150	285	0.53	36	23	49
ID23674	8	13.55	12	0	13		ID24163	#N/A	0.53	24	5	17
ID23675	443	3.98	30	72	82		ID24164	239	1.16	24	18	24
ID23678	163	0.89	36	42	63		ID24165	168	0.77	24	18	20
ID23681	3	1.25	24	42	25		ID24169	418	0.30	24	18	12
ID23682	30	15.77	15	9	26		ID24174	76	2.32	24	6	34
ID23683	248	1.69	15	9	8		ID24175	184	0.37	24	5	14
ID23684	352	5.12	36	95	151		ID24176	853	0.23	24	18	11
ID23685	26	5.84	36	75	161		ID24177	265	0.60	36	25	52
ID23689	21	13.51	24	18	83		ID24178	512	0.33	24	2	13
ID23691	140	3.44	24	38	42		ID24179	454	0.31	24	5	13
ID23692	308	2.41	30	16	64		ID24198	232	0.27	12	0	2
ID23701	43	1.15	30	24	44		ID24202	137	0.16	24	11	8

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID23732	266	8.77	24	18	67		ID24364	35	2.03	24	0	32
ID23746	70	0.74	24	13	19		ID24365	22	11.35	12	0	12
ID23747	81	0.98	24	13	22		ID24714	195	0.60	12	0	3
ID23748	97	0.26	30	16	21		ID24717	182	0.46	12	0	2
ID23754	105	0.48	24	20	16		ID24719	192	0.46	12	0	2
ID23756	63	0.12	24	0	8		ID24721	530	3.80	12	0	7
ID23762	152	0.13	36	0	24		ID24722	9	8.76	12	5	11
ID23763	1098	1.13	36	0	71		ID24758	34	35.37	12	0	21
ID24186	176	4.07	12	0	7		ID24858	142	0.99	12	0	4
ID24187	271	2.96	12	0	6		ID24859	185	0.14	12	0	1
ID24191	305	0.55	12	0	3		ID24861	478	0.44	24	12	15
ID24351	94	5.85	12	0	9		ID24862	204	4.98	24	12	50
ID24352	195	5.79	12	0	9		ID24863	99	3.66	24	12	43
ID24353	35	1.94	12	0	5		ID24867	122	2.08	24	12	33
ID24373	207	0.34	12	2	2		ID24871	8	10.79	12	3	12
ID24525	143	4.18	12	0	7		ID24872	383	2.07	12	3	5
ID24526	92	2.12	12	0	5		ID24873	377	0.87	12	3	3
ID24527	248	1.89	12	0	5		ID24884	215	0.47	24	0	15
ID24564	35	13.67	12	0	13		ID24885	411	0.05	24	1	5
ID24565	44	0.43	12	0	2		ID24892	54	0.85	12	0	3
ID24566	155	1.39	12	0	4		ID24893	291	11.83	12	0	12
ID24782	190	0.96	12	0	3		ID24894	43	8.92	12	0	11
ID24813	9	11.34	12	0	12		ID24910	135	5.63	12	0	8
ID24820	332	0.02	36	0	10		ID24915	146	0.23	24	0	112
ID24823	73	0.69	30	0	34		ID24916	318	0.28	24	0	124
ID24824	32	0.34	30	0	24		ID24917	289	0.17	24	0	96
ID24825	113	0.46	30	0	28		ID24918	138	0.30	24	0	129
ID24826	149	1.24	30	6	46		ID24919	261	0.30	36	0	310
ID24837	327	0.94	30	6	40		ID24920	205	0.29	24	0	126
ID24839	228	0.73	24	30	19		ID24921	413	0.19	24	0	102
ID24840	110	2.26	24	30	34		ID24922	186	0.45	24	0	158
ID25311	223	0.16	36	30	27		ID24923	452	0.29	24	0	125
ID25312	170	0.20	36	30	30		ID24924	612	0.15	24	5	92
ID25313	47	13.85	12	0	13		ID24925	150	0.17	24	7	96
ID25320	511	0.20	36	29	30		ID24926	185	0.13	24	10	84
ID25322	291	0.06	36	29	16		ID24927	4027	2.28	36	79	101
ID25323	364	0.13	36	30	24		ID24928	177	0.04	36	13	39
ID25324	289	0.41	42	47	65		ID24929	75	0.04	36	12	39
ID25325	310	0.63	42	47	80		ID24930	110	0.23	24	0	112
ID25344	14	14.41	15	0	25		ID24931	409	0.21	24	0	106
ID25345	446	1.96	15	0	9		ID24932	143	0.05	24	0	52
ID25348	301	0.92	36	29	64		ID24933	188	0.21	24	0	106
ID25354	59	1.69	42	47	131		ID24934	59	0.20	168	0	1821
ID25356	403	0.50	42	47	71		ID24935	86	0.20	24	0	106
ID25357	302	0.15	36	29	26		ID24938	348	0.20	24	0	104
ID25358	205	0.16	36	29	27		ID24939	222	0.11	24	0	79
ID25359	39	0.51	36	29	47		ID24940	434	0.08	24	0	68
ID25360	381	0.16	36	30	27		ID24947	4	1.80	24	38	315
ID25898	87	1.43	24	16	27		ID24948	6	2.57	24	38	376
ID25899	24	1.46	24	16	27		ID24949	221	0.05	24	38	55
ID25901	59	1.53	24	16	28		ID24950	47	0.34	24	38	137
ID25902	389	2.65	24	16	37		ID24951	81	0.20	36	38	250
ID25903	385	2.43	24	30	35		ID24952	9	0.14	24	38	88
ID25904	11	0.70	24	31	19		ID24954	74	0.15	72	38	161
ID25905	130	0.45	24	31	15		ID24956	173	0.30	24	38	128
ID25910	173	0.81	24	16	20		ID24972	39	4.37	12	0	7
ID25911	29	0.23	24	16	11		ID24978	180	1.32	12	0	4
ID25914	133	0.84	24	16	21		ID25008	334	0.05	24	0	55

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID26156	194	0.47	24	13	15		ID25009	395	0.18	24	0	105
ID26210	101	1.57	24	13	28		ID25010	493	0.23	15	0	3
ID26223	27	0.07	42	42	26		ID25013	95	0.15	48	4	55
ID26224	263	0.16	42	42	40		ID25015	665	0.14	48	4	54
ID26225	20	0.16	42	42	40		ID25016	149	3.28	24	4	455
ID26226	116	0.00	42	42	3		ID25019	61	0.12	48	0	50
ID26227	31	0.00	42	34	6		ID25020	26	23.70	24	0	110
ID26228	153	0.00	42	34	3		ID25021	401	0.10	48	1	44
ID26229	184	0.17	42	31	41		ID25022	322	0.01	42	1	4
ID26230	276	0.04	42	31	20		ID25023	422	0.16	42	2	44
ID26231	268	0.34	30	21	24		ID25025	117	1.24	24	0	280
ID26232	337	0.28	30	21	22		ID25026	201	0.11	24	0	84
ID26242	74	0.37	30	29	25		ID25027	234	0.11	24	0	84
ID26243	61	0.37	48	49	87		ID25028	395	0.16	24	0	102
ID26244	180	0.40	48	48	91		ID25029	73	0.17	24	0	102
ID26245	6	0.41	48	50	92		ID25030	230	0.12	24	0	86
ID26246	444	4.63	24	43	49		ID25033	217	0.13	24	0	92
ID26247	688	2.14	24	0	33		ID25038	103	0.35	24	0	139
ID26248	122	1.12	36	32	71		ID25039	161	9.24	24	0	713
ID26249	102	1.22	36	32	74		ID25040	157	0.16	24	0	102
ID26251	329	4.92	36	67	148		ID25041	190	0.05	24	0	55
ID26253	378	1.43	12	0	4		ID25042	236	0.11	24	0	85
ID26257	282	4.26	36	67	138		ID25043	37	1.31	24	0	288
ID26258	291	4.08	36	46	135		ID25154	41	0.04	30	1	66
ID26297	118	0.13	36	29	24		ID25156	215	0.11	36	1	22
ID26298	48	0.10	36	29	21		ID25157	126	0.03	30	1	59
ID26299	123	0.40	36	29	42		ID25158	164	0.24	30	1	170
ID26304	86	1.03	48	64	145		ID25160	287	0.36	30	6	210
ID26306	234	1.66	36	64	86		ID25163	279	0.30	48	13	79
ID26308	76	0.52	36	64	48		ID25166	21	0.30	48	14	79
ID26309	230	3.78	36	31	130		ID25168	200	6.88	12	0	9
ID26320	135	0.46	48	64	97		ID25170	1329	0.13	48	51	52
ID26321	6	0.76	48	31	126		ID25211	193	0.28	24	11	11
ID26322	5	46.24	60	31	1771		ID25212	30	0.29	24	11	11
ID26323	199	0.33	42	30	58		ID25213	174	0.28	24	11	11
ID26349	120	2.26	19	31	19		ID25214	429	0.28	24	11	11
ID26369	11	29.38	12	0	19		ID25234	471	0.31	18	0	107
ID26370	44	2.19	12	0	5		ID25235	432	0.17	18	0	82
ID26372	444	0.83	48	68	131		ID25236	657	0.16	18	5	79
ID26373	132	0.26	48	68	73		ID25237	572	0.44	18	0	130
ID26374	129	0.26	48	68	73		ID25238	38	0.34	48	0	84
ID26375	428	0.57	48	68	108		ID25239	655	0.78	24	0	652
ID26377	207	4.54	72	0	902		ID25240	167	1.24	24	0	822
ID26378	165	0.64	48	7	115		ID25241	31	1.22	24	0	815
ID26379	228	0.23	48	5	68		ID25242	156	0.98	24	0	730
ID26380	125	0.22	48	4	67		ID25243	92	0.84	24	0	676
ID26381	85	0.04	48	2	28		ID25244	52	0.73	24	0	630
ID26382	217	0.40	48	1	91		ID25255	248	0.19	24	0	320
ID26383	376	0.40	48	0	91		ID25256	156	0.19	24	0	324
ID26384	77	0.85	48	0	132		ID25257	193	0.19	24	0	319
ID26387	231	0.28	36	29	35		ID25258	159	0.19	24	0	325
ID26389	274	0.13	36	29	24		ID25259	150	0.18	24	0	313
ID26390	448	0.13	36	29	24		ID25260	74	1.27	24	0	833
ID26408	339	0.26	36	29	34		ID25261	184	1.24	24	0	822
ID26422	54	0.78	48	93	127		ID25262	109	1.33	24	0	851
ID26426	327	0.10	54	56	61		ID25263	58	0.76	24	0	645
ID26516	143	0.04	36	6	157		ID25264	114	1.41	24	0	877
ID26517	303	0.09	36	6	246		ID25265	208	0.66	24	0	602

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID26518	244	0.04	36	6	170		ID25266	420	0.86	24	0	686
ID26519	252	0.03	36	6	150		ID25267	67	1.73	48	0	189
ID26520	176	0.11	36	6	278		ID25268	117	0.54	24	0	543
ID26521	422	0.01	36	7	82		ID25269	82	0.78	24	0	652
ID26522	550	0.04	36	8	171		ID25270	548	0.96	48	0	141
ID26523	168	0.06	36	7	199		ID25363	20	10.81	12	5	12
ID26524	133	0.06	36	8	202		ID25365	54	8.60	12	5	10
ID26525	216	0.07	36	8	220		ID25366	242	8.05	12	5	10
ID26526	419	0.07	36	8	224		ID25377	203	4.17	24	33	46
ID26527	750	0.07	36	9	225		ID25378	17	24.17	24	33	111
ID26528	79	0.07	36	9	225		ID25467	114	0.60	36	15	52
ID26531	336	0.22	30	10	305		ID25468	64	1.65	36	30	86
ID26532	96	0.11	30	10	221		ID25469	68	1.10	36	30	70
ID26534	462	0.18	30	11	279		ID25470	9	22.52	24	16	107
ID26536	270	0.29	30	10	350		ID25471	1612	0.63	36	13	53
ID26537	61	0.30	30	10	410		ID25473	61	4.36	24	0	47
ID26538	426	0.12	30	11	264		ID25474	15	0.61	24	0	18
ID26539	536	0.08	30	11	210		ID25475	46	0.07	24	0	6
ID26540	329	0.12	30	11	255		ID25476	93	0.54	24	0	17
ID26541	464	0.04	30	11	151		ID25890	16	8.22	48	65	412
ID26542	365	0.11	30	11	250		ID25891	10	6.76	48	65	374
ID26545	338	0.04	30	11	159		ID25982	130	0.80	12	0	3
ID26546	246	0.07	30	11	202		ID26044	77	0.89	12	5	3
ID26548	276	0.09	30	12	234		ID26045	62	0.63	12	5	3
ID26550	67	0.37	120	12	1008		ID26047	411	0.57	24	13	17
ID26552	191	0.23	30	2	381		ID26048	389	0.44	24	13	15
ID26554	258	0.14	30	0	292		ID26095	285	1.71	12	2	5
ID26556	325	0.21	30	0	360		ID26096	347	6.02	12	2	9
ID26618	270	0.24	72	129	207		ID26097	313	1.21	12	2	4
ID26619	52	0.10	72	130	133		ID26102	191	0.07	48	15	39
ID26655	257	0.26	36	29	34		ID26103	63	0.34	48	15	84
ID26656	336	0.02	36	29	10		ID26104	177	0.24	48	15	71
ID26657	230	0.40	36	29	42		ID26109	216	1.67	12	2	5
ID26658	179	0.40	36	29	42		ID26178	308	2.24	36	40	100
ID26659	110	0.40	36	29	42		ID26179	351	0.49	36	40	46
ID26911	163	0.08	42	46	28		ID26184	100	2.59	36	61	107
ID26913	143	0.41	24	2	15		ID26197	242	0.77	36	40	58
ID26957	72	0.48	18	12	7		ID26356	136	0.49	24	0	16
ID26963	208	8.21	18	6	30		ID26368	53	0.19	36	9	29
ID26966	159	1.71	18	6	14		ID26391	20	0.19	30	30	152
ID26968	93	1.94	24	6	32		ID26395	140	0.13	36	30	24
ID26970	70	1.69	18	6	14		ID26396	481	0.13	36	30	24
ID26971	193	1.38	24	11	27		ID26397	312	0.13	36	30	24
ID26972	128	1.03	24	11	23		ID26399	220	0.13	36	30	24
ID26975	20	0.91	30	15	39		ID26400	37	1.32	12	0	4
ID26983	130	0.60	30	15	32		ID26402	282	1.13	12	0	4
ID26984	19	8.11	15	6	22		ID26403	351	0.52	12	0	3
ID26985	24	10.10	15	6	24		ID26462	480	0.93	24	12	22
ID26986	58	4.09	15	6	15		ID26464	291	0.10	36	16	21
ID27345	9	4.63	24	38	49		ID26465	732	2.04	33	16	75
ID27346	10	42.21	24	38	147		ID26621	278	2.14	24	0	33
ID27347	62	10.06	24	37	72		ID26628	392	0.85	24	9	21
ID27519	98	9.29	24	13	69		ID26641	36	4.03	24	12	45
ID27729	439	0.40	36	7	42		ID26642	243	0.92	24	12	22
ID27730	51	3.34	36	5	122		ID26649	477	0.18	30	24	149
ID27731	401	0.03	36	3	12		ID26666	492	8.47	24	0	66
ID27732	399	0.92	36	0	64		ID26668	419	4.62	24	36	49
ID27733	226	0.58	24	0	17		ID26669	287	1.03	48	62	145

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
ID27734	96	1.05	24	14	23		ID26672	37	0.78	12	0	3
ID27736	232	0.31	12	0	2		ID26673	52	0.26	24	0	12
ID27737	107	0.63	12	0	3		ID26684	218	0.70	12	0	3
ID27742	256	0.51	12	0	3		ID26690	51	1.94	24	0	31
ID27743	241	0.27	12	0	2		ID26699	52	0.00	24	2	1
ID27745	253	0.33	12	0	2		ID26704	416	0.16	24	0	9
ID27747	63	0.28	24	14	12		ID26705	532	0.04	24	0	4
ID27748	138	0.38	24	14	14		ID26708	36	0.23	24	0	11
ID27835	80	0.27	24	14	12		ID26709	337	0.78	36	24	59
ID27853	34	7.38	24	37	61		ID26710	56	11.81	12	0	12
ID27855	234	0.10	12	1	1		ID26712	123	5.02	24	0	51
ID27856	132	1.89	12	0	5		ID26752	101	3.95	24	125	225
ID36906	205	0.06	30	10	158		ID26754	285	0.31	30	219	492
ID36985	58	5.69	12	0	9		ID26771	1884	0.01	42	0	11
ID37049	215	0.26	36	29	34		ID26802	152	0.05	30	4	131
ID37050	128	0.31	36	29	37		ID26845	123	1.53	30	50	432
ID37055	705	0.27	24	0	12		ID26846	78	2.44	30	50	545
ID38995	119	6.33	24	16	57		ID26847	53	3.97	30	50	695
ID38996	140	11.25	24	16	76		ID26848	56	0.11	48	51	47
ID39191	186	4.08	36	36	135		ID26849	69	1.01	30	51	351
ID39192	195	2.42	36	36	104		ID26850	398	0.28	24	11	11
ID39193	30	1.25	36	36	75		ID26851	1287	0.41	24	11	13
ID39194	47	3.30	36	36	121		ID26902	14	3.90	30	125	1759
ID39195	36	1.96	36	36	93		ID26903	429	0.19	30	59	392
ID39198	80	1.05	36	36	68		ID26904	110	1.49	18	0	13
ID39199	128	2.19	36	36	99		ID26905	184	1.54	18	0	13
JCT4	1298	0.40	24	6	14		ID26906	74	2.43	18	0	16
JCT5	1332	0.94	30	25	40		ID26907	39	1.14	12	0	4
MH1-2.1	332	0.18	30	6	17		ID27016	1295	0.01	30	19	59
MH10-1.1	66	0.80	30	35	37		ID27017	406	0.06	84	5	150
MH10-2.1	40	3.10	30	35	72		ID27052	26	0.06	36	59	112
MH10-3.1	28	14.38	36	78	253		ID27053	597	0.15	36	59	179
MH10-4.1	30	0.51	36	80	47		ID27055	71	0.07	36	50	125
MH2-1.1	607	0.22	30	6	19		ID27056	116	0.17	36	59	189
MH3-1.1	278	0.13	36	7	24		ID27112	241	0.56	24	38	176
MH4-1.1	63	0.18	36	7	28		ID27114	52	0.22	30	25	165
MH4-2.1	318	0.13	42	28	36		ID27115	156	1.19	42	71	110
MH5-1.1	361	0.17	42	28	41		ID27116	63	1.19	30	71	381
MH6-1.1	540	0.12	48	28	49		ID27117	82	0.51	30	70	250
MH7-1.1	352	1.81	30	28	55		ID27118	104	1.52	42	70	124
MH8-1.1	189	0.83	30	28	37		ID27119	41	1.16	30	71	376
MH8-2.1	333	2.17	30	36	60		ID27120	49	0.30	42	69	55
MH9-2.1	155	2.32	30	35	63		ID27121	488	0.30	30	69	192
MSTR6773097	335	4.85	30	31	90		ID27122	98	0.57	30	49	263
MSTR6773098	207	7.18	30	31	110		ID27126	44	0.05	48	38	31
MSTR6773101	157	8.20	30	31	117		ID27127	62	0.05	48	38	31
MSTR6773103	163	3.92	30	31	81		ID27138	256	11.48	12	0	12
MSTR6773105	243	7.63	30	31	113		ID27251	734	0.81	24	0	20
MSTR6773110	194	0.69	30	31	34		ID27252	60	10.99	24	0	75
MSTR6773113	181	7.71	30	31	114		ID27254	435	0.33	24	0	13
MSTR6773114	60	1.48	24	23	28		ID27255	392	0.22	24	0	11
MSTR6773115	72	1.58	24	23	28		ID27268	204	0.70	30	0	291
MSTR6773116	91	8.72	24	23	67		ID27269	70	2.58	30	0	561
MSTR6773117	101	4.16	24	23	46		ID27272	57	2.62	30	0	565
MSTR6773118	58	0.46	24	23	15		ID27273	302	0.03	30	0	60
MSTR6773119	208	2.12	36	45	97		ID27274	114	0.40	30	0	221
MSTR6773120	328	4.39	36	45	140		ID27288	606	0.40	36	0	42
MSTR6773158	141	9.34	42	50	308		ID27289	27	1.62	30	0	444

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
MSTR6773161	412	1.05	48	83	147		ID27291	9	2.95	30	0	600
MSTR6773162	302	0.77	42	50	88		ID27293	118	0.63	36	0	53
MSTR6773193	112	5.13	42	21	228		ID27297	331	0.57	36	48	50
MSTR7835741	202	1.64	42	50	129		ID27298	45	2.23	36	48	100
MSTR7835779	268	2.45	30	17	64		ID27353	320	1.22	36	48	74
MSTR7835780	189	2.32	30	17	62		ID27521	232	3.97	36	4	133
MSTR7835782	224	7.43	24	17	62		ID27523	1297	0.19	48	0	63
MSTR7835785	191	3.44	30	17	76		ID27524	135	0.19	48	0	63
MSTR7835787	149	0.32	36	17	38		ID27525	174	0.19	48	0	63
MSTR7835790	255	0.56	36	17	50		ID27662	193	0.29	30	31	303
MSTR8641760	195	8.41	24	17	66		ID27664	44	0.32	48	29	81
MSTR8641761	49	16.14	24	17	91		ID27674	29	17.38	12	0	15
MSTR875577	347	2.41	36	21	104		ID27676	256	0.81	24	5	20
MSTR875578	190	0.46	36	21	45		ID27677	154	0.22	12	0	2
MSTR875580	162	0.44	36	21	44		ID27724	254	0.22	72	148	198
MSTR875581	217	0.28	36	21	35		ID27725	17	2.47	36	24	105
MSTR875582	146	0.28	36	21	35		ID27726	565	0.13	60	24	92
MSTR875583	70	0.29	42	21	54		ID27727	40	0.13	36	30	24
PARALLEL	1573	0.22	36	8	31		ID27728	318	0.12	36	30	23
21214	148	0.50	180	34	4481		ID27850	344	5.29	48	36	330
21215	170	2.61	180	38	10240		ID27866	206	0.51	36	40	48
21225	366	0.40	180	34	3989		ID27867	242	4.33	36	61	139
21230	214	2.36	180	59	9729		ID36897	123	0.28	24	11	11
CDT-25	112	0.18	30	9	17		ID36911	27	9.98	12	1	11
CDT-33	373	6.39	36	36	169		ID36913	37	4.07	12	2	7
CDT-335	207	2.65	24	0	37		ID36914	28	12.35	12	3	13
CDT-35	32	1.92	30	163	776		ID36929	702	2.91	36	4	114
CDT-365	347	0.34	30	5	24		ID36932	207	0.53	24	0	16
CDT-367	701	0.34	30	5	24		ID36933	401	0.25	24	0	11
CDT-369	459	0.23	12	0	9		ID38051	61	0.22	12	0	2
CDT-373	55	1.40	36	32	79		ID38052	189	0.22	12	0	2
CDT-391	284	0.66	24	10	18		ID38053	50	2.47	12	0	6
CDT-403	232	0.65	24	10	18		ID38054	74	0.04	12	0	1
CDT-415	104	4.62	18	0	23		ID38055	251	1.92	12	0	5
CDT-417	127	5.18	18	0	24		ID38057	397	1.39	12	0	4
CDT-43	58	1.04	18	0	11		ID38058	131	1.01	12	0	4
CDT-431	151	1.66	24	0	29		ID38073	260	0.14	36	24	24
CDT-439	105	2.78	21	4	26		ID38219	64	0.95	24	9	22
CDT-441	99	1.75	21	28	21		ID38484	129	4.45	12	0	8
CDT-443	360	2.55	21	26	25		ID38687	105	0.22	30	21	19
CDT-445	427	0.70	42	71	84		ID38879	295	1.88	24	0	31
CDT-447	264	1.66	36	68	86		ID38881	305	6.44	24	0	57
CDT-451	282	4.39	12	0	7		ID38883	105	1.05	24	0	23
CDT-453	147	8.25	12	0	10		ID38884	323	2.02	24	0	32
CDT-461	338	4.39	10	0	5		ID38885	360	4.18	24	0	46
CDT-470	85	16.11	24	9	91		ID38886	105	5.33	12	0	8
CDT-472	14	2.94	21	29	27		ID38887	90	4.55	12	0	8
CDT-474	66	2.12	48	99	272		ID38888	80	5.01	12	0	8
CDT-478	111	4.81	24	51	50		ID38907	205	0.38	12	0	2
CDT-480	119	0.15	24	0	9		ID38960	366	1.17	36	66	72
CDT-482	79	0.36	24	0	13		ID39026	15	4.42	24	0	48
CDT-484	34	0.15	24	0	9		ID39027	204	1.86	24	0	31
CDT-486	54	0.21	24	1	10		ID39036	145	0.51	12	0	3
CDT-488	170	0.29	30	2	22		ID39037	184	1.66	12	0	5
CDT-49	131	1.09	18	0	11		ID39039	89	0.08	36	0	18
CDT-490	149	0.25	24	3	11		ID39097	64	5.42	24	0	53
CDT-492	60	1.10	24	8	24		ID39102	104	11.72	24	0	77
CDT-496	131	0.63	18	0	11		ID39103	109	6.37	24	0	57

Pipe ID	LENGTH (ft)	Percent Slope (%)	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)		Pipe ID	LENGTH (ft)	SLOPE	Diameter (in)**	Design Flow (cfs)*	Full Flow Capacity (cfs)
CDT-500	202	0.45	18	0	9		ID39106	106	3.79	48	65	280
CDT-503	101	3.25	12	0	8		ID39107	228	3.87	12	0	7
CDT-504	92	0.18	18	0	6		ID39108	298	1.48	12	0	4
CDT-505	327	1.99	12	0	7		ID39114	22	6.84	12	0	9
CDT-506	72	0.66	18	0	11		ID39123	41	2.34	24	26	35
CDT-508	63	0.41	18	0	9		ID39124	16	15.17	12	4	14
CDT-510	146	1.77	24	0	39		ID39125	289	2.56	24	3	36
CDT-512	63	0.66	24	0	24		ID39128	358	2.09	48	7	208
CDT-514	29	4.23	36	6	178		ID39129	341	3.29	48	7	261
CDT-516	23	2.11	36	19	126		ID39131	96	1.99	24	5	32
CDT-520	288	0.32	18	8	8		ID39132	277	2.49	36	7	105
CDT-522	303	0.32	18	8	8		ID39134	329	3.73	24	0	44
CDT-524	176	0.28	18	8	7		ID39135	304	0.51	48	65	102
CDT-525	37	3.08	12	0	8		ID39138	107	3.28	48	39	260
CDT-527	109	1.03	12	0	5		ID39139	199	2.27	36	0	100
CDT-528	41	1.36	18	0	16		ID39141	171	1.03	48	29	146
CDT-530	157	0.68	24	0	24		ID39142	212	1.65	48	26	185
CDT-532	43	2.68	24	0	48		ID39143	87	0.09	24	1	7
CDT-533	46	3.09	12	0	8		ID39156	259	2.80	36	3	112
CDT-538	80	0.33	24	2	17		ID39165	192	6.07	48	65	354
CDT-546	102	1.28	15	1	10		ID39176	371	4.22	36	36	137
CDT-548	38	5.26	15	1	19		ID39180	27	14.18	48	36	541

* Design flow is based on buildout condition.

** Diameter shown includes recommended projects at buildout

APPENDIX C
COST ESTIMATE DATA

Table 1
Conceptual Cost Estimate Unit Cost Summary
Orem Storm Water Plan

Description	Unit	Size	Unit Cost
Detention Basins			
Property Acquisition	Acre		$164,000
Excavation and Hauling	Cubic Yard		$16
Landscaping (Non-irrigated Native)	Square Foot		$0.33
Landscaping (Irrigated Turfgrass)	Square Foot		$2.80
Inlet Apron	Lump Sum		$13,000
Outlet Structure	Lump Sum		$17,000
Emergency Spillway	Lump Sum		$5,000
Riprap	Lump Sum		$22,000
Storm Water Pipelines			
Permanent Easement Acquisition	Acre		$11,000
18-inch RCP	Linear Foot	18	$100
24-inch RCP	Linear Foot	24	$110
30-inch RCP	Linear Foot	30	$140
36-inch RCP	Linear Foot	36	$170
42-inch RCP	Linear Foot	42	$210
48-inch RCP	Linear Foot	48	$250
54-inch RCP	Linear Foot	54	$290
60-inch RCP	Linear Foot	60	$330
66-inch RCP	Linear Foot	66	$370
72-inch RCP	Linear Foot	72	$420
78-inch RCP	Linear Foot	78	$480
84-inch RCP	Linear Foot	84	$540
90-inch RCP	Linear Foot	90	$600
96-inch RCP	Linear Foot	96	$660
Manhole	Each		$4,600
Catch Basin	Each		$3,300
Traffic Control	Linear Foot		$20
Storm Water Culvert Road Crossings for Creeks and Washes			
Pipe Culvert	See RCP Storm Water Costs Above		
3' X 6' Box Culvert (2-5 feet of cover)	Lump Sum		$66,000
Headwalls	Lump Sum		$5,200
Riprap	Lump Sum		$70,000
Traffic Control	Lump Sum		$5,800
Asphalt Road Repair	Linear Foot		(Pipe Diameter [in feet] + 5') * $7
Channel Construction			
Excavation and Hauling	Cubic Yard		$15
Landscaping (Non-irrigated Native)	Square Yard		$2
Riprap	Cubic Yard		$38
Other			
Mobilization/Traffic control	5%		5 Percent of Construction Cost
Contingency	10%		10 Percent of Construction Cost
Engineering, Legal, and Administration	10%		10 Percent of Construction Cost

Table 2
Conceptual Cost Estimate - Pipes
Orem Storm Water Capital Facility Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Subtotal Cost	Mobilization/Traffic control	Construction Cost Subtotal	Contingency (10%)	Engineering, Legal, Admin. (10%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
PN1A	110	36	1	0	0	$ 28,160	$ 1,408	$ 29,568	$ 2,816	$ 2,816	$ 33,800
PN1B	3450	30	9	11	0	$ 744,425	$ 37,221	$ 781,646	$ 74,443	$ 74,443	$ 893,300
PN1C	2780	30	7	9	0	$ 599,650	$ 29,983	$ 629,633	$ 59,965	$ 59,965	$ 719,600
PN2	120	30	1	0	0	$ 26,400	$ 1,320	$ 27,720	$ 2,640	$ 2,640	$ 31,700
PN3	70	24	1	0	0	$ 14,430	$ 722	$ 15,152	$ 1,443	$ 1,443	$ 17,300
PN4A	640	24	2	2	0	$ 117,560	$ 5,878	$ 123,438	$ 11,756	$ 11,756	$ 141,100
PN4B	800	24	3	2	0	$ 146,300	$ 7,315	$ 153,615	$ 14,630	$ 14,630	$ 175,600
PN5A	950	36	3	3	0	$ 238,400	$ 11,920	$ 250,320	$ 23,840	$ 23,840	$ 286,100
PN5B	410	30	2	1	0	$ 90,125	$ 4,506	$ 94,631	$ 9,013	$ 9,013	$ 108,200
PN5C	1030	18	3	3	0	$ 173,565	$ 8,678	$ 182,243	$ 17,357	$ 17,357	$ 208,300
PN6A	120	30	1	0	0	$ 26,400	$ 1,320	$ 27,720	$ 2,640	$ 2,640	$ 31,700
PN6B	3040	24	8	10	0	$ 555,760	$ 27,788	$ 583,548	$ 55,576	$ 55,576	$ 666,900
PN7	1010	30	3	3	0	$ 218,125	$ 10,906	$ 229,031	$ 21,813	$ 21,813	$ 261,800
PN8A	990	24	3	3	0	$ 181,110	$ 9,056	$ 190,166	$ 18,111	$ 18,111	$ 217,300
PN8B	1670	30	5	5	0	$ 360,975	$ 18,049	$ 379,024	$ 36,098	$ 36,098	$ 433,200
PN8C	770	24	2	2	0	$ 138,230	$ 6,912	$ 145,142	$ 13,823	$ 13,823	$ 165,900
PN8D	700	18	2	2	0	$ 117,650	$ 5,883	$ 123,533	$ 11,765	$ 11,765	$ 141,200
PN8E	690	18	2	2	0	$ 116,195	$ 5,810	$ 122,005	$ 11,620	$ 11,620	$ 139,400
PN8F	1110	24	3	3	0	$ 200,190	$ 10,010	$ 210,200	$ 20,019	$ 20,019	$ 240,200
PN9A	1340	36	4	4	0	$ 334,440	$ 16,722	$ 351,162	$ 33,444	$ 33,444	$ 401,300
PN9B	880	36	3	2	0	$ 217,980	$ 10,899	$ 228,879	$ 21,798	$ 21,798	$ 261,600
PN10A	590	18	2	1	0	$ 97,045	$ 4,852	$ 101,897	$ 9,705	$ 9,705	$ 116,500
PN10B	680	48	2	2	0	$ 228,640	$ 11,432	$ 240,072	$ 22,864	$ 22,864	$ 274,400
PN10C	4230	42	11	14	0	$ 1,240,685	$ 62,034	$ 1,302,719	$ 124,069	$ 124,069	$ 1,488,800
PN11	640	36	2	2	0	$ 160,440	$ 8,022	$ 168,462	$ 16,044	$ 16,044	$ 192,500
PN12A	620	36	2	2	0	$ 155,920	$ 7,796	$ 163,716	$ 15,592	$ 15,592	$ 187,100
PN12B	520	24	2	1	0	$ 93,880	$ 4,694	$ 98,574	$ 9,388	$ 9,388	$ 112,700
PN14A	860	30	3	2	0	$ 184,650	$ 9,233	$ 193,883	$ 18,465	$ 18,465	$ 221,600
PN14B	1360	30	4	4	0	$ 293,400	$ 14,670	$ 308,070	$ 29,340	$ 29,340	$ 352,100
PN14C	1350	30	4	4	0	$ 291,475	$ 14,574	$ 306,049	$ 29,148	$ 29,148	$ 349,800
PN14D	1430	30	4	4	0	$ 306,875	$ 15,344	$ 322,219	$ 30,688	$ 30,688	$ 368,300
PN14E	1940	30	5	6	0	$ 417,550	$ 20,878	$ 438,428	$ 41,755	$ 41,755	$ 501,100
PN14F	1400	18	4	4	0	$ 235,300	$ 11,765	$ 247,065	$ 23,530	$ 23,530	$ 282,400
PN14G	700	18	2	2	0	$ 117,650	$ 5,883	$ 123,533	$ 11,765	$ 11,765	$ 141,200
PN14H	1190	30	3	3	0	$ 252,775	$ 12,639	$ 265,414	$ 25,278	$ 25,278	$ 303,300
PN14I	290	24	1	0	0	$ 49,410	$ 2,471	$ 51,881	$ 4,941	$ 4,941	$ 59,300
PN16B	3518	24	9	11	0	$ 639,662	$ 31,983	$ 671,645	$ 63,966	$ 63,966	$ 767,600
PN18A	2040	42	6	6	0	$ 597,180	$ 29,859	$ 627,039	$ 59,718	$ 59,718	$ 716,600
PN18B	670	36	2	2	0	$ 167,220	$ 8,361	$ 175,581	$ 16,722	$ 16,722	$ 200,700
PN19	1700	30	5	5	0	$ 366,750	$ 18,338	$ 385,088	$ 36,675	$ 36,675	$ 440,100
PN20A	1160	42	3	3	0	$ 336,320	$ 16,816	$ 353,136	$ 33,632	$ 33,632	$ 403,600
PN20B	400	30	2	1	0	$ 88,200	$ 4,410	$ 92,610	$ 8,820	$ 8,820	$ 105,800
PN21	1240	18	4	4	0	$ 212,020	$ 10,601	$ 222,621	$ 21,202	$ 21,202	$ 254,400
PN22A	340	36	1	1	0	$ 84,740	$ 4,237	$ 88,977	$ 8,474	$ 8,474	$ 101,700
PN22B	1040	36	3	3	0	$ 258,740	$ 12,937	$ 271,677	$ 25,874	$ 25,874	$ 310,500
PN22C	350	30	1	1	0	$ 75,275	$ 3,764	$ 79,039	$ 7,528	$ 7,528	$ 90,300
PN24	1130	36	3	3	0	$ 279,080	$ 13,954	$ 293,034	$ 27,908	$ 27,908	$ 334,900
PN26	1050	18	3	3	0	$ 176,475	$ 8,824	$ 185,299	$ 17,648	$ 17,648	$ 211,800
PN28	800	24	3	2	0	$ 146,300	$ 7,315	$ 153,615	$ 14,630	$ 14,630	$ 175,600
PN30A	140	48	1	0	0	$ 47,120	$ 2,356	$ 49,476	$ 4,712	$ 4,712	$ 56,500
PN32	1550	54	4	5	0	$ 588,775	$ 29,439	$ 618,214	$ 58,878	$ 58,878	$ 706,500
PN33	1370	42	4	4	0	$ 400,815	$ 20,041	$ 420,856	$ 40,082	$ 40,082	$ 481,000
PN34	2400	36	7	8	0	$ 602,300	$ 30,115	$ 632,415	$ 60,230	$ 60,230	$ 722,800
PN35	20	60	1	0	0	$ 11,300	$ 565	$ 11,865	$ 1,130	$ 1,130	$ 13,600
PN36	40	60	1	0	0	$ 19,300	$ 965	$ 20,265	$ 1,930	$ 1,930	$ 23,200
PN37	60	60	1	0	0	$ 27,300	$ 1,365	$ 28,665	$ 2,730	$ 2,730	$ 32,800
PN38A	1310	24	4	4	0	$ 239,890	$ 11,995	$ 251,885	$ 23,989	$ 23,989	$ 287,900
PN38B	1740	30	5	5	0	$ 374,450	$ 18,723	$ 393,173	$ 37,445	$ 37,445	$ 449,300
PN39A	1140	36	3	3	0	$ 281,340	$ 14,067	$ 295,407	$ 28,134	$ 28,134	$ 337,600

Table 2
Conceptual Cost Estimate - Pipes
Orem Storm Water Capital Facility Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Subtotal Cost	Mobilization/Traffic control	Construction Cost Subtotal	Contingency (10%)	Engineering, Legal, Admin. (10%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
PN39B	2030	18	6	6	0	$ 342,765	$ 17,138	$ 359,903	$ 34,277	$ 34,277	$ 411,300
PN40A	90	36	1	0	1	$ 40,640	$ 2,032	$ 42,672	$ 4,064	$ 4,064	$ 48,800
PN40B	1070	66	3	3	0	$ 498,245	$ 24,912	$ 523,157	$ 49,825	$ 49,825	$ 597,900
PN40C	2080	66	6	6	0	$ 969,880	$ 48,494	$ 1,018,374	$ 96,988	$ 96,988	$ 1,163,900
PN40D	360	60	1	1	0	$ 151,900	$ 7,595	$ 159,495	$ 15,190	$ 15,190	$ 182,300
PS6A	1780	30	5	5	0	$ 382,150	$ 19,108	$ 401,258	$ 38,215	$ 38,215	$ 458,600
PS6B	4450	36	12	14	1	$ 1,126,700	$ 56,335	$ 1,183,035	$ 112,670	$ 112,670	$ 1,352,000
PS11	380	36	1	1	0	$ 93,780	$ 4,689	$ 98,469	$ 9,378	$ 9,378	$ 112,500
PS13	300	36	1	1	0	$ 75,700	$ 3,785	$ 79,485	$ 7,570	$ 7,570	$ 90,800
PS14	570	30	2	1	0	$ 120,925	$ 6,046	$ 126,971	$ 12,093	$ 12,093	$ 145,100
PS15	690	36	2	2	0	$ 171,740	$ 8,587	$ 180,327	$ 17,174	$ 17,174	$ 206,100
PS16A	1660	36	5	5	0	$ 414,660	$ 20,733	$ 435,393	$ 41,466	$ 41,466	$ 497,600
PS16B	1680	30	5	5	0	$ 362,900	$ 18,145	$ 381,045	$ 36,290	$ 36,290	$ 435,500
PS18	1190	48	3	3	0	$ 396,170	$ 19,809	$ 415,979	$ 39,617	$ 39,617	$ 475,400
PS19	1870	30	5	6	0	$ 404,075	$ 20,204	$ 424,279	$ 40,408	$ 40,408	$ 484,900
PS20	1130	36	3	3	0	$ 279,080	$ 13,954	$ 293,034	$ 27,908	$ 27,908	$ 334,900
PS21	1010	36	3	3	0	$ 251,960	$ 12,598	$ 264,558	$ 25,196	$ 25,196	$ 302,400
PS22A	1210	36	4	4	0	$ 305,060	$ 15,253	$ 320,313	$ 30,506	$ 30,506	$ 366,100
PS22B	1530	36	4	5	0	$ 381,980	$ 19,099	$ 401,079	$ 38,198	$ 38,198	$ 458,400
PS23	1280	42	4	4	0	$ 376,560	$ 18,828	$ 395,388	$ 37,656	$ 37,656	$ 451,900
PS24	40	24	1	0	0	$ 9,660	$ 483	$ 10,143	$ 966	$ 966	$ 11,600
PS25A	750	42	2	2	0	$ 217,925	$ 10,896	$ 228,821	$ 21,793	$ 21,793	$ 261,500
PS25B	240	36	1	0	0	$ 57,540	$ 2,877	$ 60,417	$ 5,754	$ 5,754	$ 69,000
PS26A	3130	42	8	10	0	$ 915,935	$ 45,797	$ 961,732	$ 91,594	$ 91,594	$ 1,099,100
PS26B	4600	30	12	15	0	$ 994,100	$ 49,705	$ 1,043,805	$ 99,410	$ 99,410	$ 1,192,900
PS27	390	24	1	1	0	$ 69,910	$ 3,496	$ 73,406	$ 6,991	$ 6,991	$ 83,900
PS28	1100	42	3	3	0	$ 320,150	$ 16,008	$ 336,158	$ 32,015	$ 32,015	$ 384,200
PS29A	11720	30	30	39	0	$ 2,534,500	$ 126,725	$ 2,661,225	$ 253,450	$ 253,450	$ 3,041,400
PS29B	4360	36	11	14	0	$ 1,086,060	$ 54,303	$ 1,140,363	$ 108,606	$ 108,606	$ 1,303,300
PS29C	1490	30	4	4	0	$ 318,425	$ 15,921	$ 334,346	$ 31,843	$ 31,843	$ 382,100
PS31	3240	18	9	10	0	$ 547,120	$ 27,356	$ 574,476	$ 54,712	$ 54,712	$ 656,500
PS32	940	42	3	3	0	$ 277,030	$ 13,852	$ 290,882	$ 27,703	$ 27,703	$ 332,400
PS33	160	42	1	0	0	$ 46,420	$ 2,321	$ 48,741	$ 4,642	$ 4,642	$ 55,700
PS35	540	30	2	1	0	$ 115,150	$ 5,758	$ 120,908	$ 11,515	$ 11,515	$ 138,200
PS36	5120	36	13	17	1	$ 1,295,220	$ 64,761	$ 1,359,981	$ 129,522	$ 129,522	$ 1,554,300
PS37A	270	36	1	0	0	$ 64,320	$ 3,216	$ 67,536	$ 6,432	$ 6,432	$ 77,200
PS37B	2120	36	6	7	0	$ 531,120	$ 26,556	$ 557,676	$ 53,112	$ 53,112	$ 637,300
PS38	50	36	1	0	0	$ 14,600	$ 730	$ 15,330	$ 1,460	$ 1,460	$ 17,500
PS39	820	48	3	2	0	$ 275,760	$ 13,788	$ 289,548	$ 27,576	$ 27,576	$ 330,900
PS41	60	48	1	0	0	$ 22,080	$ 1,104	$ 23,184	$ 2,208	$ 2,208	$ 26,500
PS42A	4090	42	11	13	0	$ 1,198,355	$ 59,918	$ 1,258,273	$ 119,836	$ 119,836	$ 1,438,000
PS42B	510	42	2	1	0	$ 148,645	$ 7,432	$ 156,077	$ 14,865	$ 14,865	$ 178,400
PS43A	2250	54	6	7	1	$ 871,125	$ 43,556	$ 914,681	$ 87,113	$ 87,113	$ 1,045,400
PS43B	1440	36	4	4	0	$ 357,040	$ 17,852	$ 374,892	$ 35,704	$ 35,704	$ 428,400
PS44	1180	36	3	3	0	$ 290,380	$ 14,519	$ 304,899	$ 29,038	$ 29,038	$ 348,500
PS45	500	24	2	1	0	$ 90,700	$ 4,535	$ 95,235	$ 9,070	$ 9,070	$ 108,800
PS46	410	60	2	1	0	$ 175,200	$ 8,760	$ 183,960	$ 17,520	$ 17,520	$ 210,200
PS47A	940	60	3	3	0	$ 399,700	$ 19,985	$ 419,685	$ 39,970	$ 39,970	$ 479,600
PS47B	830	54	3	2	0	$ 314,995	$ 15,750	$ 330,745	$ 31,500	$ 31,500	$ 378,000
PS47C	1460	48	4	4	0	$ 488,580	$ 24,429	$ 513,009	$ 48,858	$ 48,858	$ 586,300
PS47D	2360	36	6	7	0	$ 585,360	$ 29,268	$ 614,628	$ 58,536	$ 58,536	$ 702,400
PS48	280	36	1	0	0	$ 66,580	$ 3,329	$ 69,909	$ 6,658	$ 6,658	$ 79,900
PS49	520	24	2	1	1	$ 110,880	$ 5,544	$ 116,424	$ 11,088	$ 11,088	$ 133,100
PS51A	450	24	2	1	0	$ 82,750	$ 4,138	$ 86,888	$ 8,275	$ 8,275	$ 99,300
PS51B	360	24	1	1	0	$ 65,140	$ 3,257	$ 68,397	$ 6,514	$ 6,514	$ 78,200
PS52	890	24	3	2	0	$ 160,610	$ 8,031	$ 168,641	$ 16,061	$ 16,061	$ 192,700
PS55A	710	54	2	2	0	$ 268,915	$ 13,446	$ 282,361	$ 26,892	$ 26,892	$ 322,700
PS55B	1290	60	4	4	1	$ 564,600	$ 28,230	$ 592,830	$ 56,460	$ 56,460	$ 677,500
PS58A	1350	36	4	4	0	$ 336,700	$ 16,835	$ 353,535	$ 33,670	$ 33,670	$ 404,000

Table 2
Conceptual Cost Estimate - Pipes
Orem Storm Water Capital Facility Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Subtotal Cost	Mobilization/Traffic control	Construction Cost Subtotal	Contingency (10%)	Engineering, Legal, Admin. (10%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
PS58B	2820	36	8	9	0	$ 705,120	$ 35,256	$ 740,376	$ 70,512	$ 70,512	$ 846,100
PS58C-1	940	36	3	3	0	$ 236,140	$ 11,807	$ 247,947	$ 23,614	$ 23,614	$ 283,400
PS58C-2	940	42	3	3	0	$ 277,030	$ 13,852	$ 290,882	$ 27,703	$ 27,703	$ 332,400
PS58D	1310	36	4	4	0	$ 327,660	$ 16,383	$ 344,043	$ 32,766	$ 32,766	$ 393,200
PS59A	2000	42	6	6	0	$ 586,400	$ 29,320	$ 615,720	$ 58,640	$ 58,640	$ 703,700
PS59B	2360	36	6	7	0	$ 585,360	$ 29,268	$ 614,628	$ 58,536	$ 58,536	$ 702,400
PS59C-1	1250	30	4	4	0	$ 272,225	$ 13,611	$ 285,836	$ 27,223	$ 27,223	$ 326,700
PS59C-2	1250	36	4	4	0	$ 314,100	$ 15,705	$ 329,805	$ 31,410	$ 31,410	$ 376,900
PS59D	760	36	2	2	0	$ 187,560	$ 9,378	$ 196,938	$ 18,756	$ 18,756	$ 225,100
PS59E	670	30	2	2	0	$ 144,775	$ 7,239	$ 152,014	$ 14,478	$ 14,478	$ 173,700
PS59F	1810	24	5	6	0	$ 331,890	$ 16,595	$ 348,485	$ 33,189	$ 33,189	$ 398,300
PS60	3500	36	9	11	0	$ 871,300	$ 43,565	$ 914,865	$ 87,130	$ 87,130	$ 1,045,600
PS61	2660	30	7	8	0	$ 571,950	$ 28,598	$ 600,548	$ 57,195	$ 57,195	$ 686,300
PS62A	1840	36	5	6	0	$ 459,940	$ 22,997	$ 482,937	$ 45,994	$ 45,994	$ 551,900
PS62B	1360	30	4	4	0	$ 293,400	$ 14,670	$ 308,070	$ 29,340	$ 29,340	$ 352,100
PS62C	680	24	2	2	0	$ 123,920	$ 6,196	$ 130,116	$ 12,392	$ 12,392	$ 148,700
PS63	2400	36	7	8	0	$ 602,300	$ 30,115	$ 632,415	$ 60,230	$ 60,230	$ 722,800
PS64	900	24	3	3	0	$ 166,800	$ 8,340	$ 175,140	$ 16,680	$ 16,680	$ 200,200
PS65A	3270	30	9	10	0	$ 705,175	$ 35,259	$ 740,434	$ 70,518	$ 70,518	$ 846,200
PS65B	675	24	2	2	1	$ 140,125	$ 7,006	$ 147,131	$ 14,013	$ 14,013	$ 168,200
PS65C	3850	42	10	12	1	$ 1,371,850	$ 137,185	$ 1,509,035	$ 137,185	$ 137,185	$ 1,646,200
PS66A	1113	18	3	3	0	$ 185,642	$ 9,282	$ 194,924	$ 18,564	$ 18,564	$ 222,800
PS66B	3450	24	9	11	0	$ 628,850	$ 31,443	$ 660,293	$ 62,885	$ 62,885	$ 754,600
CS1	100	60	0	1	1	$ 61,600	$ 3,080	$ 64,680	$ 6,160	$ 6,160	$ 73,900
CS2	810	96	0	2	0	$ 617,510	$ 30,876	$ 648,386	$ 61,751	$ 61,751	$ 741,000
										Pipe Subtotal:	**$ 58,797,100**

Table 3
Conceptual Cost Estimate - Detention Basins
Orem Storm Water Capital Facility Plan

Project Identifier	Project Name	Volume (acre-ft)	Footprint (acre)	Excavation and Hauling (yd^3)	Landscaping	Inlet Apron	Outlet Structure	Emergency Spillway	Land Acquisition	Contingency (10%)	Engineering, Legal, Admin. (10%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
DBN1	Bonneville Park	0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBN2	Bonneville School	2.8	1.4	$ 94,155	$ 20,125	$ 13,000	$ 17,000	$ 5,000	$ 229,600	$ 37,900	$ 37,900	**$ 454,700**
DBN3	Windsor Park	3.2	1.6	$ 107,605	$ 23,000	$ 13,000	$ 17,000	$ 5,000	$ 262,400	$ 42,800	$ 42,800	**$ 513,600**
DBN4	Orchard Park	1.3	0.65	$ 43,715	$ 9,344	$ 13,000	$ 17,000	$ 5,000	$ 106,600	$ 19,500	$ 19,500	**$ 233,700**
DBN5	Sharon Park	3.9	1.955	$ 131,480	$ 28,103	$ 13,000	$ 17,000	$ 5,000	$ 320,620	$ 51,500	$ 51,500	**$ 618,200**
DBN6		2.6	1.3	$ 87,429	$ 18,687	$ 13,000	$ 17,000	$ 5,000	$ 213,200	$ 35,400	$ 35,400	**$ 425,100**
DBN7		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBN8		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS1		4.7	2.35	$ 158,045	$ 33,781	$ 13,000	$ 17,000	$ 5,000	$ 385,400	$ 61,200	$ 61,200	**$ 734,600**
DBS2		9.1	4.55	$ 306,003	$ 65,405	$ 13,000	$ 17,000	$ 5,000	$ 746,200	$ 115,300	$ 115,300	**$ 1,383,200**
DBS3		3.6	1.8	$ 121,056	$ 25,875	$ 13,000	$ 17,000	$ 5,000	$ 295,200	$ 47,700	$ 47,700	**$ 572,500**
DBS4	424 E West Union Canal (Provo)	1.0	0.5	$ 33,627	$ 56,273	$ 13,000	$ 17,000	$ 5,000	$ 228,000	$ 35,300	$ 35,300	**$ 423,500**
DBS5		6.3	3.15	$ 211,848	$ 45,281	$ 13,000	$ 17,000	$ 5,000	$ 516,600	$ 80,900	$ 80,900	**$ 970,500**
DBS6		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS7		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS8		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS9		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS10		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS11		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS12		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS13		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS14		0.0	0	$ -	$ -	$ -	$ 17,000	$ -	$ -	$ 1,700	$ 1,700	**$ 20,400**
DBS15		1.8	0.9	$ 60,528	$ 12,937	$ 12,000	$ 17,000	$ 5,000	$ 147,600	$ 25,500	$ 25,500	**$ 306,100**
DBS16		0.0	0	$ -	$ -	$ -	$ 16,000	$ -	$ -	$ 1,600	$ 1,600	**$ 19,200**
											Detention Basin Subtotal:	**$ 6,899,700**

APPENDIX D
DETENTION ALTERNATIVE

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

TO:	Chris Tschirki Public Works Director Orem City Municipal Corp 1450 W 550 N Orem, Utah 84057
COPIES:	File
FROM:	Nathan Wright/Keith Larson
DATE:	January 8, 2016
SUBJECT:	Alternative Detention Improvements
JOB NO.:	374-13-03

ALTERNATIVE DETENTION IMPROVEMENTS

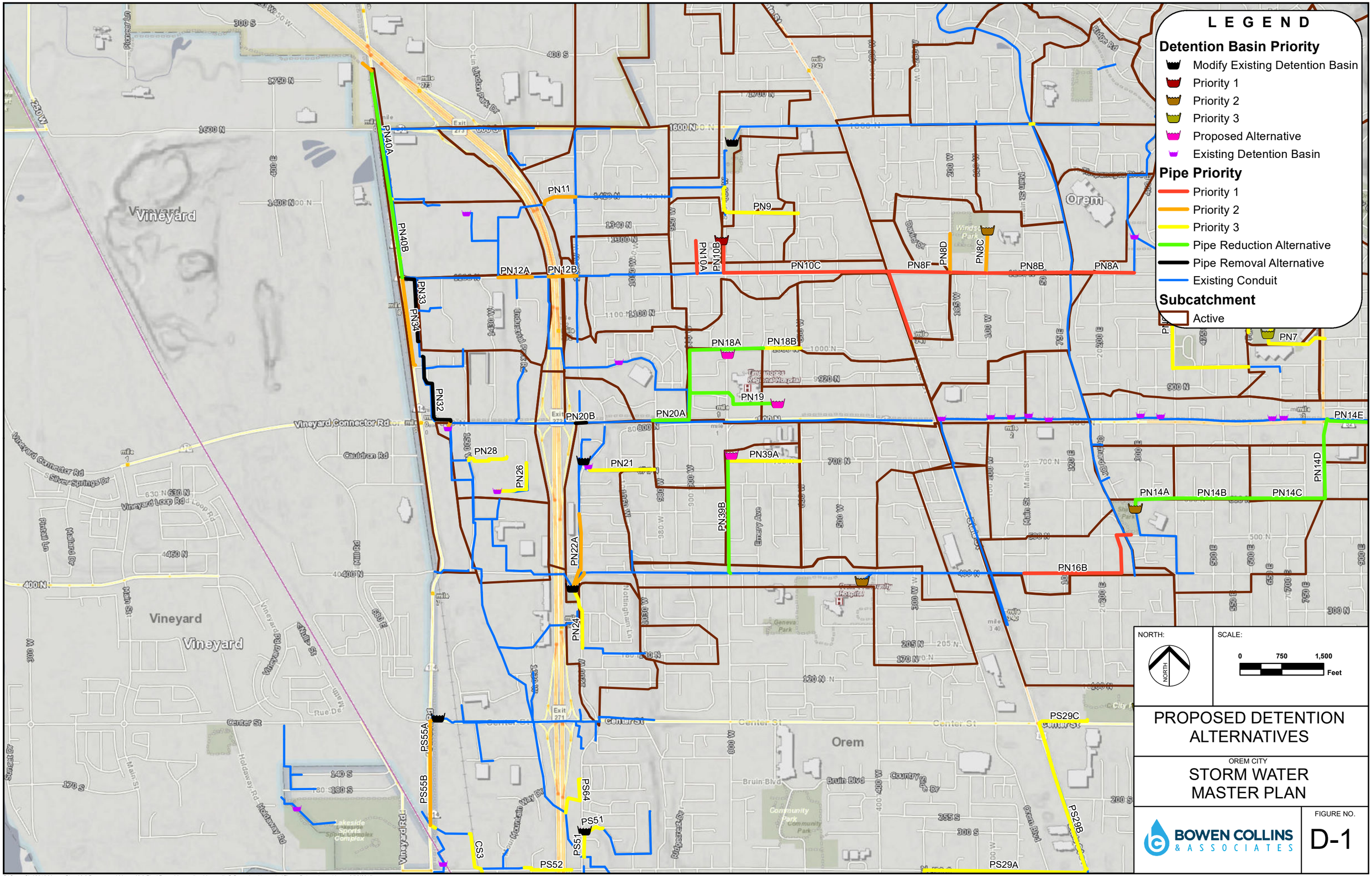
INTRODUCTION

The 2016 Storm Water Master Plan documents the most cost effective approach to future improvements based on available information regarding likely detention basin properties and other system conditions. The original selection of likely locations for future detention basins was based on a series of meeting between Bowen Collins & Associates (BC&A) and Orem City personnel. During these meetings, each major outfall in the City was examined and probable properties appropriate for detention were selected. However, some additional project optimization may be possible if the City can secure additional properties for detention basins other than those initially identified. The purpose of this memorandum is to examine the potential costs savings associated with adding detention to some of the City's major storm water outfalls.

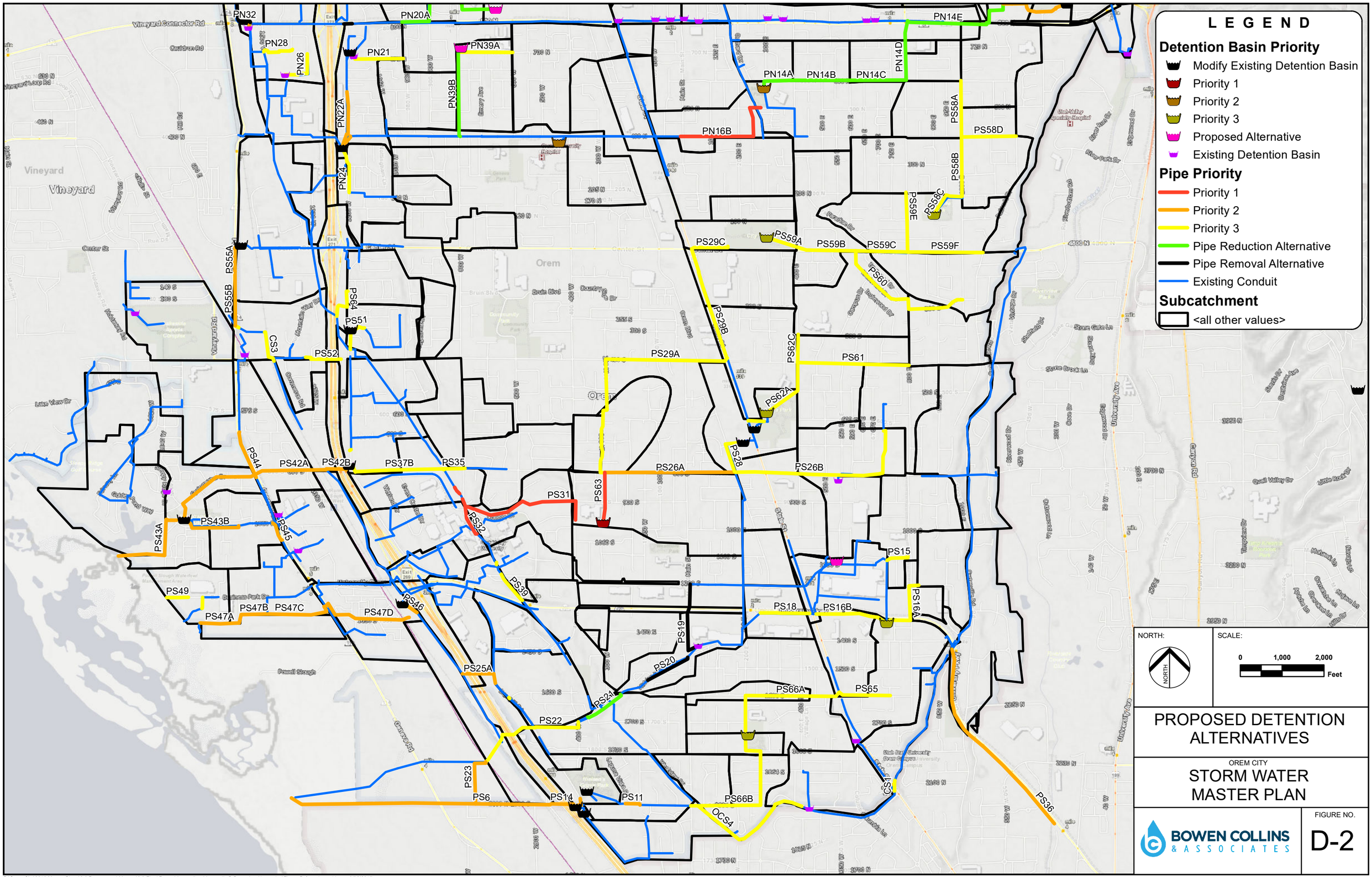
DETENTION ALTERNATIVES

After the completion of the master plan, BC&A returned to the model to look for other opportunities where the addition of detention could reduce downstream improvements and save the City money. In this analysis, BC&A did not worry about the probability of success in obtaining required property for detention; potential for cost saving reductions in downstream infrastructure was the only concern.

Ultimately, most of the City's major outfalls already have a significant amount of detention and adding more detention is not effective in reducing overall costs. However, BC&A did identify three general locations where additional detention could potentially reduce total storm water improvement costs for the City. The general locations of potential detention basins along with their impact on system improvements are shown in Figures D-1 and D-2 and described in the following sections. It should be noted that costs in the following analyses include property acquisition costs of $150,000/acre. In



P:\Orem City\2013 Master Plans\6.0 Reports and Memos\6.3 Final Report\Appendices\Appendix D Detention Alternative\Figure D-1.mxd amckinnon 9/22/2017



P:\Orem City\2013 Master Plans\6.0 Reports and Memos\6.3 Final Report\Appendices\Appendix D Detention Alternative\Figure D-2.mxd amckinnon 9/22/2017

pursuing property for detention, the City should keep in mind that any additional expenditures above this amount will erode into the projected savings of each alternative.

Foothill Park Detention

A 1.3 acre foot detention basin could be constructed near Foothill Park to detain upstream flows to 6 cfs. With the construction of this project, Projects PN14A, PN14B, PN14C, PN14D, PN14E, and PN14G could all be reduced one pipe size from the sizes currently shown in the Master Plan. Project PN14F would only require 2 parallel pipes instead of 3. The installation of this project is believed to have a potential savings to the City of approximately $225,000.

Timpanogos Hospital Detention

There are 3 detention facilities that could be constructed near the Timpanogos Hospital:

- A northern detention facility could be constructed with a volume of 1.7 acre feet and a release rate of 22 cfs to detain flow master planned for 1000 North. This would allow Project PN18A to be reduced from a 42" to a 30" pipe.
- A central detention facility could be constructed with a volume of 1.2 acre feet and a release rated of 6 cfs to detain flow master planned for 880 North. This would allow Project PN19 to be reduced from a 30" to a 18" pipe.
- The combined effect of the two detention facilities above would allow Project PN20A to be reduced from a 42" pipe to a 30" pipe and Project PN20B could be eliminated completely.
- A southern detention facility could be constructed with a volume of 1.3 acre feet and a release rate of 4 cfs to detain flow master planned for 700 North and 800 West. This would allow Project PN39B to be reduced from a 30" to an 18" pipe.
- The combined effect of the 3 detention facilities would reduce flows such that Projects PN32 and PN33 can be eliminated completely. Additionally, Projects PN40B, PN40C, and PN40D can be reduced by one pipe size.

The estimated savings of constructing all three of these projects is approximately $1,000,000.

University Mall Detention

A 1.8 acre foot detention basin could be constructed near the north end of the University Mall to detain upstream flows to 10 cfs. The construction of the detention pond would allow for the elimination of Projects PN19 and PN20. Additionally, Project PN21 could be reduced from a 36" to a 30" pipe. It should be noted that the most logical location for this proposed pond is on property that is part of the University Mall and may be difficult to acquire. However, if a parcel can be found elsewhere along the alignment, the results would be similar. The estimated savings of constructing this project (assuming the regular property acquisition costs) is approximately $500,000.

CONCLUSIONS AND RECOMMENDATIONS

There are at least three areas where securing property for additional detention could potentially result in savings to Orem City. It is recommended that the City look for potential opportunities to acquire property in these areas. If the City is successful in obtaining the required properties, the Master Plan results should be updated to reflect the revised approach. It is recommended that each project be examined in detail as part of final design. With the additional information available during detailed design, it is expected that the City will be able adjust some of the components of each project to optimize overall system performance.

Draper, Utah Office:
154 East 14075 South
Draper, Utah 84020
Phone: (801) 495-2224
Fax: (801) 495-2225

Eagle, Idaho Office:
776 East Riverside Drive
Suite 250
Eagle, Idaho 83616
Phone: (208) 939-9561
Fax: (208) 939-9571

St. George, Utah Office:
20 North Main
Suite 107
St. George, Utah 84770
Phone: (435) 656-3299
Fax: (435) 656-2190

WWW.BOWENCOLLINS.COM

BOWEN COLLINS
& ASSOCIATES
Celebrating 20 Years