



PREPARED FOR:

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STORM WATER MASTER PLAN

FEBRUARY 2025

STORM WATER MASTER PLAN

February 2025

Prepared for:



Prepared by:



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CHAPTER 1 INTRODUCTION

INTRODUCTION

In 2016, the City of Orem (City) completed a comprehensive storm water master plan. In 2018 the master plan was revised and updated to reflect the loss of the West Union Canal as a part of the storm water system. In 2020 the plan was updated again to reflect changes in drinking water source protection zones, and the annexation of a large area to the southwest of the existing city limits. This 2025 revision reflects a change in policy regarding the drinking water source protection zones.

The City's current policy regarding source protection zones is to eliminate storm water sumps and retention ponds within the 250-day Zone. This is a change from the previous policy that prohibited these facilities within the 3-year Zone. This change allows for more local retention which results in lower costs for stormwater conveyance in the downstream system.

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 2018 study were incorporated into a Rate Study that was used to establish a five-year rate plan to adjust storm water rates to a level that would fund capital improvement projects to an acceptable level. There are currently no plans to change the five-year rate plan endorsed in 2018, but some adjustments may be needed depending on the extent of the City's desire to address stormwater issues.

This 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 an 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:** Collect and review updated storm water system information and update existing InfoSWMM model with new GIS data provided by the City of Orem.
- Task 2:** Review the updated well protection zones and complete an evaluation of the effect on the proposed projects.
- Task 3:** Revise and update the existing report figures and text to reflect changes in the groundwater protection policy.
- Task 4:** Update the Capital Improvement Plan to reflect changes in the groundwater protection policy.

This report is prepared as part of Task 3.

ACKNOWLEDGMENTS

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

Chris Tschirki	Public Works Director
Reed Price	Assistant Public Works Director
Taggart Bowen	City Engineer
Rick Sabey	Stormwater Division Manager
Steve Johnson	Stormwater Senior GIS 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.

Keith Larson	Principle-in-Charge / Project Manager
Roland Rocha	Project Engineer
Nathan Davis	Project Engineer
Mike Hilbert	Clerical

CHAPTER 2 EXISTING FACILITIES

INTRODUCTION

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

SERVICE AREA

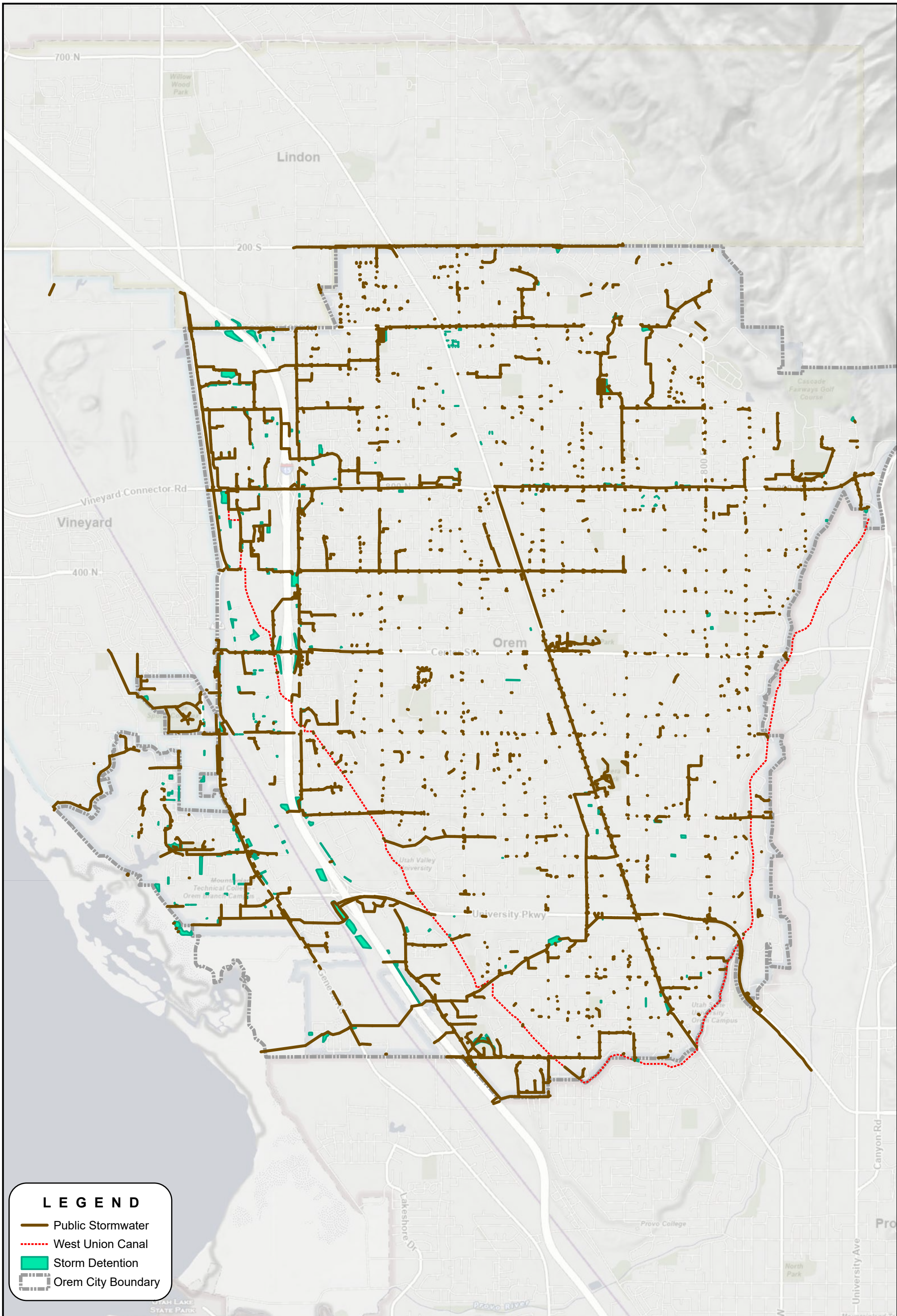
The City of Orem is located about 30 miles south of Salt Lake City. Most of the City sits on a bench of the old Lake Bonneville. As a result, much of the City has relatively mild slopes with few major drainage channels. The Provo River runs along the eastern edge of the City, but only collects a small 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 92 miles of public storm water pipe in the City of Orem storm water system that are cataloged in the GIS database. There are an additional 86 miles of private stormwater, groundwater drains, and gravity irrigation pipelines that are tangled in with the storm water system. Open channel irrigation canals also serve as a means of storm water conveyance in the city. Table 2-1 contains a summary of the dedicated storm water pipes in the public and private systems based on the City's GIS database.

**Table 2-1
City of Orem Storm Water Pipe Lengths**

Diameter (in)	Public Storm Pipe (mi)	Private Storm Pipe (mi)	Total Length (mi)
<12"	3.20	20.31	23.51
12"-17"	29.39	20.43	49.82
18"-23"	15.49	4.42	19.91
24"-29"	11.85	3.06	14.91
30"-35"	10.29	1.37	11.66
36"-41"	6.64	0.57	7.21
42"-47"	1.44	0.40	1.84
48"	2.13	0.20	2.33
>48"	1.16	0.14	1.30
<i>Unknown</i>	<i>10.52</i>	<i>35.39</i>	<i>45.91</i>
Total	92.11	86.29	178.40



LEGEND

-  Public Stormwater
-  West Union Canal
-  Storm Detention
-  Orem City Boundary

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DETENTION FACILITIES

There are 338 mapped public and private detention basins and vaults 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 and often provide water quality benefits. Figure 2-1 shows all the regional detention facilities in the City. A total of 54 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.

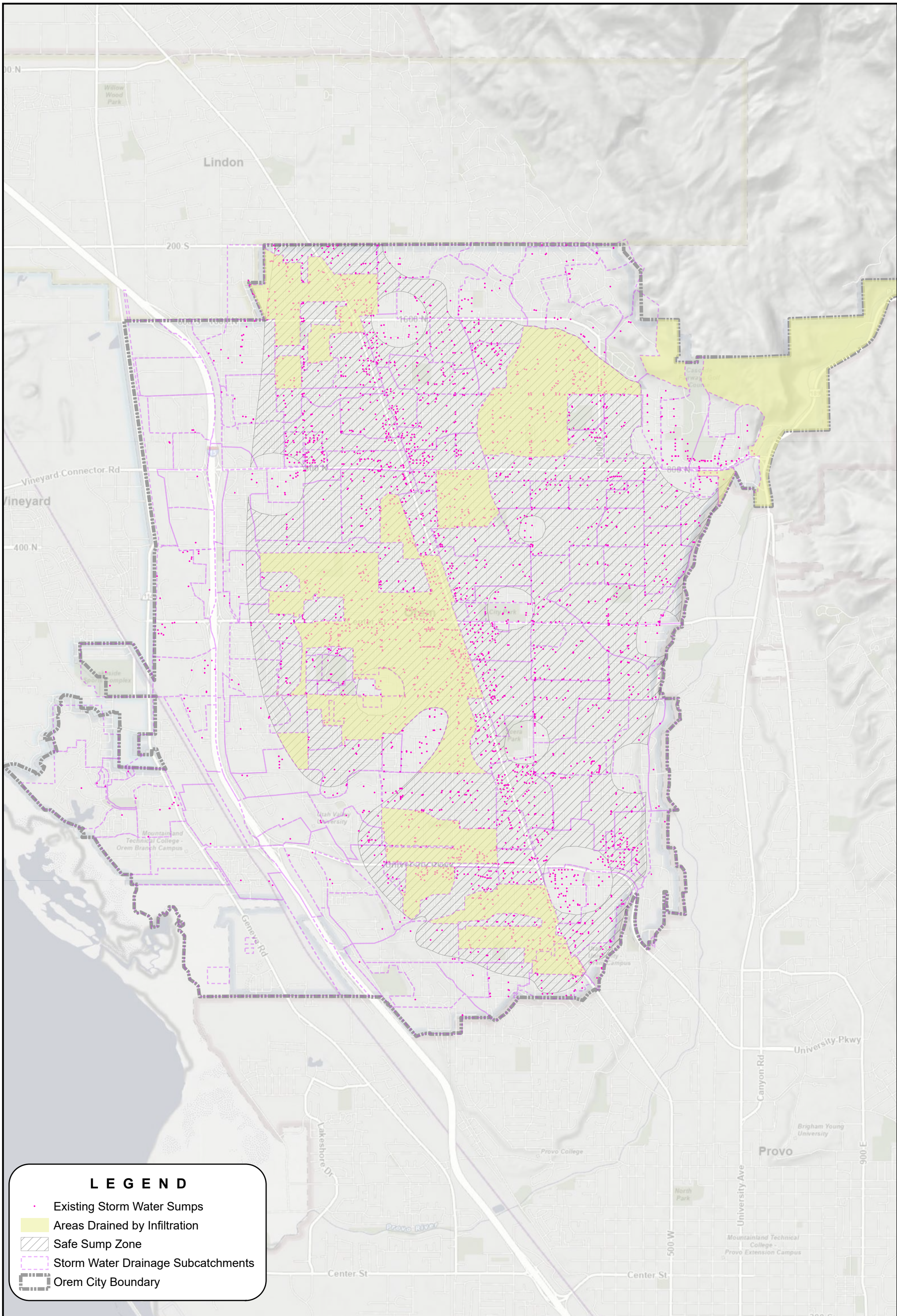
SUMPS AND INFILTRATION BASINS

A large portion of the City of Orem is built upon gravelly soil which allows for significant infiltration of water. As a result, the City has historically used a large number of sumps and infiltration basins to capture and inject storm water into the ground. Currently, there are 3,633 sumps mapped and shown in Figure 2-2. Large portions of the city rely completely on sumps to infiltrate storm water runoff and are not connected to the storm water system of the City.

Orem also has a few detention basins which have significant infiltration. City personnel estimate the detention basins at Timpanogos High School and Bonneville 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.

Given the absence of any observed or reported nuisance flooding in certain areas, the local sumps are effective at capturing and infiltrating runoff from the 10-year design storm event. Correspondingly, it is not expected that these areas will require conveyance pipelines to move runoff below the surface and to regional stormwater facilities and outfalls. Areas where this assumption has been made are shown in yellow in Figure 2-2 as “Areas Drained by Infiltration.” There are other areas of the City where sumps are interspersed with storm water pipes. For the purpose of this master plan, it is assumed that areas with sumps are able to infiltrate the 10-year event.

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.



CHAPTER 3 HYDROLOGIC ANALYSIS

To evaluate the capacity of the City of Orem 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 the City of Orem. Hydraulic modeling will be addressed in the following chapter.

HYDROLOGIC MODELING

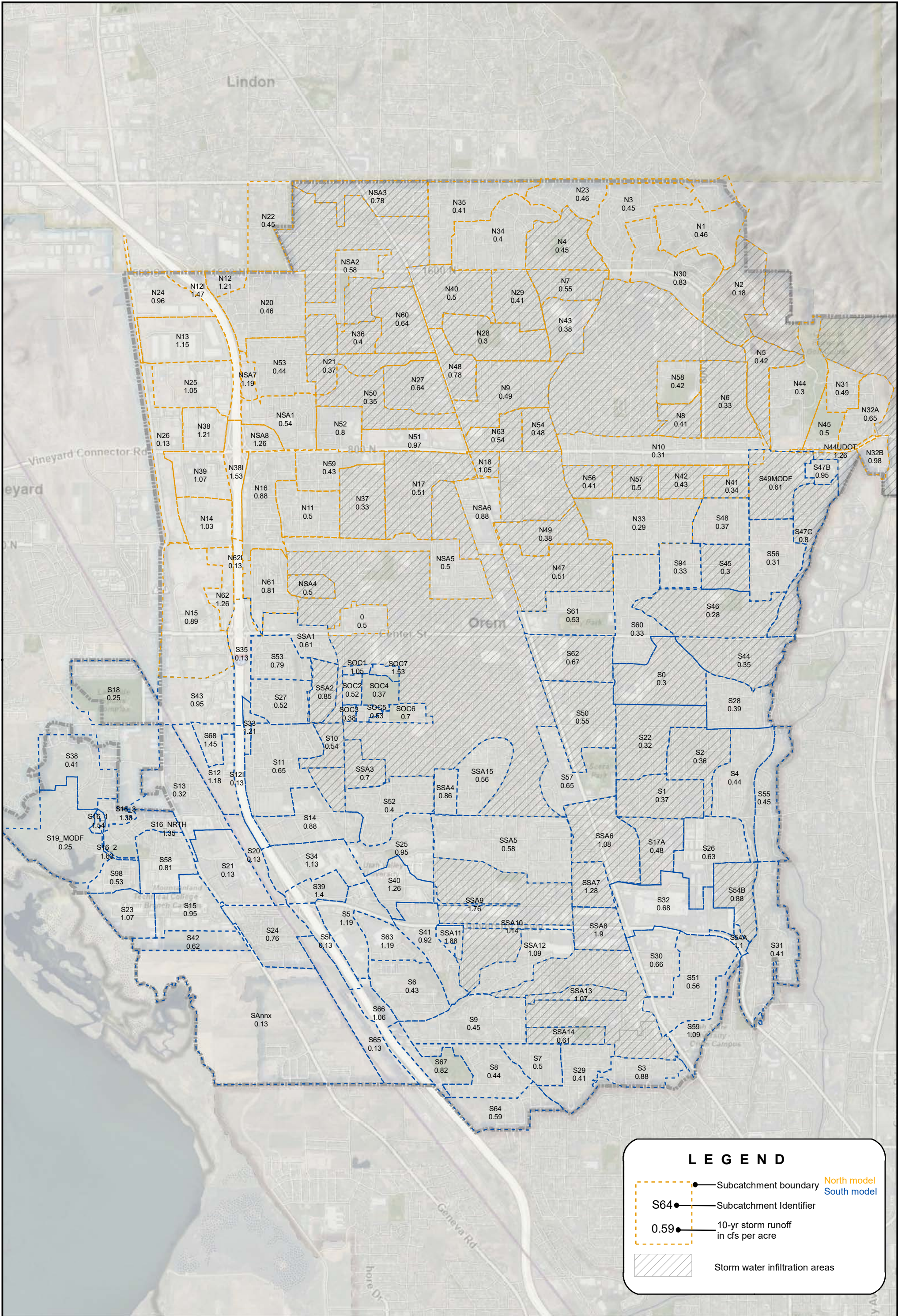
The City of Orem was divided into two hydrologic study areas for the purposes of this master plan update, a North Study Area and a South Study Area. A hydrologic computer model was developed for both study areas using the most current version of InfoSWMM. InfoSWMM uses an Environmental Protection Agency 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 aurally 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. The number of subcatchments was kept to approximately 150 for the two models to make the models less cumbersome to run for the City, and a unit flow rate for each subcatchment was calculated to aid in local storm pipeline design.



LEGEND

- Subcatchment boundary North model
- Subcatchment boundary South model
- Subcatchment Identifier
- 10-yr storm runoff in cfs per acre
- Storm water infiltration areas

HYDROLOGIC MODEL PARAMETERS

The next step in developing the InfoSWMM 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:

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

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 2023 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 the City of Orem. 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
 - 25-Year: 1.40 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 the City of Orem. 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 City of Orem storm water system requires both a hydrologic and hydraulic analysis. The hydrologic analysis estimates the storm water runoff volume and peak discharges generated by a design rainfall 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 the City of Orem.

A hydraulic computer model of the study area was developed using the most current version of InfoSWMM. 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, detention basins, and outfalls.

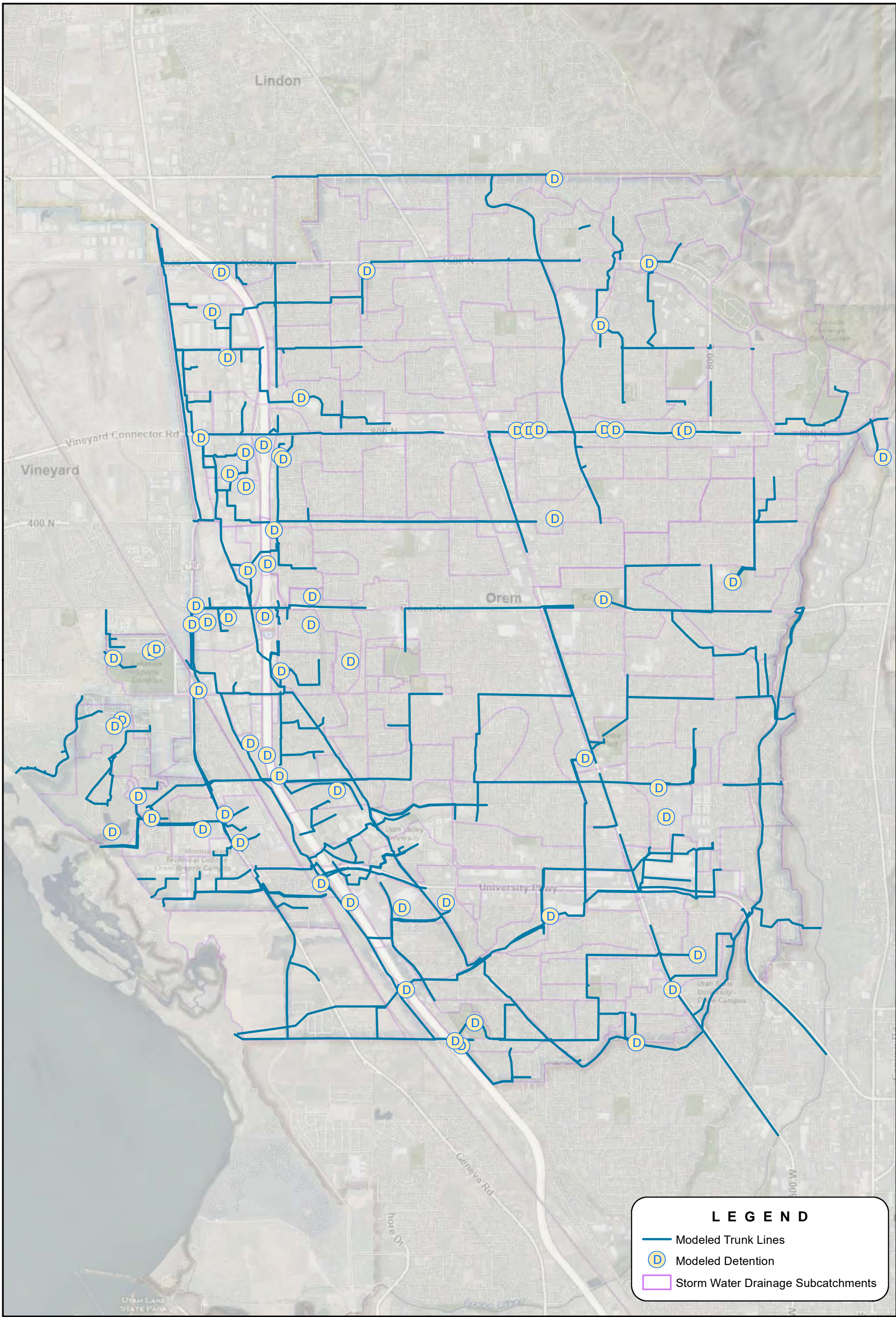
Modeled Conveyance

The model developed for the 2020 Storm Water Master Plan was updated with new additions and corrections to the storm water system mapping provided by the City.

As with the previous master plan, 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 the City of Orem 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. 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.



LEGEND

- Modeled Trunk Lines
- D Modeled Detention
- Storm Water Drainage Subcatchments

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Sumps

In areas where sumps exist in the City's safe sump zone, it is assumed that subcatchment flows enter the sumps and not the City's pipe network. These subcatchments are shown in the previous section, Figure 3-3.

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.

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 the City of Orem personnel at the beginning of this study and are documented below. The level of service provided by the City of Orem 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. More specifically, the future of the West Union Canal is uncertain. The West Smith Ditch irrigation company, which historically shared the same open channel as the West Union Canal from the Provo River to University Parkway, is expected to be dissolved as most shares have been purchased by local water districts in an effort to reduce maintenance and liability concerns. The West Union Canal, however, continues to operate using a groundwater well. The City plans on active irrigation within the canal to end eventually. When that occurs, the City will need to take over and maintain a few segments of the canal that will serve as a permanent part of the City's storm water conveyance system. Outside of these stretches, many of the projects identified in this master plan are driven by the City's need to remove storm water discharge from the West Union Canal due to inability to maintain or replace sections of the canal that are inaccessible.

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.

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 the City of Orem discharges into the Provo River, evaluation of the floodplain was not evaluated as part of this study. Where 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.

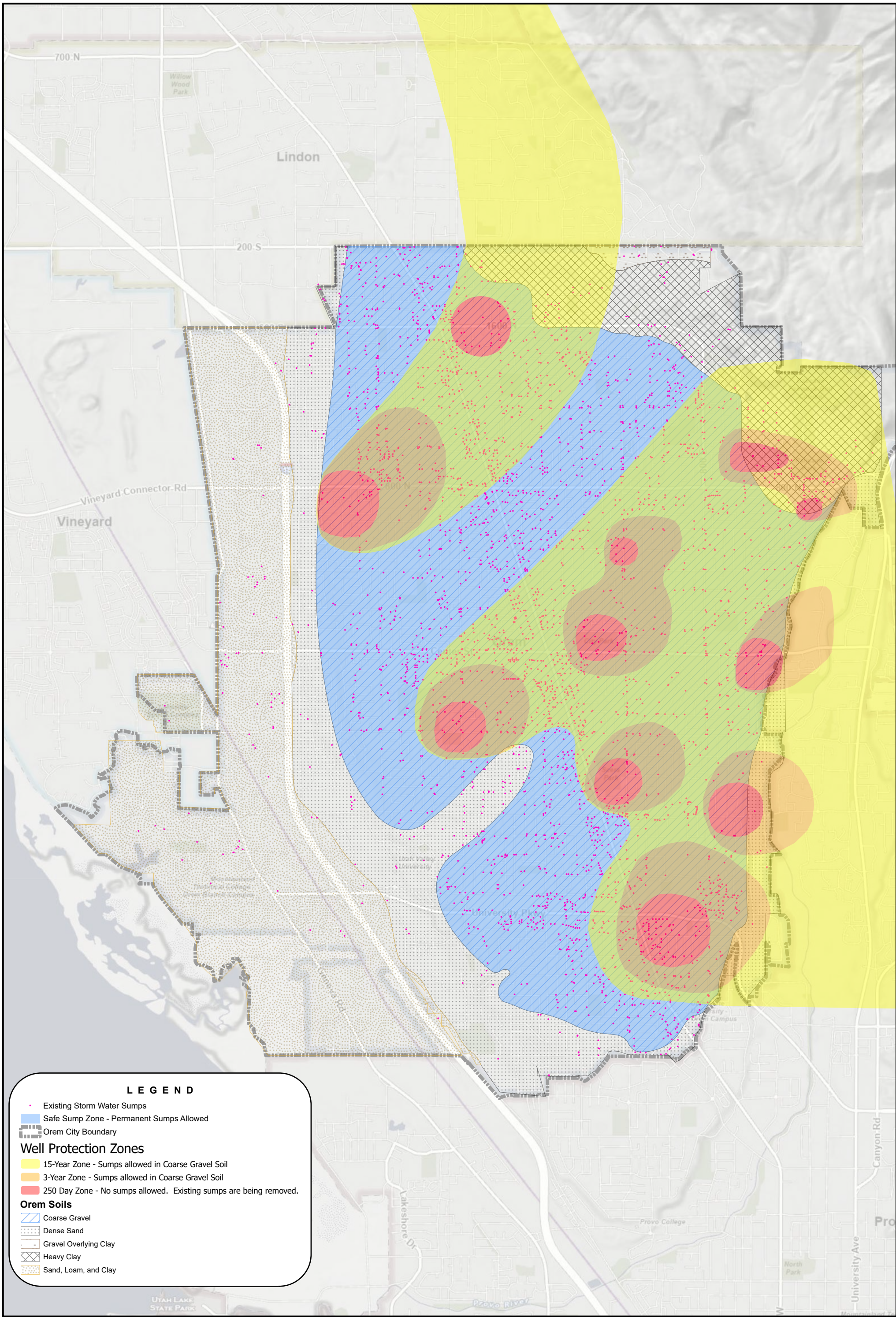
Detention Basins

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 3,633 mapped sumps in the City of Orem. Sumps require special attention as they can impact both the storm water and drinking water systems. The City's approach to allowing and maintaining infiltration sumps has changed over time. In the City of Orem's 1998 "Storm Drainage Master Plan", the City decided that it would eliminate all the City's sumps to reduce potential concerns for its groundwater wells. This in principle is the most conservative approach to protecting City wells, but is also prohibitively expensive and would be challenging to implement. To optimize the storm water approach for the City of Orem, the City has considered two issues that affect the level of risk associated with sumps:

- ***Drinking Water Source Protection Zones*** – As part of the State of Utah Drinking Water Source Protection (DWSP) Rule, the City is required to define drinking water source protection zones for each of its wells. Drinking water source 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 distance and time of travel (100-feet, 250 day, 3-year, 15-year) for a particle of water to move from a specific point to the well as shown in Figure 5-1. 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 drinking water source protection zones pose the highest immediate risk to the current City wells.



LEGEND

- Existing Storm Water Sumps
- Safe Sump Zone - Permanent Sumps Allowed
- Orem City Boundary
- Well Protection Zones**
- 15-Year Zone - Sumps allowed in Coarse Gravel Soil
- 3-Year Zone - Sumps allowed in Coarse Gravel Soil
- 250 Day Zone - No sumps allowed. Existing sumps are being removed.
- Orem Soils**
- Coarse Gravel
- Dense Sand
- Gravel Overlying Clay
- Heavy Clay
- Sand, Loam, and Clay

- **Soil Type** – Soils vary throughout the City of Orem. 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 the City of Orem’s drinking water source 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 drinking water source protection zones or well protection zones (WPZs).

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”. Outside of the “Safe Sump Zone”, this master plan addresses sumps as follows:

- **250-Day Drinking Water Source Protection Zones** – Due to the water quality, regulation, and maintenance concerns identified above, it has been assumed that all sumps located inside the 250-day WPZs for the City of Orem wells will be prioritized for removal and replacement with a storm water system consisting of catch basins and conveyance pipelines. This master plan includes both site specific improvements and downstream capacity improvements to remove all sumps in the 250-day WPZs. Orem’s policy prohibits construction of future stormwater sumps in the 250-day WPZs.
- **3-Year Drinking Water Source Protection Zones** – In previous versions of the City’s Master Plan, removal of sumps in the 3-year WPZs was also desired. Recent City policy changes now allow for storm water sumps to remain in the 3-year WPZs. This plan does not include previous master plan projects that were included to remove sumps from the 3-year WPZs¹. The City will continue to monitor the effect of sumps in this zone.
- **15-Year Drinking Water Source Protection Zones** – Because of their larger extents, the 15-year WPZs presented a unique challenge. Whereas removal of sumps in these areas would be desirable from a drinking water quality perspective, elimination of these sumps would severely limit the City’s ability to retain and infiltrate stormwater (which is considered desirable from downstream receiving water perspective). Previous versions of the City’s Master Plan attempted to balance these competing interests. Recent City policy changes now allow for storm water sumps to remain in the 15-year WPZs
- **Areas Outside Both the Drinking Water Source Protection Zones and the Safe Sump Area** – There is a significant portion of the City (predominantly along the City’s western edge) that falls under this description. Sumps may be considered by the City Engineer in this area, but history suggests that soil conditions will limit their effectiveness. Thus, for the purposes of this master plan, it has been assumed that existing sumps will be abandoned in this area and no new sumps will be added.

EXISTING CONVEYANCE SYSTEM ANALYSIS

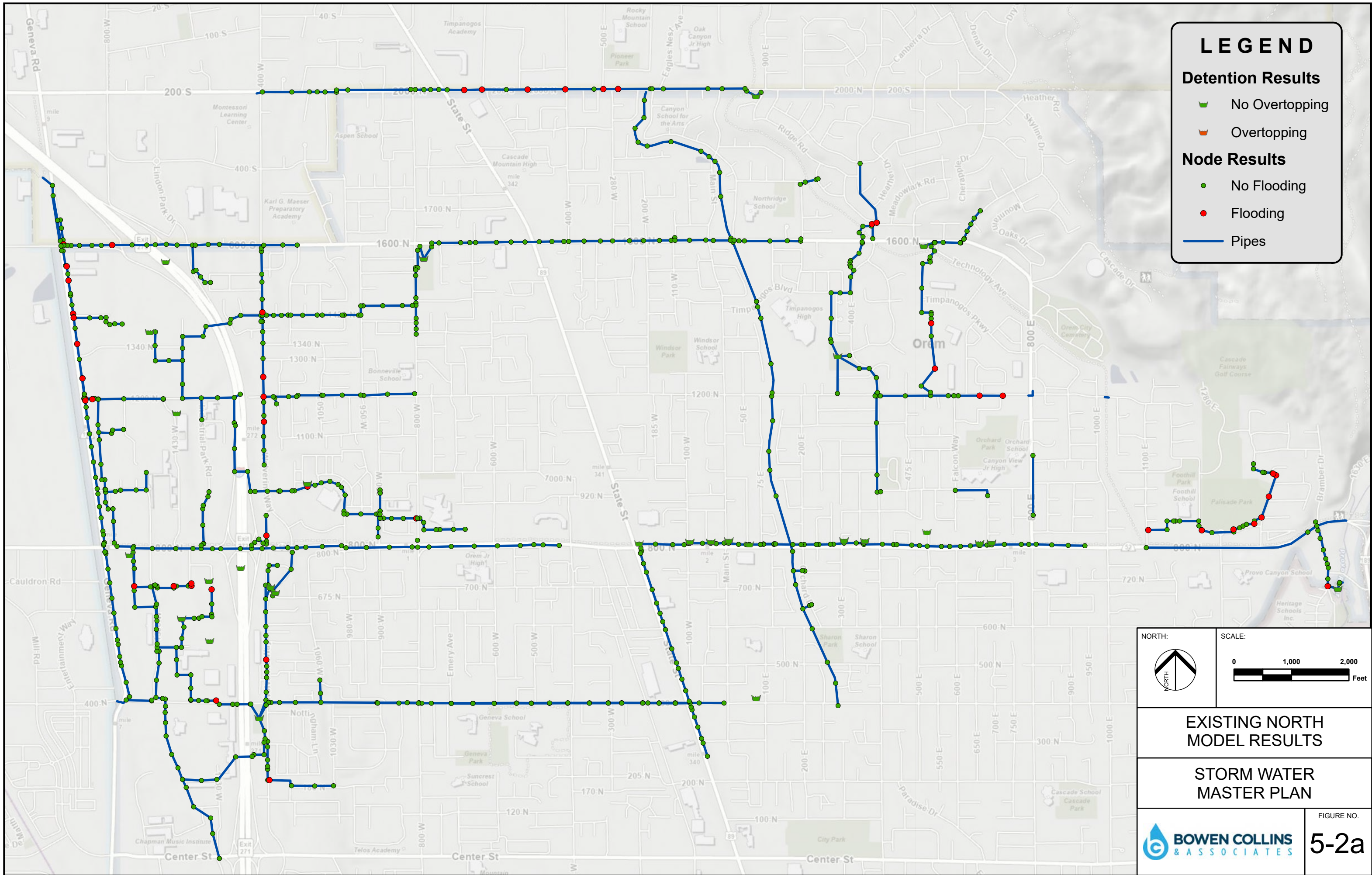
Figures 5-2a and 5-2b show the model results for the storm water system under existing development conditions and the design criteria defined above. Model results identify where

¹ Note that evaluation of the 3-year WPZ for the future 1600 North Well has not been evaluated since the final location and WPZ boundaries have not yet been defined. Once this well site is finalized, all WPZs should be re-evaluated. The 250-day WPZ for this well has been approximately located for budgeting purposes associated with local drainage improvements.

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 pipelines 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.



LEGEND

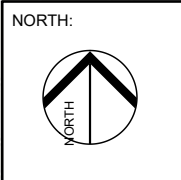
Detention Results

- No Overtopping
- Overtopping

Node Results

- No Flooding
- Flooding

Pipes

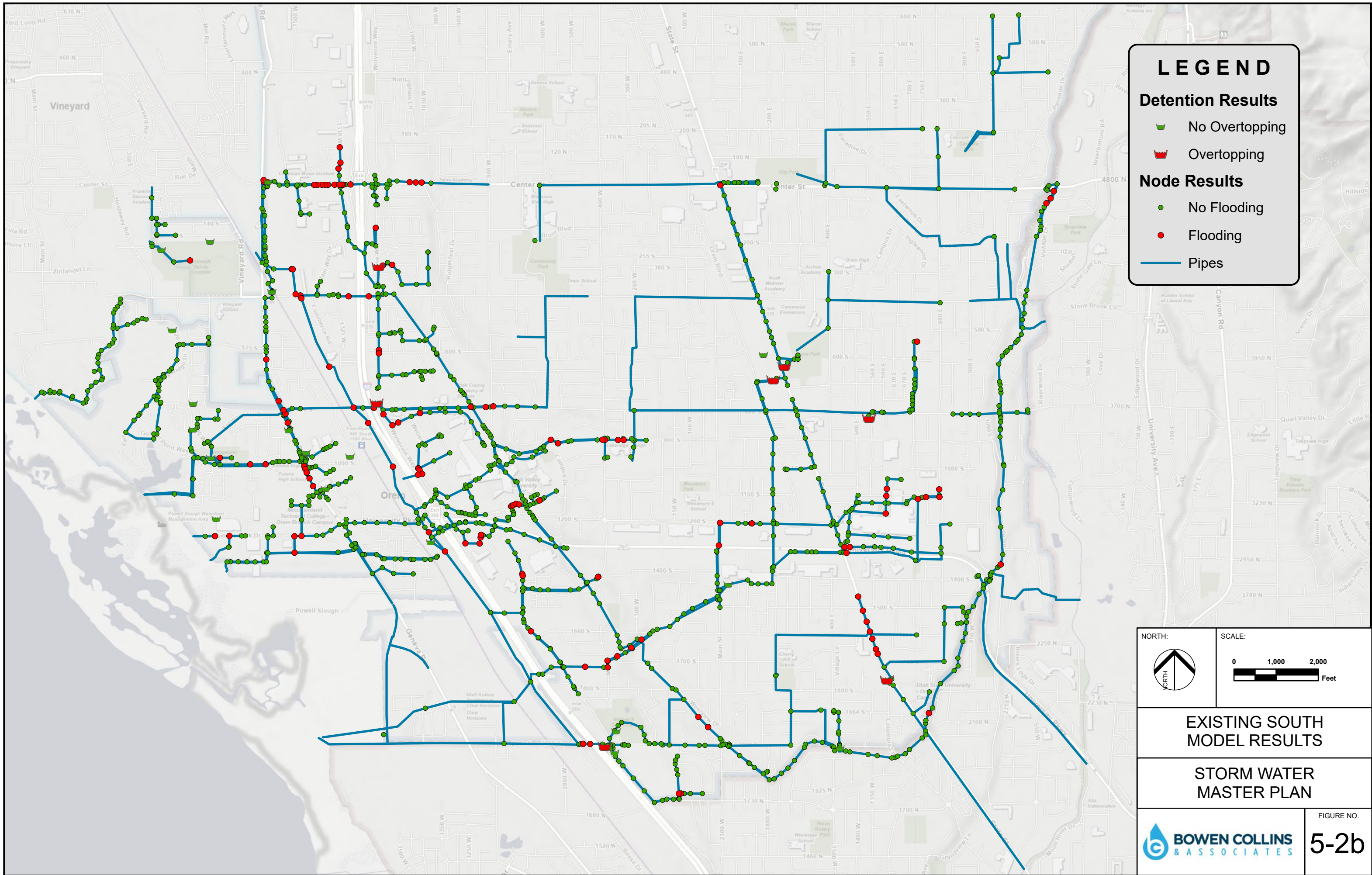


**EXISTING NORTH
MODEL RESULTS**

**STORM WATER
MASTER PLAN**

**BOWEN COLLINS
& ASSOCIATES**

FIGURE NO.
5-2a



LEGEND

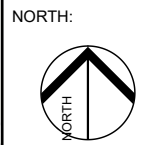
Detention Results

- No Overtopping
- Overtopping

Node Results

- No Flooding
- Flooding

Pipes



**EXISTING SOUTH
MODEL RESULTS**

**STORM WATER
MASTER PLAN**

**BOWEN COLLINS
& ASSOCIATES**

FIGURE NO.
5-2b

CHAPTER 6 RECOMMENDED SYSTEM IMPROVEMENTS

The City's 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, the City of Orem 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 2020 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 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 a 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 to 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 Fiscal Year 2025 dollars. The costs are intended to be planning level and all-inclusive. For more detailed project data associated with each pipeline project,

see Appendix B. Analysis for well protection zone projects was originally completed as part of the 2020 Master Plan and is included as Appendix C. The adjusted well protection zone projects shown in this list of projects are based on that analysis, but adjusted to account for the change in policy, which allows sumps in all zones, except the 250 day zone.

WEST UNION CANAL ISSUES

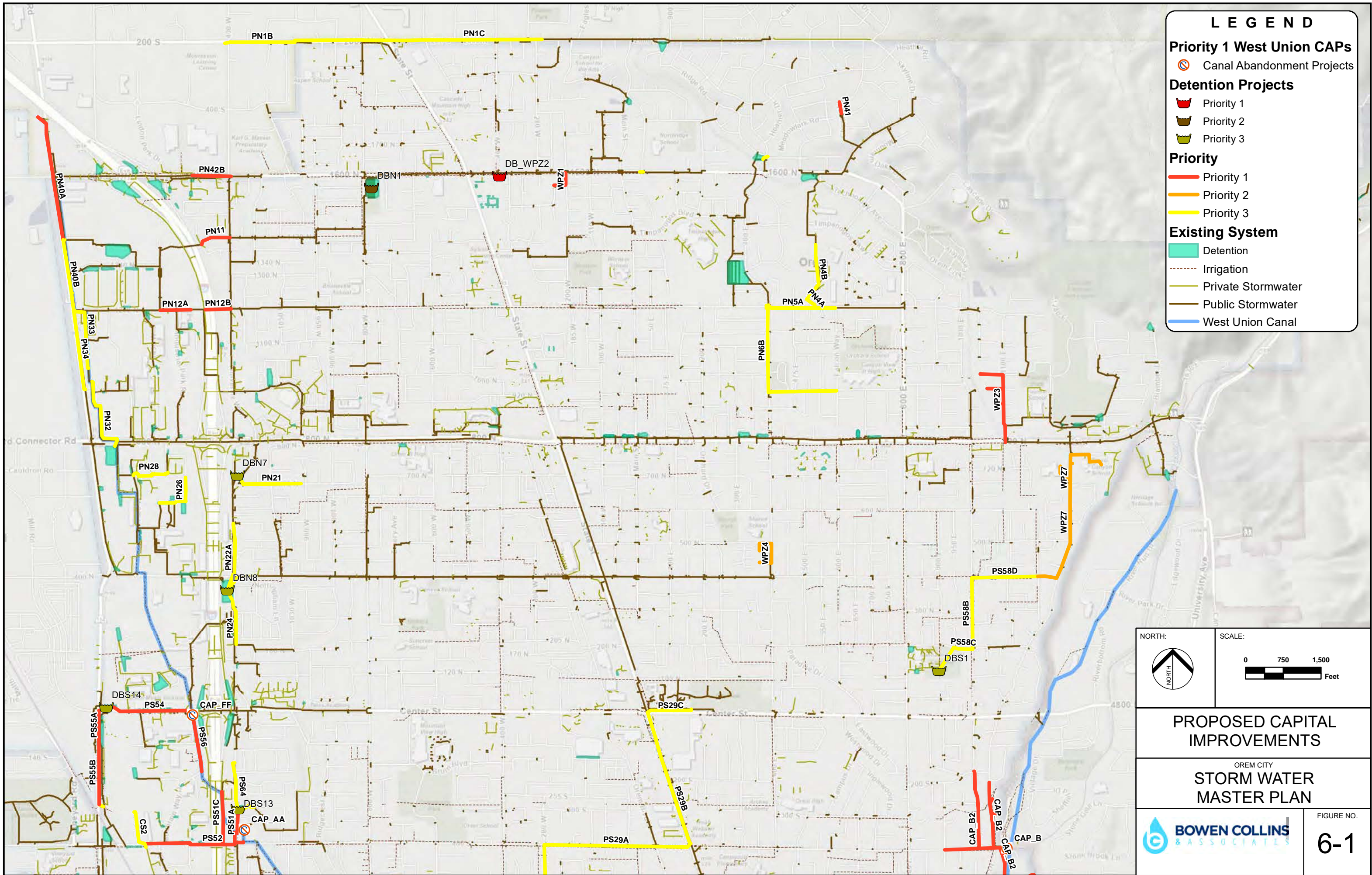
The West Union Canal is one of the largest open channels in the City that is used by the City for storm water conveyance. The canal company has already phased out some parts of the canal and is expected to abandon the entire canal at some point in the future. As a result, the City needs to begin phasing 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 from the canal except for only a few locations where the City will continue to convey storm water temporarily until it can be diverted permanently.

All projects required to eliminate storm water concerns with the West Union Canal have been included as part of the Capital Improvement Plan summarized in Table 6-1. Details regarding these canal abandonment projects (abbreviated as CAPs) can be found in Appendix D, which was completed as part of the 2020 Master Plan and some updates have been included 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 mitigate drainage from larger drainage areas. Of special note are the following:

- Project series with the prefix PS65 will eliminate all connections to the canal between University Parkway and State Street (including the bypass for Well #1). UDOT is already interested in constructing a project along State Street to eliminate its own contributions to the West Union Canal. Costs in Table 6-1 are based on the City of Orem cost alone and there are likely cost savings to participate with UDOT in a combined project. 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 potentially reduce the City of Orem's potential cost contributions to a future UDOT State Street storm water project.
- Once the canal company phases out use of the canal, the City of Orem will also need to construct Project 66A, a detention basin and storm water pipeline to allow water to drain south and west away from the current alignment of the canal. 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 planned to be under the 2000 South roadway. This detention basin will be routed to flow through storm water pipes running through Provo City. As a result, there will need to be some coordination to accommodate some local drainage issues for Provo City. Provo City has some master planned facilities in the area, so the improvement project would be mutually beneficial.

IMPROVEMENT ALTERNATIVES

The improvements identified in the master plan are planning level concepts. Other alternatives and variations are likely to be found as each project is considered in greater detail. It is recommended that such alternatives be explored during the design phase. Over time, more or better information may become available, assumptions and policies will change, and factors influencing design decisions will evolve.



LEGEND

Priority 1 West Union CAPs
 Canal Abandonment Projects

Detention Projects
 Priority 1
 Priority 2
 Priority 3

Priority
 Priority 1
 Priority 2
 Priority 3

Existing System
 Detention
 Irrigation
 Private Stormwater
 Public Stormwater
 West Union Canal

NORTH:

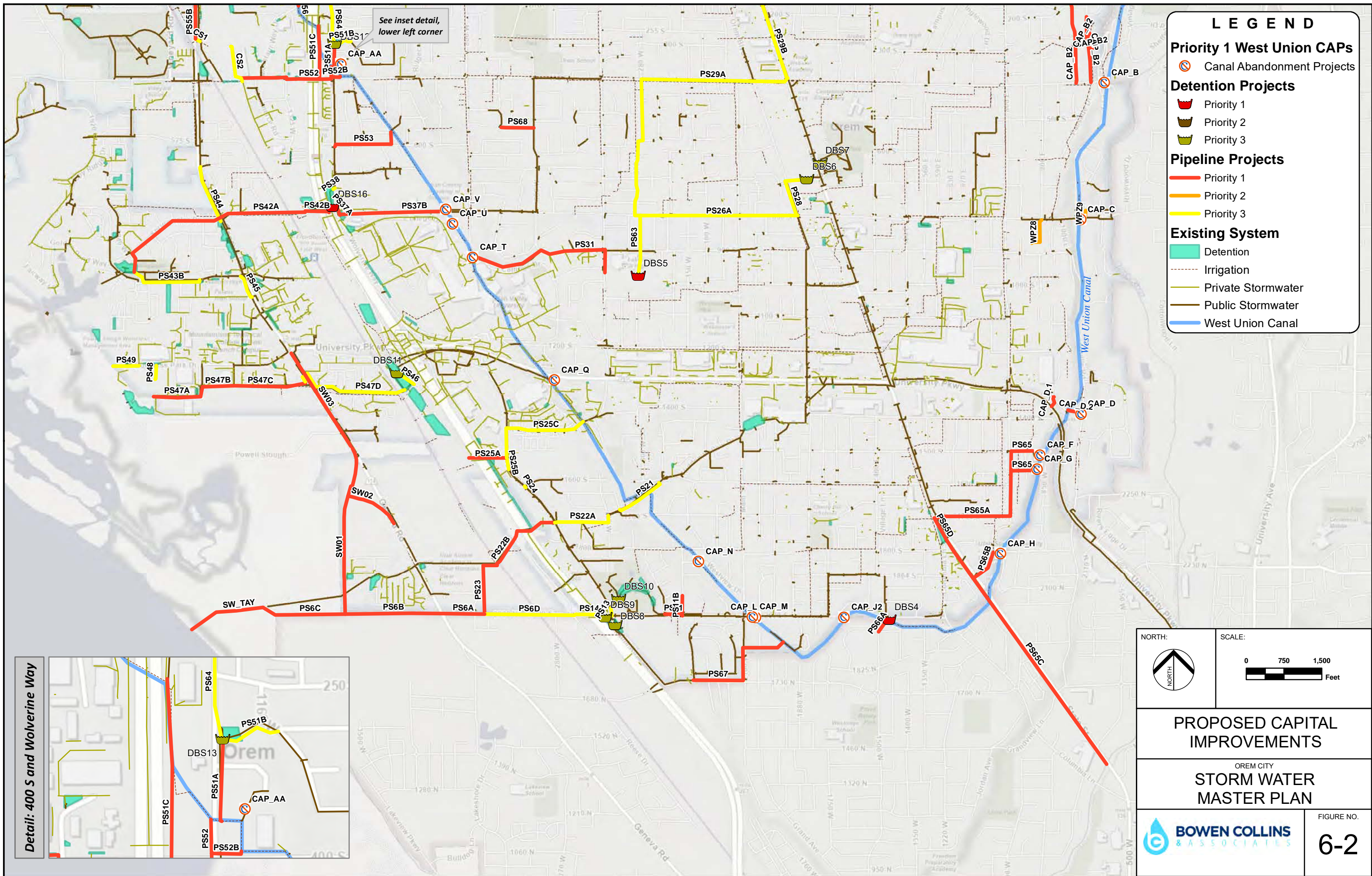
SCALE:

PROPOSED CAPITAL IMPROVEMENTS

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. **6-1**



**Table 6-1
Storm Water Trunkline Improvements**

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
CAP_C	WUC Diversion Structure at 800 S	n/a	n/a	\$50,000	1	2034		New
CAP_D	University Pkwy (D)/WUC, 1385 S at Carterville Rd. Includes Bore and 2 new deepwells. Plug current inlet/install new inlet(s) and pipe through turf burm to U.P.	621	24	\$514,400	1	2028		New
CAP_FF	Diversion Ctr St and 1330 W @ WUC	n/a	n/a	\$100,000	1	2028		New
CAP_J2	424 E 2000 S at WUC Abandonemet	n/a	n/a	\$50,000	1	2031		New
CAP_L	Diversion, 2000 S @ WUC	n/a	n/a	\$50,000	1	2031		New
CAP_M	Diversion, 2000 S Main St at WUC	n/a	Varies	\$50,000	1	2031		New
CAP_N	WUC from 200 S to 1430 S. Plug and surface drain to PS11B	n/a	n/a	\$10,000	1	2031		New
CAP_Q	University Pkwy @ WUC diversion improvements	n/a	n/a	\$50,000	1	2031		New
CAP_T	Adopt canal section at CAP T Location	n/a	Varies	\$0	1	2031		Modify Existing
CAP_U	Pipe canal when development occurs.	n/a	Varies	\$0	1	2031		Modify Existing
CAP_V	Diversion box improvements and plug canal going north at CAP V location	n/a	n/a	\$50,000	1	2031		New
CAP_AA	400 S 1165 W and WUC	n/a	n/a	\$20,000	1	2032		New
CAP_B2	400 South @ 1000 East - Phase 2	5250	Varies	\$2,675,000	1	2026	mixed	New
PN1A	2000 N (A)	103	36	\$66,500	3	10+	94	Upsize
PN1B	2000 N (B)	3551	30	\$2,129,800	3	10+	66	Upsize
PN1C	2000 N (C)	2689	30	\$1,612,800	3	10+	42	Upsize

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
PN2	Moore Ln	120	30	\$71,700	3	10+	51	Upsize
PN3	1600 N	70	24	\$44,700	3	10+	14 (29)	Parallel
PN4A	Research Way (A)	640	24	\$373,300	3	10+	13	Upsize
PN4B	Research Way (B)	800	24	\$459,800	3	10+	13	Upsize
PN5A	1200 N (I)	950	36	\$602,400	3	10+	27	Upsize
PN5B	1200 N (J)	410	30	\$253,400	3	10+	16	Upsize
PN6A	400 E (A)	120	30	\$71,700	3	10+	18	New
PN6B	400 E (B)	3040	24	\$1,743,500	3	10+	18	New
PN11	1420 N	640	36	\$413,200	1	2028	95	Upsize
PN12A	1200 N (F)	620	36	\$402,600	1	2030	87	Upsize
PN12B	1200 N (G)	520	24	\$291,800	1	2030	47	Upsize
PN21	675 N	1240	18	\$644,900	3	10+	18	New
PN22A	1200 W (A)	340	36	\$217,200	3	10+	73	Upsize
PN22B	Orem Skate Park (B)	350	30	\$211,500	3	10+	52 (76)	Parallel
PN24	1200 W (B)	1130	36	\$709,500	3	10+	37	Upsize
PN26	1340 E	1050	18	\$541,700	3	10+	15	Upsize
PN28	1370 W	800	24	\$459,800	3	10+	22	Upsize
PN30A	800 N (B)	140	48	\$100,200	3	10+	136	Upsize
PN32	800 N (C)	1550	54	\$1,228,200	3	10+	136	Upsize
PN33	1200 N (H)	1370	42	\$940,200	3	10+	67 (145)	Parallel
PN34	Geneva Rd (B)	2400	36	\$1,532,100	3	10+	21	Upsize
PN35	Geneva Rd (J)	20	60	\$27,000	3	10+	18	Connect Parallel Lines
PN36	Geneva Rd (K)	40	60	\$41,800	3	10+	16	Connect Parallel Lines

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
PN37	Geneva Rd (L)	60	60	\$56,700	3	10+	21	Connect Parallel Lines
PN40A	Geneva Rd (A)	90	36	\$124,600	1	2031	185	Parallel (2)
PN40B	Geneva Rd (C)	1070	66	\$997,800	3	10+	123 (154)	Parallel
PN41	NE Area Improvements (Heather Road, Cherapple Circle)	200	Varies	\$650,500	1	2026	mixed	New
PN42B	1600 N 1200 West Pipe Extension	800	24	\$689,700	1	2027	4	New
PN43	Lindon Hollow Improvements with PG and Lindon	n/a	n/a	\$498,000	1	2026	n/a	New
PS6A	2000 S - Geneva Road to 850' east	1675	60	\$954,900	1	2026	28	New
PS6B	2000 S - Geneva Road to Lakeview Pkwy	1930	36	\$1,205,000	1	2025	90	New
PS6C	2000 S - Lakeview Pkwy to Southwest Taylor Drain	800	54	\$300,000	1	2027	202	New
PS6D	2000 S (A) - Phase 2 (East of PS23)	1780	30	\$1,060,400	3	10+	54	New
PS11	2000 S, 180 W to Nielsen's Grove	380	36	\$238,300	1	2030	36	Upsize
PS11B	180 W, 2000 S	400	24	\$236,000	1	2030	24	New
PS13	Nielson Grove Park	300	36	\$196,000	3	10+	43	Upsize
PS14	2000 S (D)	570	30	\$332,900	3	10+	18	Upsize
PS21	Hidden Hollow Dr. (B)	1010	36	\$646,200	3	10+	60	Upsize
PS22A	400 W (A)	1210	36	\$777,300	3	10+	77	Upsize
PS22B	400 W (B)	1530	36	\$1,457,850	1	2027	62	Upsize
PS23	Taylor Drain Outlet	1280	42	\$887,500	1	2028	47	New
PS24	Sandhill Rd (B)	40	24	\$30,700	3	10+	4	Connect Parallel Lines
PS25A	I-15 & 1500 S	750	42	\$514,200	1	2030	67	Upsize

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
PS25B	Sandhill Rd (A)	240	36	\$150,900	3	10+	35	Upsize
PS25C	1430 S, Canal outfall	2200	36	\$1,400,900	3	10+	31.146	New
PS26A	800 S (C)	3130	42	\$2,159,700	3	10+	74	New
PS28	Orem Blvd	1100	42	\$756,600	3	10+	39 (54)	Parallel
PS29A	400 S (A)	11720	30	\$7,060,700	3	10+	64	New Parallel (2)
PS29B	State Str	4360	36	\$2,756,500	3	10+	38	Parallel
PS29C	Center Str (A)	1490	30	\$890,700	3	10+	36	Upsize
PS31	900 S	3240	18	\$1,663,300	1	2033	8	New/Upsize
PS37A	WUC exit, Campus Dr to DBS16 (A)	263	42	\$178,000	1	2032	105	Upsize
PS37B	WUC exit at 800 S to College Dr (F)	2132	36	\$1,352,900	1	2032	72	Upsize
PS38	College Dr (B)	50	36	\$38,500	3	10+	61	Upsize
PS42A	800 S (A)	4090	42	\$2,822,300	1	2031	105	New
PS42B	800 S (B)	510	42	\$348,100	1	2031	108	Upsize
PS43B	Springwater Park Ln	1440	36	\$910,800	3	10+	39 (62)	Parallel
PS44	Geneva Rd (E)	1180	36	\$735,900	3	10+	27	Upsize
PS45	Geneva Rd (F)	500	24	\$282,500	3	10+	17	Reroute
PS46	Kent Drain	410	60	\$354,700	3	10+	73	Reroute
PS47A	1330 S - West of Geneva Rd - A	940	60	\$225,000	1	2026	147	Upsize
PS47B	1330 S - West of Geneva Rd - B	830	54	\$225,000	1	2026	137	Parallel
PS47C	1330 S - West of Geneva Rd - C	1460	48	\$200,000	1	2026	93	Parallel
PS47D	1300 S (C)	2360	36	\$1,485,300	3	10+	52	Upsize
PS48	Business Park Dr (A)	280	36	\$172,000	3	10+	24	Upsize
PS49	Business Park Dr (B)	520	24	\$356,800	3	10+	11	Upsize
PS51A	1200 W (C)/Wolverine Way, 300 S	450	24	\$259,200	1	2032	28	Upsize
PS51B	1200 W (D)/Wolverine Way, 300 S	360	24	\$205,200	3	10+	17	Upsize

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
PS51C	WUC, Point BB to 400 S	1060	18	\$545,800	1	2032		New
PS52	400 S (B), 1200 W to 1500 W	2065	24	\$1,175,200	1	2032	12	Upsize
PS52B	400 S, 1150 W to 1200 W	187	18	\$88,400	1	2032		New
PS53	543 S 1020 W	1423	18	\$683,300	1	2033		New
PS54	Pipe WUC from CAP_FF to outfall	1800	48	\$1,334,600	1	2027	44	New
PS55A	Geneva Rd (G)	710	54	\$562,700	1	2034	96	Upsize
PS55B	Geneva Rd (H)	1290	60	\$1,163,000	1	2034	111	Upsize
PS56	Rehabilitate WUC pipe from DD to FF	1140	Varies	\$240,000	1	2027		New
PS58B	1000 E (B)	2820	36	\$1,791,400	3	10+	100	New Parallel (2)
PS58C-1	Cascade Park	940	36	\$597,100	3	10+	52 (132)	New Parallel (PS58C-2)
PS58C-2	Cascade Park	940	42	\$650,900	3	10+	70 (132)	New Parallel (PS58C-1)
PS58D	400 N (B)	1310	36	\$830,100	3	10+	45	New
PS63	Lake Ridge Jr. High	2400	36	\$1,532,100	3	10+	148	New Parallel (2)
PS64	1200 W (D)	900	24	\$519,900	3	10+	22	Upsize
PS65	CAP F & G. Install pipelines on 1500 S and 1550 S east of 800 East	870	18	\$442,600	1	2029		New
PS65A	Pipe along 800 E and 1700 S for Well #1 bypass drain.	3271	42	\$2,254,300	1	2029	27	New
PS65B	CAP H. Pipe to route 750 E to State Street.	675	24	\$389,500	1	2029	11	New
PS65C	State Street	3850	42	\$2,721,300	1	2029	95	New
PS65D	Hillcrest Area perforated pipe	200	42	\$300,000	1	2029	27	New
PS66A	WUC - Provo 1730 N Alignment	3776	24	\$1,107,200	1	2028	4.613	New
PS67	WUC - 2075 S & 2200 S	2500	30	\$1,636,800	1	2030		New

Project ID	Project Description	Pipe Length (ft)	Diameter (in) ²	Opinion of Probable Cost ³	Priority Level	Build Year	Design Flow Rate (cfs) ¹	Status
PS68	550 South from 700 W to 600 W	700	18	\$691,000	1	2026	2	New
SW01	Lakeview Parkway Road Project	5250	Varies	\$325,000	1	2027	mixed	New
SW02	Geneva Road Widening Project - A	5473	Varies	\$500,000	1	2028	mixed	New
SW03	Geneva Road Widening Project - B	2195	Varies	\$350,000	1	2026	mixed	New
WPZ1	1560 N Sump Drain	520	12	Water Funded	1	Water Funded	0.7	New
WPZ3	1101 E Near Well 6	1071	18	Water Funded	1	Water Funded	1	New
WPZ4	Drain N. Lupe Circle to 500 N. and E.450 N to 400 E.	1000	12	Water Funded	2	Water Funded	1	New
WPZ7	N. Palisades Dr	3905	21	Water Funded	2	Water Funded	mixed	New
WPZ8	Remove sump from 870 S, pipe north to 800 S	638	12	Water Funded	2	Water Funded	1.7	New
WPZ9	Plug sump, regrade existing pipe, daylight outlet to 800 S gutter	114	12	Water Funded	2	Water Funded	0.5	New

Notes:

1. First number is design flow for the proposed parallel pipe. Value in parentheses is the total combined design flow.
2. 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.
3. Fiscal Year 2025 dollars. Actual costs may be higher or lower depending on details discovered during design. Costs will vary by market conditions and material prices at the time of bidding. This is a planning-level opinion that includes contingency, engineering, administrative, and legal fees.

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 the City of Orem. Where applicable, property acquisition costs have been estimated at \$200,000/acre and were included in the total cost estimate.

**Table 6-2
Required Capacity at Detention Basins**

Project Identifier	Project Name	Opinion of Probable Cost 2025	Volume (acre-ft)	Discharge Rate (cfs)	Status**	Priority (year)
DBN7	1200 W 675 N	\$60,000	0	13.5	Modify	3
DBN8	Orem Skate Park	\$60,000	0	42	Modify	3
DBS1	Cascade Park	\$1,886,000	4.7	15.5	New	3
DBS4	424 E West Union Canal – Construction	\$750,000	TBD	TBD	New	1 (2028)
DBS5	Lakeridge Jr. High	\$2,486,300	6.3	6.5	New	3
DBS6	700 S & State Str.	\$60,000	0	41	Upsize	3
DBS7	Scera Park (B)	\$60,000	0	3	Upsize	3
DBS8	Ercanbrack East	\$60,000	0	7	Modify	3
DBS9	Ercanbrack West	\$60,000	0	54	Modify	3
DBS10	Nielson's Grove	\$60,000	0	36	Modify	3
DBS11	Kent Drain	\$60,000	0	61	Modify	3
DBS13	12th West	\$60,000	0	16.5	Modify	3
DBS14	Geneva Rd. & Center St.	\$60,000	0	47	Modify	3
DBS16	8th S & 12th W	\$60,000	0	110	Modify	3
DB_WPZ2	Underground detention or lining of existing detention - Water Funded Project	\$0	Match existing	Match existing	Modify	1

* These dates should correspond to the year the corresponding well is constructed that prompts these storm water system improvements. Year shown is only an estimate.

** 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.

CULVERT IMPROVEMENTS

Figures 6-1 and 6-2 show the location of recommended storm water culvert improvements. Table 6-3, on the following page, lists the recommended culvert capacity and costs needed in the City of Orem.

**Table 6-3
Required Capacity at Culverts**

Project Identifier	Project Name	Opinion of Probable Cost 2025
CS1	Geneva Rd	\$152,900
CS2	400 South, 1500 West	\$1,149,500

SOUTHWEST TAYLOR DRAIN

The Taylor Drain is a key component of Orem's stormwater system because it is an open channel in the Utah Lake Wetlands that conveys stormwater runoff to the lake. The channel is in need of continual maintenance, which is not a capital improvement, and will be included in the maintenance section of the implementation plan.

ALTERNATIVE DETENTION IMPROVEMENTS

As noted previously, this chapter documents a cost-effective approach to future improvements based on available information regarding likely detention basin properties and other system conditions. Some additional project optimization may be possible if the City can secure additional properties for detention basins other than those initially identified.

CHAPTER 7 IMPLEMENTATION PLAN

In Chapter 6, a capital improvement plan was developed identifying and prioritizing all recommended improvements in the City of Orem 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, and other miscellaneous improvements.

As outlined in Chapter 6, there are several high priority projects related to existing conveyance deficiencies 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.

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 City of Orem personnel. The projects have been organized to address the most important needs of the system first. A discussion of each of the storm water system funding needs 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.
- **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 the City of Orem customers expect. Based on conversations with City of Orem personnel an annual budget of \$350,000 (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. Funds have also been included here to account for maintenance of the Southwest Taylor Drain every other year.

- **Unplanned Repairs** – In addition to the regularly scheduled maintenance items identified in the budget item above, the City of Orem 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 \$300,000 (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 \$443,000 in 2025 and adjusted based on City staff projections in following years.

**Table 7-1
10-Year Capital Improvement Plan**

Project ID	Project Description	OPC 2025	OPC Build Year	Build Year
PS6B	2000 S - Geneva Road to Lakeview Pkwy	\$1,205,000	\$1,205,000	2025
PN42A	1600 N Basin Improvements. Paid by UDOT.	\$0	\$0	2025
SW03	Geneva Road Widening Project - B	\$350,000	\$350,000	2026
PS47A, B, C	1330 S	\$650,000	\$650,000	2026
PN43	Lindon Hollow Improvements with PG and Lindon	\$498,000	\$518,000	2026
PN41	NE Area Improvements (Heather Road, Cherapple Circle)	\$650,500	\$677,000	2026
PS68	550 South from 700 W to 600 W	\$691,000	\$719,000	2026
PS6A	2000 S - Geneva Road to 850' east	\$954,900	\$994,000	2026
CAP_B2	400 South @ 1000 East - Phase 2	\$2,675,000	\$2,782,000	2026
PS56	Rehabilitate WUC pipe from DD to FF	\$240,000	\$260,000	2027
PS6C	2000 S - Lakeview Pkwy to Southwest Taylor Drain	\$300,000	\$300,000	2027
SW01	Lakeview Parkway Road Project	\$325,000	\$352,000	2027
PN42B	1600 N 1200 West Pipe Extension	\$689,700	\$746,000	2027
PS54	Pipe WUC from CAP_FF to outfall	\$1,334,600	\$1,444,000	2027
PS22B	400 W (B)	\$1,457,850	\$1,577,000	2027
CAP_FF	Diversion, Ctr St and 1330 W @ WUC	\$100,000	\$113,000	2028
PN11	1420 N	\$413,200	\$465,000	2028
SW02	Geneva Road Widening Project - A. Majority paid by UDOT.	\$500,000	\$500,000	2028

Project ID	Project Description	OPC 2025	OPC Build Year	Build Year
CAP_D	University Pkwy (D)/WUC, 1385 S at Carterville Rd. Includes Bore and 2 new deepwells. Plug current inlet/install new inlet(s) and pipe through turf burm to U.P.	\$514,400	\$579,000	2028
DBS4	424 E 2000 S Under Roadway	\$750,000	\$844,000	2028
PS23	Taylor Drain Outlet	\$887,500	\$999,000	2028
PS66A	WUC - Provo 1730 N Alignment	\$1,107,200	\$1,246,000	2028
PS65D	Hillcrest Area perforated pipe	\$300,000	\$351,000	2029
PS65B	CAP H. Pipe to route 750 E to State Street.	\$389,500	\$456,000	2029
PS65	CAP F & G. Install pipelines on 1500 S and 1550 S east of 800 East	\$442,600	\$518,000	2029
PS65A	Pipe along 800 E and 1700 S for Well #1 bypass drain.	\$2,254,300	\$2,638,000	2029
PS65C	State Street	\$2,721,300	\$3,184,000	2029
PS11B	180 W, 2000 S	\$236,000	\$288,000	2030
PS11	2000 S, 180 W to Nielsen's Grove	\$238,300	\$290,000	2030
PN12B	1200 N (G)	\$291,800	\$356,000	2030
PN12A	1200 N (F)	\$402,600	\$490,000	2030
PS25A	I-15 & 1500 S	\$514,200	\$626,000	2030
PS67	WUC - 2075 S & 2200 S	\$1,636,800	\$1,992,000	2030
CAP_T	Adopt canal section at CAP T Location	\$0	\$0	2031
CAP_U	Pipe canal when development occurs.	\$0	\$0	2031
CAP_N	WUC from 200 S to 1430 S. Plug and surface drain to PS11B	\$10,000	\$13,000	2031
CAP_J2	424 E 2000 S at WUC	\$50,000	\$64,000	2031
CAP_L	Diversion, 2000 S @ WUC	\$50,000	\$64,000	2031
CAP_M	2000 S Main St at WUC	\$50,000	\$64,000	2031
CAP_Q	University Pkwy @ WUC	\$50,000	\$64,000	2031
CAP_V	Diversion box improvements and plug canal going north at CAP V location	\$50,000	\$64,000	2031
PN40A	Geneva Rd (A)	\$124,600	\$158,000	2031
PS42B	800 S (B)	\$348,100	\$441,000	2031
PS42A	800 S (A)	\$2,822,300	\$3,572,000	2031
CAP_AA	400 S 1165 W and WUC	\$20,000	\$27,000	2032
PS52B	400 S, 1150 W to 1200 W	\$88,400	\$117,000	2032

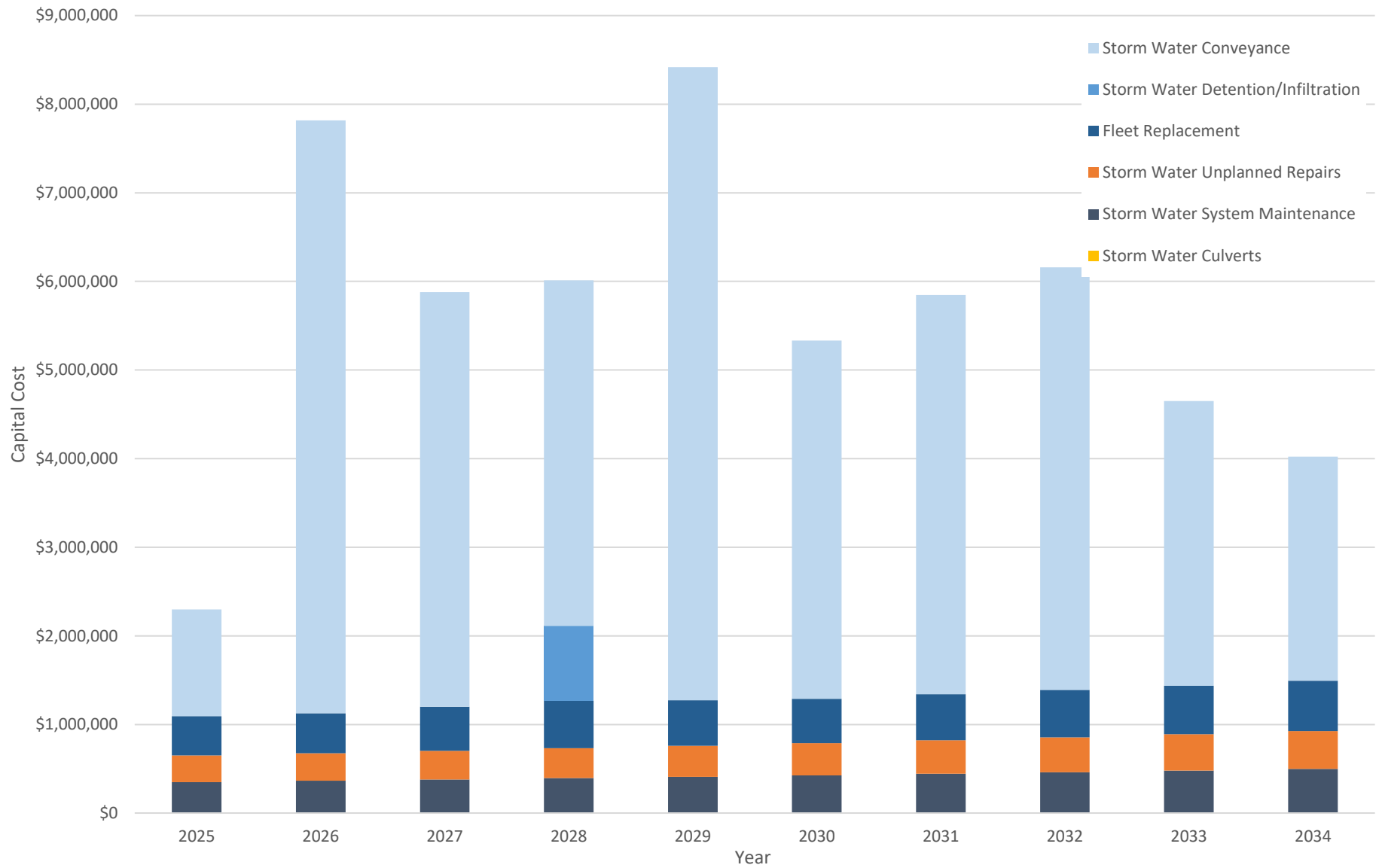
Project ID	Project Description	OPC 2025	OPC Build Year	Build Year
PS37A	WUC exit, Campus Dr to DBS16 (A)	\$178,000	\$235,000	2032
PS51A	1200 W (C)/Wolverine Way, 300 S	\$259,200	\$342,000	2032
PS51C	WUC, Point BB to 400 S	\$545,800	\$719,000	2032
PS52	400 S (B), 1200 W to 1500 W	\$1,175,200	\$1,547,000	2032
PS37B	WUC exit at 800 S to College Dr (F)	\$1,352,900	\$1,781,000	2032
PS53	543 S 1020 W	\$683,300	\$936,000	2033
PS31	900 S	\$1,663,300	\$2,277,000	2033
CAP_C	WUC Diversion Structure at 800 S	\$50,000	\$72,000	2034
PS55A	Geneva Rd (G)	\$562,700	\$801,000	2034
PS55B	Geneva Rd (H)	\$1,163,000	\$1,656,000	2034

* project costs driven by drinking water well development have been moved to the water master plan capital improvement plan.

FUNDING THE 10-YEAR IMPLEMENTATION PLAN

Understanding that postponing the highest priority projects threatens public health, safety, and property, the City has elected to fund critical projects through means of storm water rates, existing storm water system cash reserves, and bond funding. The City is currently conducting a separate rate study to determine necessary funding levels from these sources.

Figure 7-1 illustrates the spending from all funding sources combined through 2034. Figure 7-2 shows the location of projects listed in Table 7-1.



City of Orem Storm Drain Capital Improvement Plan 2025

LEGEND

Priority 1 West Union CAPs

- Canal Abandonment Projects

Detention Projects

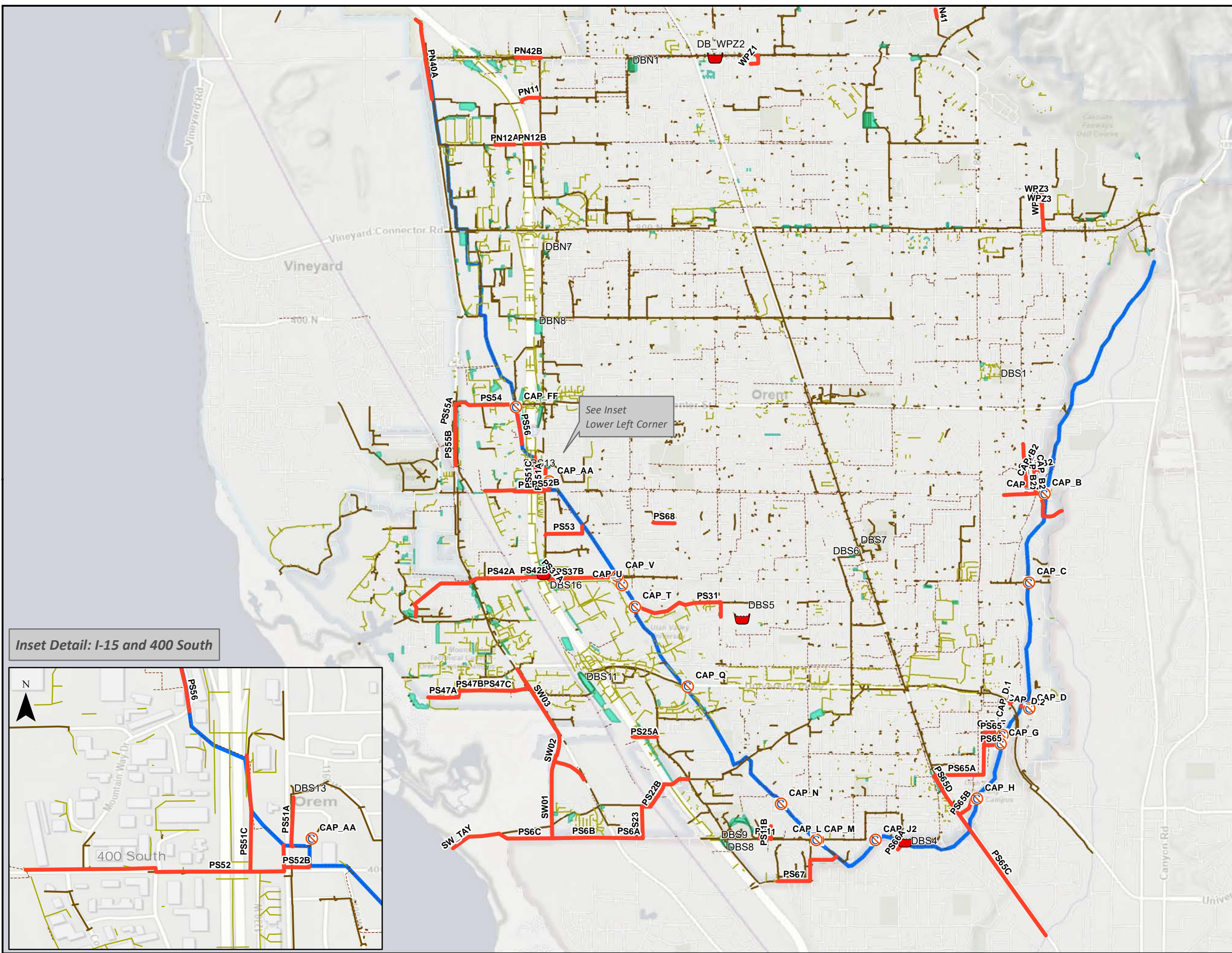
- Priority 1

Pipeline Projects

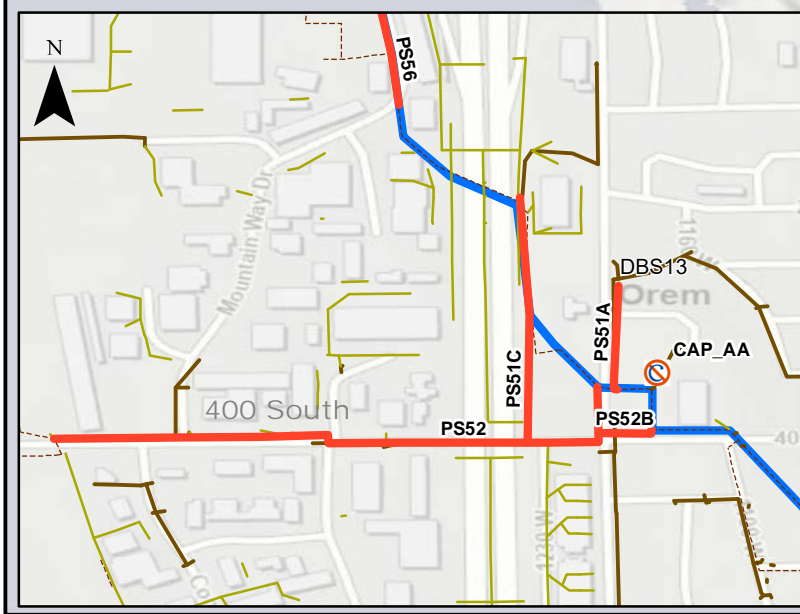
- Priority 1

Existing System

- Detention
- Irrigation
- Private Stormwater
- Public Stormwater
- West Union Canal



Inset Detail: I-15 and 400 South



NORTH:

SCALE:

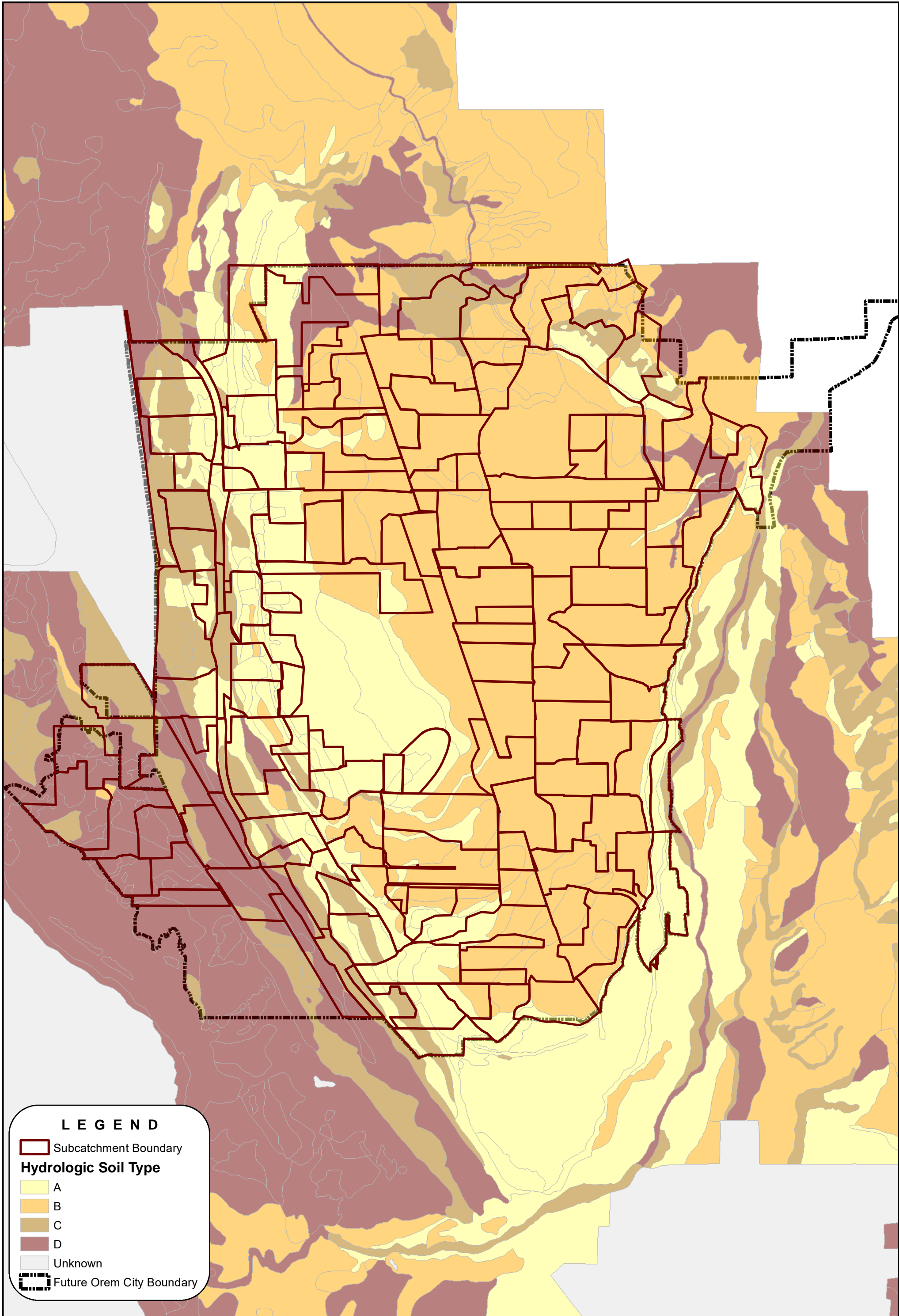
PROJECTS IN THE NEXT 10 YEARS

OREM CITY
STORM WATER MASTER PLAN








BOWEN COLLINS & ASSOCIATES

FIGURE NO. **7-2**

APPENDIX A
SOILS AND IDF DATA



LEGEND

-  Subcatchment Boundary
- Hydrologic Soil Type**
-  A
-  B
-  C
-  D
-  Unknown
-  Future Orem City Boundary



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 Trypanuk, 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 & aeriels](#)

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).

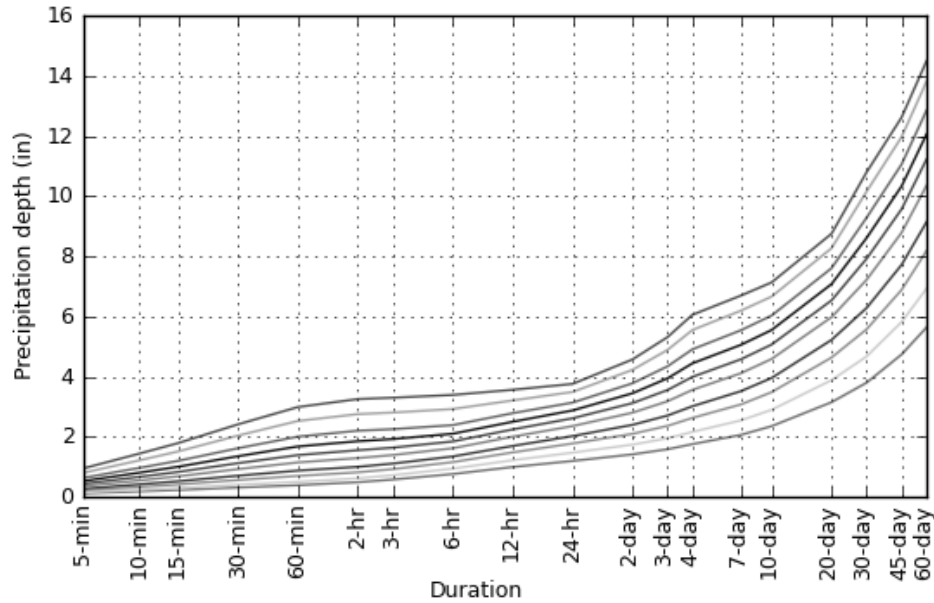
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

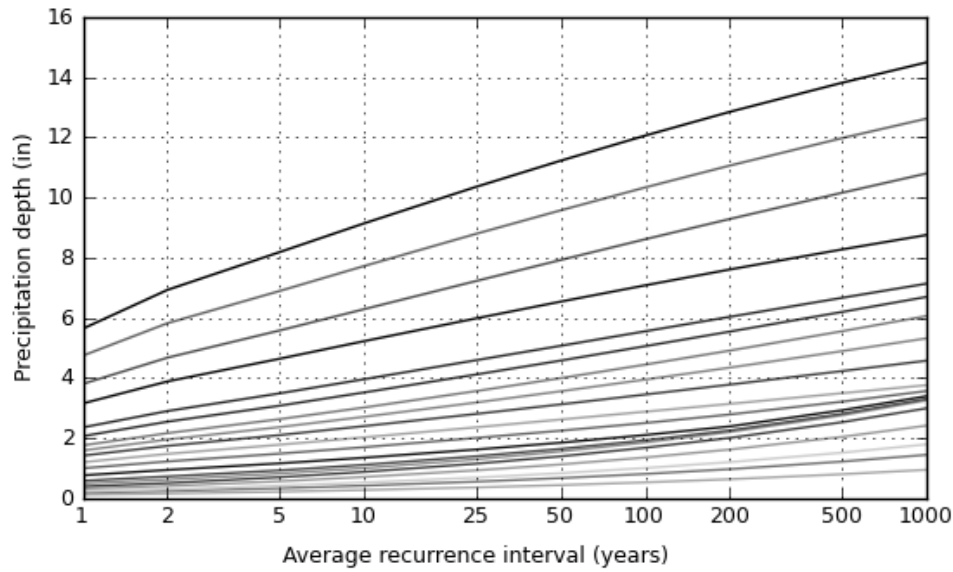
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PF graphical

PDS-based depth-duration-frequency (DDF) curves
 Latitude: 40.2878°, Longitude: -111.6687°



Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000



Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

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Maps & aerials

Small scale terrain





Large scale terrain

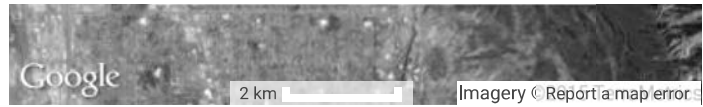


Large scale map



Large scale aerial





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1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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APPENDIX B
COST DATA

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

Description	Unit	Size	Unit Cost
Detention Basins			
Property Acquisition	Acre		\$463,000
Excavation and Hauling	Cubic Yard		\$35
Landscaping (Non-irrigated Native)	Square Foot		\$0.35
Landscaping (Irrigated Turfgrass)	Square Foot		\$3.50
Inlet Apron	Lump Sum		\$35,000
Outlet Structure	Lump Sum		\$50,000
Emergency Spillway	Lump Sum		\$17,000
Riprap	Lump Sum		\$31,000
Storm Water Pipelines			
Permanent Easement Acquisition	Acre		\$46,000
12-inch RCP	Linear Foot	12	\$125
18-inch RCP	Linear Foot	18	\$230
21-inch RCP	Linear Foot	21	\$250
24-inch RCP	Linear Foot	24	\$270
30-inch RCP	Linear Foot	30	\$290
36-inch RCP	Linear Foot	36	\$310
42-inch RCP	Linear Foot	42	\$350
48-inch RCP	Linear Foot	48	\$380
54-inch RCP	Linear Foot	54	\$420
60-inch RCP	Linear Foot	60	\$460
66-inch RCP	Linear Foot	66	\$520
72-inch RCP	Linear Foot	72	\$590
78-inch RCP	Linear Foot	78	\$680
84-inch RCP	Linear Foot	84	\$760
90-inch RCP	Linear Foot	90	\$860
96-inch RCP	Linear Foot	96	\$930
Manhole	Each		\$10,400
Catch Basin	Each		\$9,300
Traffic Control	Linear Foot		\$28
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		\$93,000
Headwalls	Lump Sum		\$7,400
Riprap	Lump Sum		\$100,000
Traffic Control	Lump Sum		\$8,200
Asphalt Road Repair	Linear Foot		(Pipe Diameter [in feet] + 5') * \$8
Channel Construction			
Excavation and Hauling	Cubic Yard		\$35
Landscaping (Non-irrigated Native)	Square Yard		\$3
Riprap	Cubic Yard		\$127
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

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	Unlisted items (service loops, utility relocations, etc.) (20%)	Engineering, Legal, Admin. (10%)	Estimated Project Cost (includes Contingency, Engineering, Admin. and Legal Fees)
PN42A											\$0
PS6B	1930	36	10	6	1	\$988,980	\$49,449	\$1,038,429	\$197,796	\$98,898	\$1,205,000
PS6C	1675	60	9	5	0	\$0	\$0	\$0	\$0	\$0	\$300,000
PS6A	800	54	5	2	0	\$489,700	\$24,485	\$514,185	\$97,940	\$48,970	\$954,900
SW01	5250	Varies	-	-	-	\$0	\$0	\$0	\$0	\$0	\$325,000
SW02	5473	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$500,000
SW03	2195	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$350,000
PS47A, B, C											\$650,000
CAP_B2	5250	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$2,675,000
PN41	200	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$650,500
PN11	640	36	4	2	0	\$317,840	\$15,892	\$333,732	\$63,568	\$31,784	\$413,200
PS66A	3776	24	19	12	1	\$1,703,308	\$85,165	\$1,788,473	\$340,662	\$170,331	\$1,107,200
PS68	700	18	0	0	0	\$0	\$0	\$0	\$0	\$0	\$691,000
PS65C	3850	42	20	12	1	\$2,093,300	\$209,330	\$2,302,630	\$418,660	\$209,330	\$2,721,300
PN42B	800	24	5	2	0	\$353,700	\$17,685	\$371,385	\$70,740	\$35,370	\$689,700
CAP_J2											\$50,000
PS67	2500	30	13	8	2	\$1,259,100	\$62,955	\$1,322,055	\$251,820	\$125,910	\$1,636,800
CAP_D	621	24	4	2	0	\$280,318	\$14,016	\$294,334	\$206,064	\$28,032	\$514,400
PS65	870	18	5	2	0	\$340,480	\$17,024	\$357,504	\$68,096	\$34,048	\$442,600
PS65A	3271	42	17	10	0	\$1,734,050	\$86,703	\$1,820,753	\$346,810	\$173,405	\$2,254,300
PS65B	675	24	4	2	0	\$299,650	\$14,983	\$314,633	\$59,930	\$29,965	\$389,500
PS65D	200	42	2	0	0	\$0	\$0	\$0	\$0	\$0	\$300,000
CAP_L											\$50,000
CAP_M	50	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$50,000
CAP_N	50	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$10,000
CAP_Q	50	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$50,000
CAP_T	10	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$0
CAP_U	10	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$0
CAP_V	10	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$50,000
CAP_FF											\$100,000
PS54	1800	48	10	6	0	\$1,026,600	\$51,330	\$1,077,930	\$205,320	\$102,660	\$1,334,600
PS56	1140	Varies	0	0	0	\$0	\$0	\$0	\$0	\$0	\$240,000
PN40A	90	36	1	0	1	\$95,840	\$4,792	\$100,632	\$19,168	\$9,584	\$124,600
PS25A	750	42	4	2	0	\$395,500	\$19,775	\$415,275	\$79,100	\$39,550	\$514,200
PN12A	620	36	4	2	0	\$309,720	\$15,486	\$325,206	\$61,944	\$30,972	\$402,600
PN12B	520	24	3	1	0	\$224,460	\$11,223	\$235,683	\$44,892	\$22,446	\$291,800
PS11	380	36	2	1	0	\$183,280	\$9,164	\$192,444	\$36,656	\$18,328	\$238,300
PS11B	400	24	3	1	0	\$181,500	\$9,075	\$190,575	\$36,300	\$18,150	\$236,000
PS31	3240	18	17	10	0	\$1,279,460	\$63,973	\$1,343,433	\$255,892	\$127,946	\$1,663,300
PS37A	263	42	2	0	0	\$136,950	\$6,848	\$143,798	\$27,390	\$13,695	\$178,000
PS42A	4090	42	21	13	0	\$2,171,000	\$108,550	\$2,279,550	\$434,200	\$217,100	\$2,822,300
PS42B	510	42	3	1	0	\$267,800	\$13,390	\$281,190	\$53,560	\$26,780	\$348,100
PS37B	2132	36	11	7	0	\$1,040,692	\$52,035	\$1,092,727	\$208,138	\$104,069	\$1,352,900
PS52	2065	24	11	6	0	\$903,970	\$45,199	\$949,169	\$180,794	\$90,397	\$1,175,200
PS52B	187	18	1	0	0	\$68,018	\$3,401	\$71,419	\$13,604	\$6,802	\$88,400
CAP_AA											\$20,000
PS51A	450	24	3	1	0	\$199,400	\$9,970	\$209,370	\$39,880	\$19,940	\$259,200
PS51C	1060	18	6	3	0	\$419,840	\$20,992	\$440,832	\$83,968	\$41,984	\$545,800
PS23	1280	42	7	4	0	\$682,700	\$34,135	\$716,835	\$136,540	\$68,270	\$887,500
PS22B	1530	36	8	5	0	\$0	\$0	\$0	\$0	\$0	\$1,457,850
PS53	1423	18	4	4	0	\$525,622	\$26,281	\$551,903	\$105,124	\$52,562	\$683,300
CAP_C											\$50,000
PS55A	710	54	4	2	0	\$432,880	\$21,644	\$454,524	\$86,576	\$43,288	\$562,700
PS55B	1290	60	7	4	1	\$894,580	\$44,729	\$939,309	\$178,916	\$89,458	\$1,163,000
PN40B	1070	66	6	3	0	\$767,520	\$38,376	\$805,896	\$153,504	\$76,752	\$997,800
PS63	2400	36	13	8	0	\$1,178,500	\$58,925	\$1,237,425	\$235,700	\$117,850	\$1,532,100
PS38	50	36	1	0	0	\$29,600	\$1,480	\$31,080	\$5,920	\$2,960	\$38,500
PS26A	3130	42	16	10	0	\$1,661,300	\$83,065	\$1,744,365	\$332,260	\$166,130	\$2,159,700
PS28	1100	42	6	3	0	\$582,000	\$29,100	\$611,100	\$116,400	\$58,200	\$756,600
CS1	100	60	0	1	1	\$117,600	\$5,880	\$123,480	\$23,520	\$11,760	\$152,900
CS2	810	96	0	2	0	\$884,260	\$44,213	\$928,473	\$176,852	\$88,426	\$1,149,500
PN1B	3551	30	18	11	0	\$1,638,282	\$81,914	\$1,720,196	\$327,656	\$163,828	\$2,129,800
PN1C	2689	30	14	8	0	\$1,240,598	\$62,030	\$1,302,628	\$248,120	\$124,060	\$1,612,800
PN6B	3040	24	16	10	0	\$1,341,120	\$67,056	\$1,408,176	\$268,224	\$134,112	\$1,743,500
PN22A	340	36	2	1	0	\$167,040	\$8,352	\$175,392	\$33,408	\$16,704	\$217,200
PN4A	640	24	4	2	0	\$287,120	\$14,356	\$301,476	\$57,424	\$28,712	\$373,300
PN4B	800	24	5	2	0	\$353,700	\$17,685	\$371,385	\$70,740	\$35,370	\$459,800
PN21	1240	18	7	4	0	\$496,060	\$24,803	\$520,863	\$99,212	\$49,606	\$644,900

APPENDIX C
WELL PROTECTION ZONE

TECHNICAL MEMORANDUM

TO: Chris Tschirki, Orem Public Works Director
COPIES: Reed Price, Orem Maintenance Division Manager
FROM: Roland Rocha, PE
DATE: 4/9/2021
SUBJECT: Storm Water Improvements for Well Protection
JOB NO.: Orem: A-2020-0126/BCA: 374-20-01-03

INTRODUCTION AND BACKGROUND

Newly revised well protection zones surrounding Orem's potable wells have been delineated by Hansen, Allen, Luce and provided to Bowen, Collins, and Associates (BC&A). These zones are characterized by the time it will likely take ground-surface infiltration to reach the potable water wells. These zones are illustrated here in Exhibit 1:

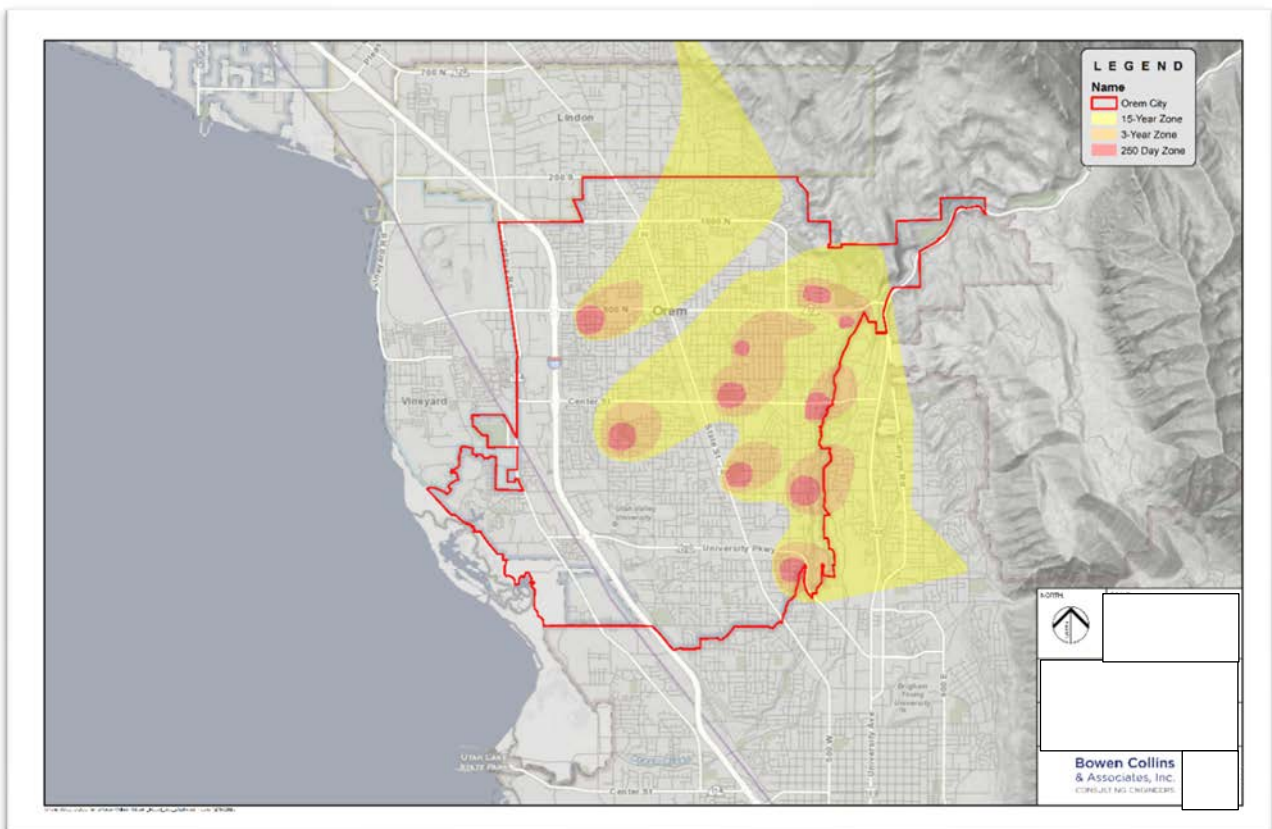


Exhibit 1. Well Protection Zones, Orem, Utah 2020.

Because groundwater infiltration of contaminant-laden storm water is a potential water quality threat to these potable wells, the City has directed BC&A to identify improvements necessary to eliminate storm water infiltration facilities within the 250-day well protection zones.

The following sections identify changes to Orem’s well protection zones and the recommended improvements. The last section of this technical memorandum addresses the potential costs for these improvements to the storm water system.

IMPROVEMENTS FOR WELL PROTECTION ON 1600 N

There is a future well to be constructed somewhere east of State Street along 1600 N. Because the exact location is presently undetermined, the corresponding protection zones have not been delineated. At the City’s direction, BC&A has established a potential 250-day protection zone around a possible location for this future well. This potential protection zone is illustrated in Exhibit 2.

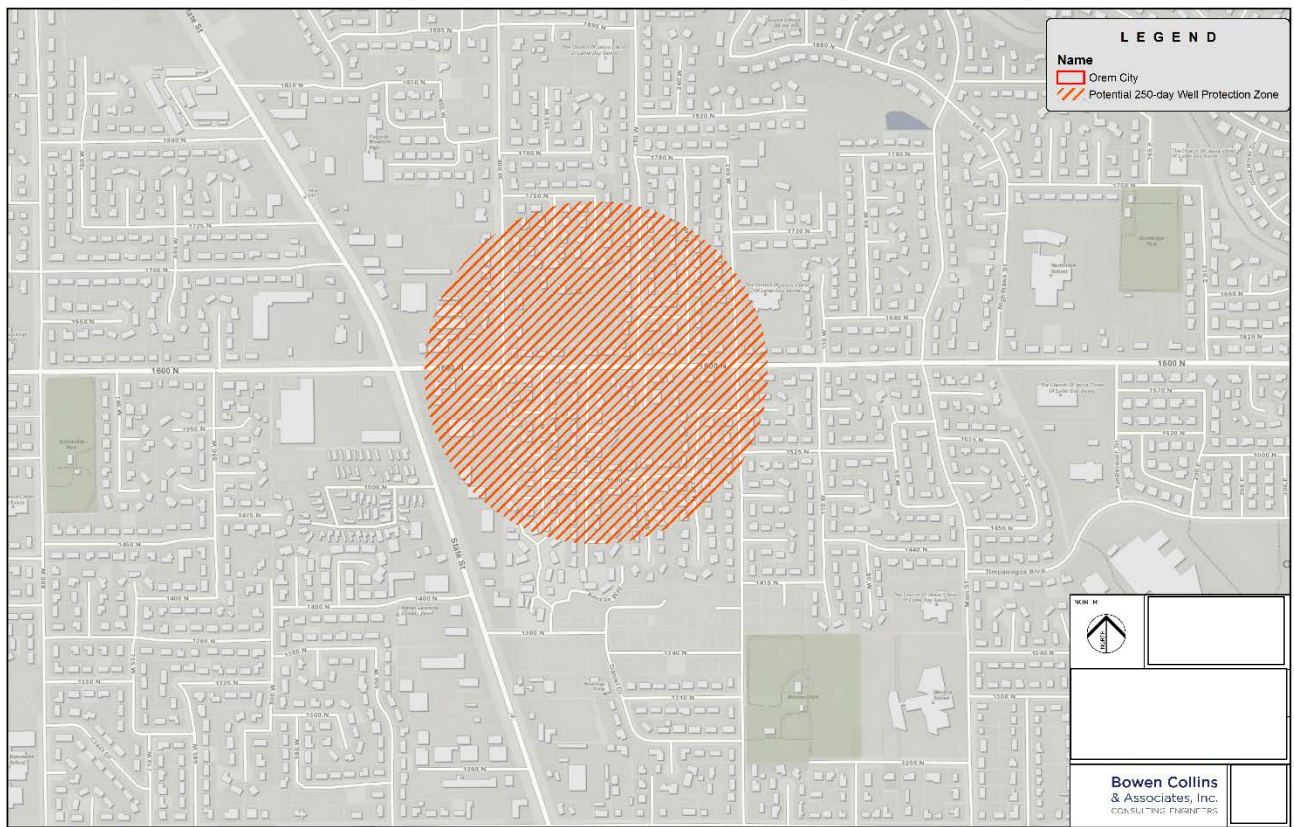


Exhibit 2. Potential Future Well Protection Zone.

There are several sumps and one unlined storm water/irrigation equalization basin within the 250-day well protection zone for the proposed future well on 1600 N. The mapped facilities are shown here in Exhibit 3.

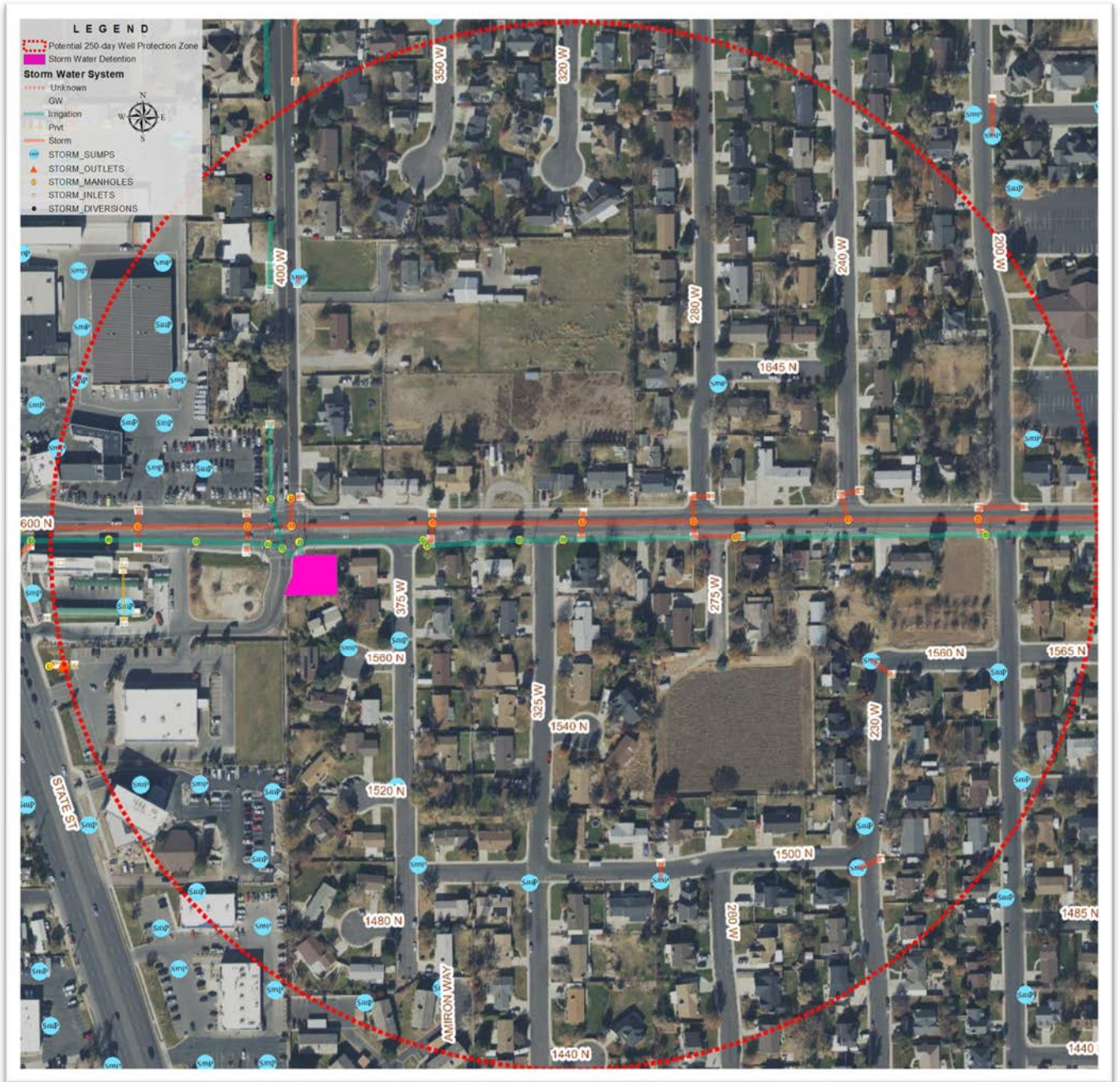


Exhibit 3. Future Well Protection Zone Storm Infrastructure.

There is an existing 48-inch diameter storm water drain running east to west on 1600 N. The storm improvements for this potential well protection zone will be minimal. The grading in the area surface flows to 1600 N and the areas are divided enough (i.e. they don't all flow to one collection point) that gutter flow will probably be adequate to convey the design storm runoff to the existing 48-inch on 1600 N without overtopping and threatening property.

An exception to this general pattern is found at the corner of 230 W and 1560 N. This is a local low spot with an existing sump and no outlet. There is a small area immediately adjacent to the sump. The approximate 1.3 acre area draining to this sump is shown here in Exhibit 4.



Exhibit 4. Sump in Low Spot on 230 W.

An estimated peak flow 0.7 cfs is likely to be generated from this area from the 10-year design event. The volume will be relatively small, but because of the local grading, this spot will collect runoff at the existing sump site. When the sump is filled, the water will stagnate and become a nuisance until it evaporates. The mere existence of a sump in this area indicates there is likely enough runoff prone to collect here on a regular basis to warrant some minor improvements if the sump is eliminated.

Approximately 500-feet of 8-inch diameter pipe is recommended to carry the peak flow at the available 0.007 ft/ft slope from the existing sump location to the existing storm water inlet at the corner of 200 W and 1600 N. In practice, the smallest recommended diameter for storm water pipe is 12-inches. This project will be labeled as WPZ1 and the opinion of cost for this improvement will be based on a 12-inch diameter pipe. The proposed alignment is shown here:



Exhibit 5. Proposed Local Improvement to Replace Sump

For this master plan the City has identified parcel number 490320014 at the intersection of 400 W as the possible location for the future well. This site is shown in Exhibit 6 with the well location marked with a green dot.

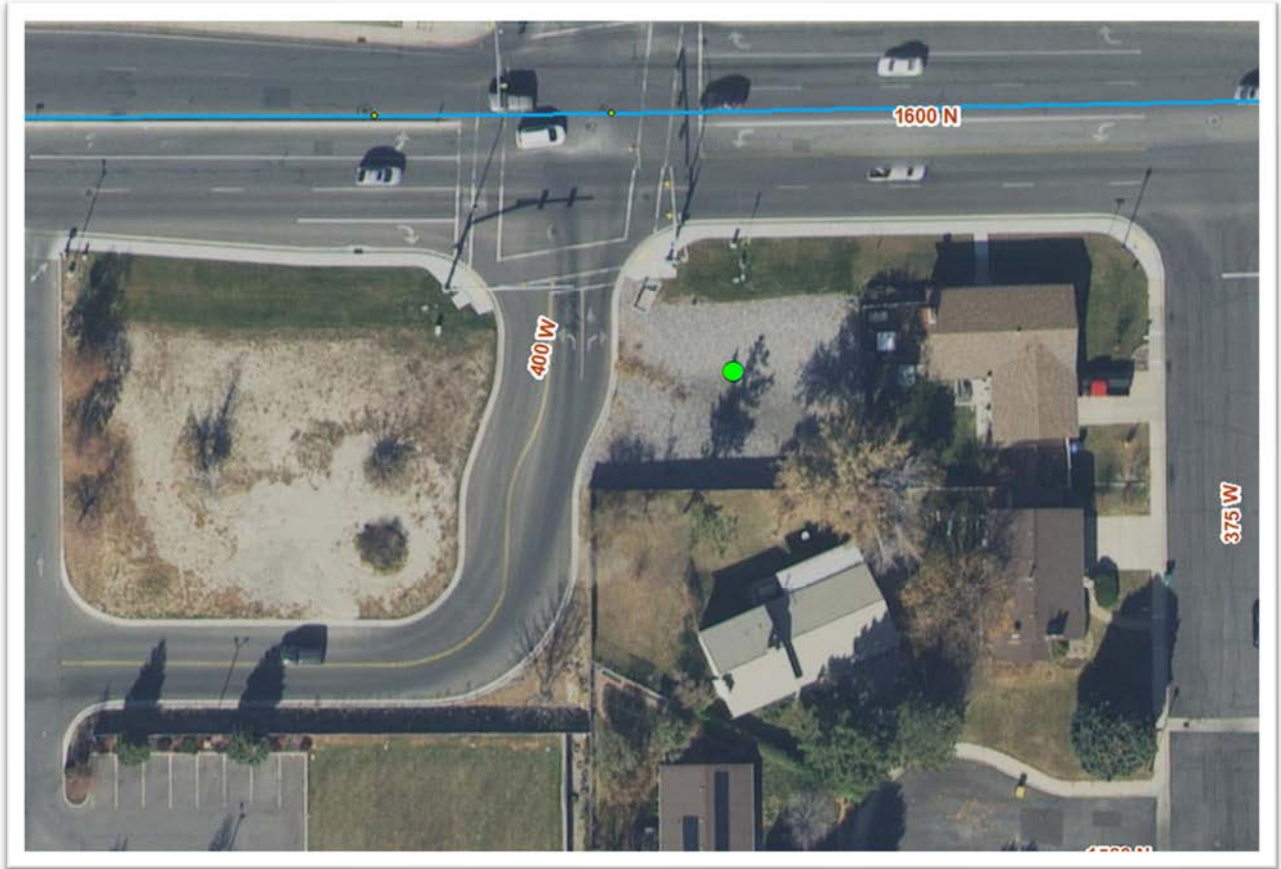


Exhibit 6. Possible Future Well Location on 1600 N.

There is currently gravel-covered storm water detention and irrigation equalization pond on the parcel. Based on the available utility mapping provided by the City, it does not appear to be a significant component of the storm water system and may only serve as storm water detention by nature of its lower elevation and a narrow curb opening on the west border of the pond.

The facility's value to the irrigation system has not been evaluated as part of this study and it may be possible to abandon the facility or replace it elsewhere in the irrigation system. Regardless, the City currently plans to keep this pond as an active part of the infrastructure. Exhibit 7 shows the current street-level view of the proposed site.



Exhibit 7. Street-level View of Possible Well Site.

If the function of this equalization pond is deemed necessary to keep, then it is recommended that an underground, double-lined, non-percolating container be installed since this irrigation storage facility/stormwater detention facility would be located immediately over the future well. If the existing facility can be lined to prevent percolation, that may be an alternative lower cost option.

This replacement underground facility can be on the same site or in the adjacent roadway 400 W. The container should be designed to at least match the existing volume (including what is currently lost to infiltration and evaporation), provide settling and filtering, and be accessible for inspection and maintenance. A large underground concrete storage vault or series of interconnected precast vaults will likely provide the best long-term value.

The recommended size of the box cannot be determined at this point because the infiltration capacity of this site is unknown. However, to replace the physical volume above ground, it would need to be at least 90,000 gallons.

IMPROVEMENTS NEAR OREM BOULEVARD AND STATE STREET

The area between Orem Blvd and State St just south of 400 S and north of 800 S was previously outside the safe sump zone (SSZ). With recent modifications to the well protection zones, this area is now in the SSZ. The resources that may have been planned to fill the sumps in this area can now be diverted to other projects. This boundary adjustment doesn't change the other planned improvements in the area (PS62, PS92, PS28) because they are still needed for other purposes.

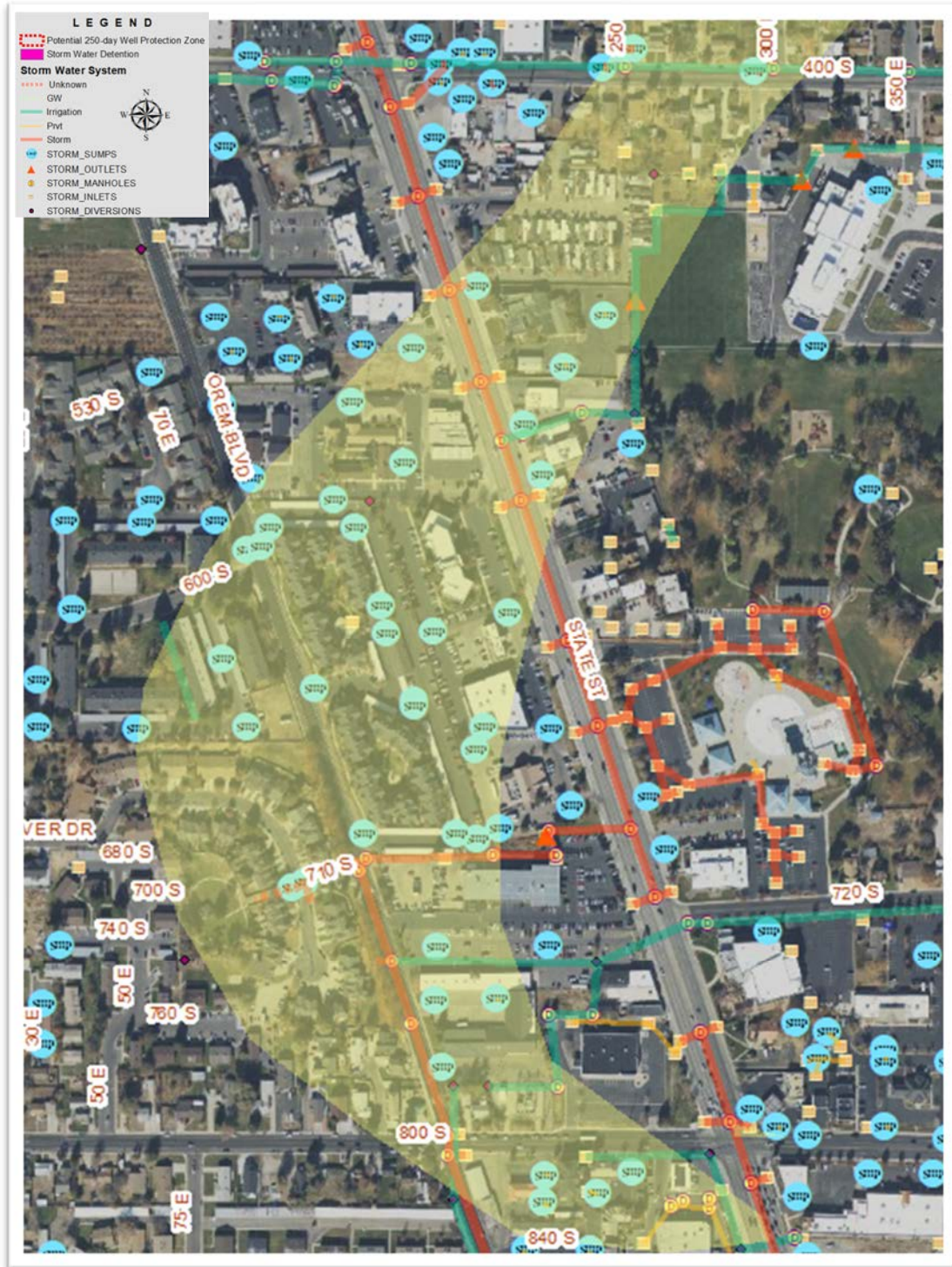


Exhibit 8. New Area Added to the Safe Sump Zone.

IMPROVEMENTS NEAR OREM COMMUNITY PARK

A well planned near the south end of Community Park will require elimination of several sumps. Because of the flat grade in the area, piping will be required to convey runoff away from the well

protection zone. As with all well protection zone improvements, it is assumed that sumps and pipelines will keep runoff from flowing over into the protection zone. During the design of these projects, that would be an important assumption to confirm.

The recommended improvements for Community Park involve long runs of larger diameter pipes and will be a fairly large project. For this reason, it has been included in the master plan's CIP as project WPZ6. The project has been broken into parts A and B for budget phasing.

With varying times to concentration and attenuation through the drains, the model predicts the combined peak from this area to be 32 cfs. The total runoff volume from the design event is 1.1 ac-ft.

There is not a nearby network, but there is a possibility that the runoff be routed to a new retention site outside the WPZ and the SSZ. Assuming a 5-ft depth for the retention pond, the storage component would require a 0.22-acre footprint. With ancillary landed need for maintenance, access, and basic landscaping, a 0.35-acre site is the minimum required footprint.

Parcel ID 180290033 may be a candidate, but the soil would need to be tested for infiltration capacity. This is recommended for evaluation during design. The master planned improvement assumes retention is not an option so the pipeline would need to extend to 800 South and connect with improvement PS35. The proposed alignment of the improvements is illustrated in Exhibit 9.



Exhibit 9. Community Park Improvements (light blue lines)

IMPROVEMENTS NEAR WELL 6

Another area affected by the well protection zones is the area around well 6 north of 800 N. The affected basin is highlighted in Exhibit 10.

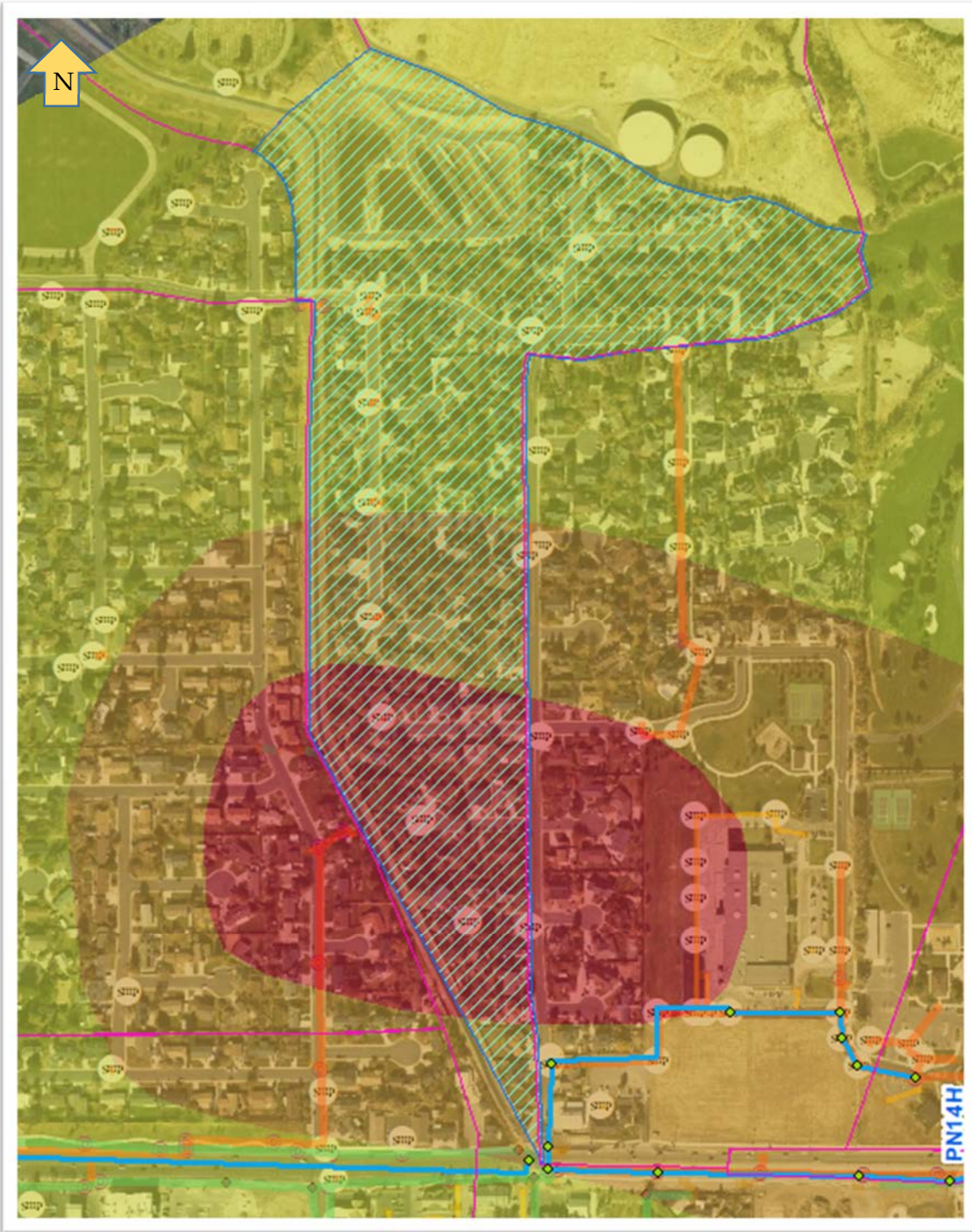


Exhibit 10. Well 6 Protection Zone.

The sumps in the 250-day zone will need to be abandoned. Generally, the drainage will run south to 800 N. However, there are three cul-de-sacs in the 250-day zone that slope toward the dead-end. These will need to have adverse-to-ground graded pipe installed and run to the nearest storm water system connection. These cul-de-sacs are 1010 N, 965 N, and 920 N as shown in Exhibit 11.

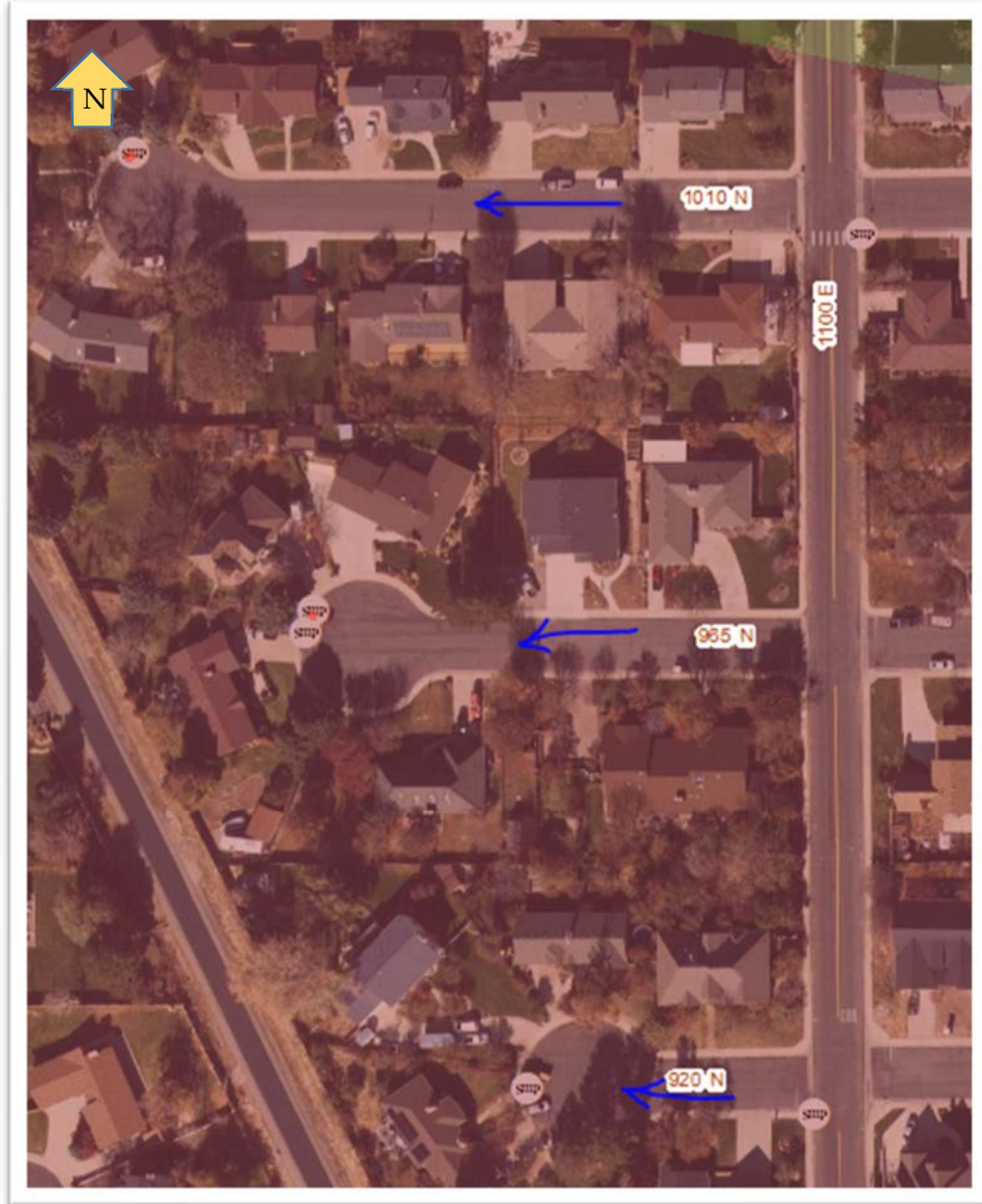


Exhibit 11. Low Point Cul-de-sacs.

The contributing area to these sumps is approximately 9 acres of the total 51 acres that makes up sub catchment N5. The overall sub catchment has a peak flow of 21.3 cfs or 0.414 cfs/ac. Because the sub catchment is homogenous, it can be assumed that the peak flow from this smaller portion is approximately 3.7 cfs. To connect to the existing storm drain system, the available slope is somewhat fixed at 0.0027 ft/ft. At that slope, 1,020 feet of an 18-inch pipe will

be necessary south of 965 N. Pipe diameters of 12-inch will likely be adequate for everything upstream of that. The alignments are shown in Exhibit 12.



Exhibit 12. Well Protection Improvements on 1100 E (light blue lines)

IMPROVEMENTS NEAR PALISADES DRIVE

The 250-day WPZ near 750 N and N Palisades Dr also has sumps sitting in low spots. When the sumps are filled, the runoff will pond in these areas and become a nuisance until they evaporate. In larger storm events, these areas will pond until they flood the surrounding

businesses. The general flow pattern is shown by the blue arrows in Exhibits 12 and 13. These sumps are on private property, but they affect the City well.



Exhibit 13. Sumps in the 250-day Zone near Palisades Drive.



Exhibit 14. Sumps in the 250-day Zone near Palisades Drive.

The contributing area, shown in Exhibit 14, is approximately 13.5 acres. The sub catchment is measured to be 53% impervious with 75% of the impervious area being directly connected. The model predicts a peak runoff of 13 cfs or about 0.96 cfs/ac and total runoff volume of 0.5 ac-ft for the design storm event.



Exhibit 15. Contributing Area.

Pipe that is adverse to ground slope will need to be installed to drain these low-lying areas in the private parking lots. The pipe will be too deep to daylight once it reaches N Palisades Drive, so a new storm drain will need to be constructed to run south on N Palisades Drive.

The recommend pipe sizes are a 21-inch diameter pipe down Palisades Drive with 12-inch diameter collectors on the two private properties. Everything else in the area will drain over the surface and through the gutters to a system entry point.

Two potential options for storm water disposal from this area are a large roadway sump outside the WPZ, or a long run of pipe to the south to connect with the existing system.

The potential Palisades Drive roadway sump would need to have a floor approximately 10-ft below grade, be traffic rated, and be accessible for maintenance. The existing water, sewer, and other utilities in the roadway would need to be shifted to one side. With a potential water depth of 5 feet in the sump after a design storm event, and a 25-ft interior width, the sump would need to be about 175 feet long. Among other things, the viability of the roadway sump would also depend on the infiltration capacity of the soil and the groundwater conditions. A rough estimate of this project would put the total cost at about \$850,000. This is more than double of what it would likely cost to run the pipeline further south.

The recommended alternative is to extend the 21-inch pipeline another 1,350 feet south on N. Palisades Dr to connect to the existing storm drain system. In roughly 700 feet downstream of this potential connection point, this section of the existing storm drain system connects to master plan improvement PS58D. If the existing 21-inch diameter irrigation drain on 1200 E cannot be used, the new storm water pipeline will need to be extended another 700 feet to parallel the irrigation drain on 1200 E. Because this is a larger diameter and longer run project than other well protection improvements, this project is included in the master plan CIP as WPZ7. The improvements are summarized in Exhibit 16.

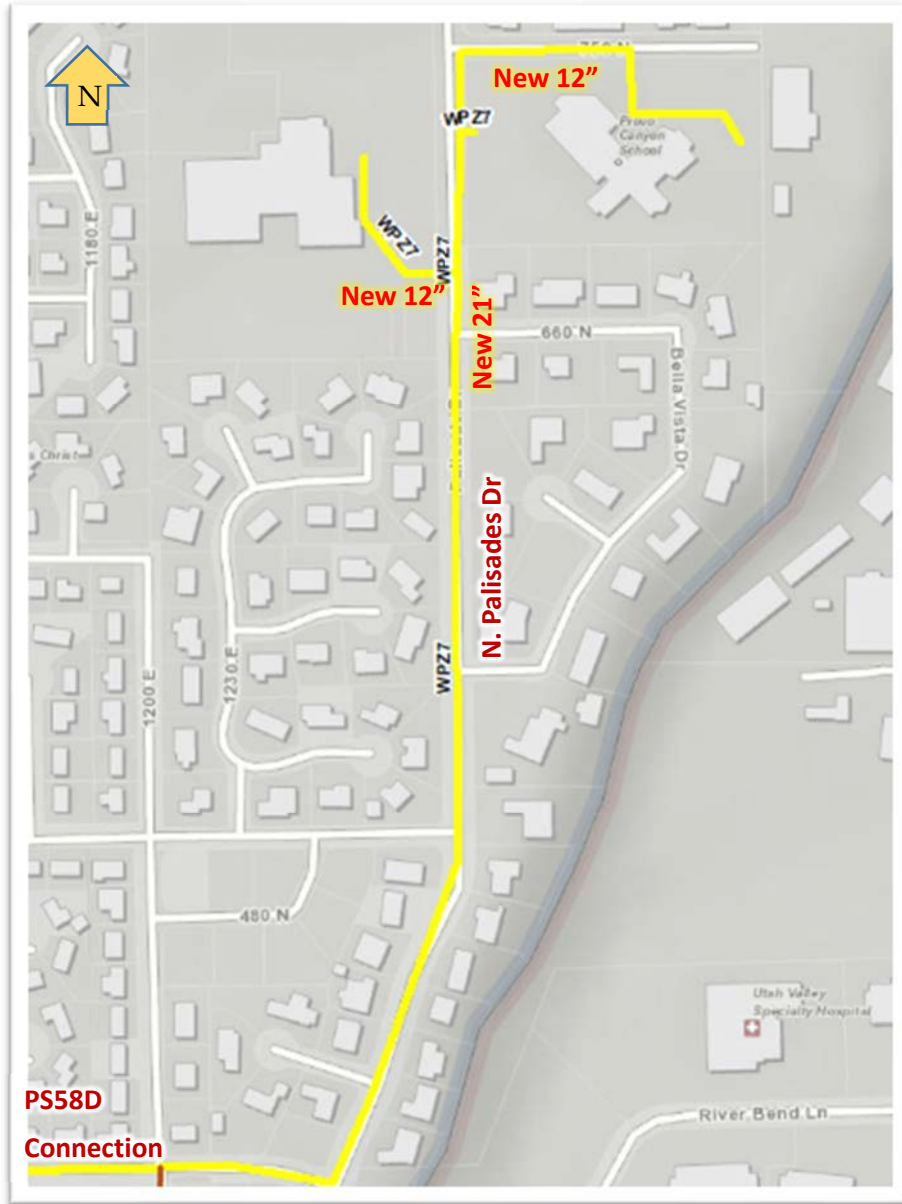


Exhibit 16. N Palisades Dr Improvements.

IMPROVEMENTS NEAR 500 N AND 400 E

The 250-day WPZ near 500 N and 400 E also has sumps at the dead end of two cul-de-sacs (E 450 N and North Lupe Circle). When the sumps are filled, the runoff will pond in these areas and become a nuisance or may damage property. The area in question and general drainage direction to the existing sumps is shown in Exhibit 17.



Exhibit 17. Low-lying sumps near 400 E and 500 N.

The new storm drains in each of the cul-de-sacs will need to be installed at a grade adverse to the existing ground slope. The distance is short, so it not anticipated to be significantly deeper than typical storm water pipe installations. Existing grading on the main roads makes it so N. Lupe Circle could be piped to 500 N and then turn west to connect into the recently completed storm water master plan project PN16B. This project will extend from the upstream of PN16B and will be called WPZ4.

Drainage from E 450 N can be piped to the existing storm drain on 400 E which runs south to connect with the other leg of the previously master planned project PN16B on E 400 N. The diameter of the existing storm drain on 400 E is unknown. It is assumed it is large enough to carry the small amount of runoff from E 450 N. This assumption will need to be verified during design. This project will be part of WPZ4.

These will both connect to the existing storm water main on 400 E and drain south to 400 N. The improvements are in red and labeled in Exhibit 18 shown here.

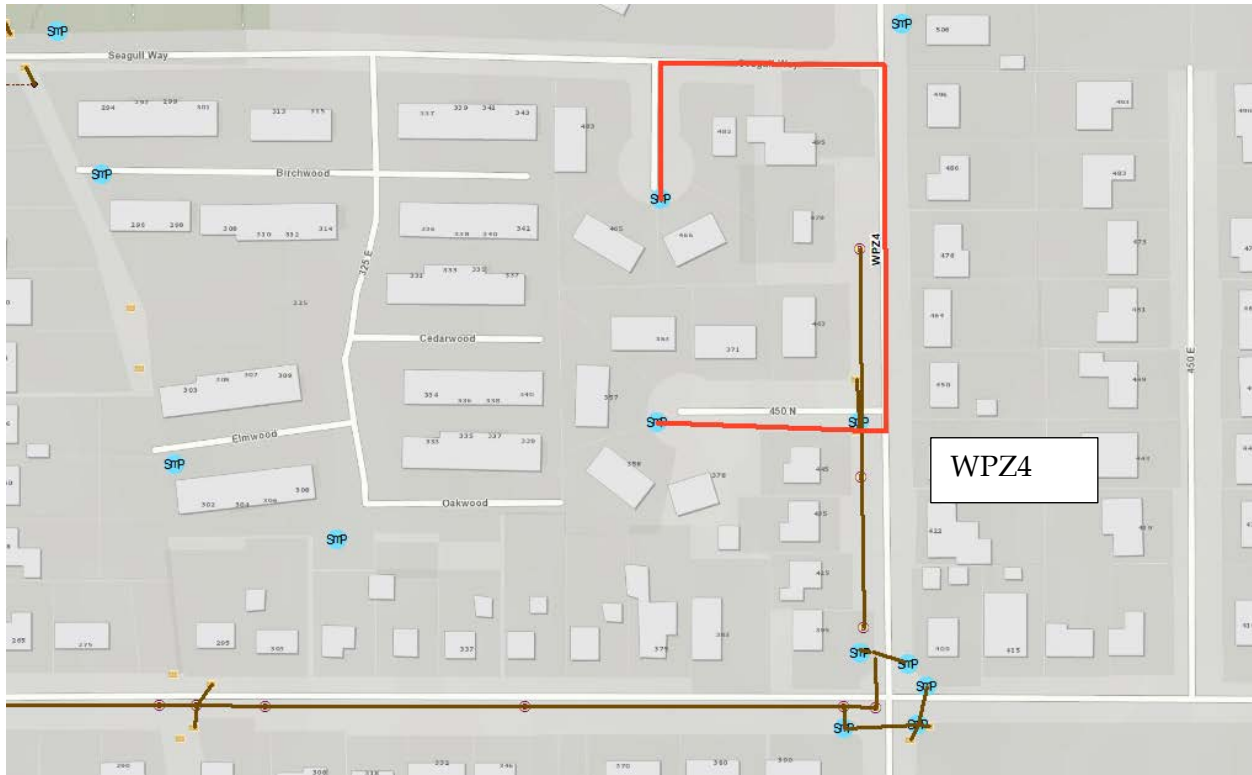


Exhibit 18. WPZ Improvements Near 400 E and 500 N.

IMPROVEMENTS NEAR 800 S AND CARTERVILLE ROAD

Due to some changes to related projects in the area, new alternatives have been developed to remove sumps from the 250-day WPZ near 800 S and Carterville Road. also has sumps at the dead end of two cul-de-sacs (E 450 N and North Lupe Circle). When the sumps are filled, the runoff will pond in these areas and become a nuisance or may damage property. The area in question and general drainage direction to the existing sumps is shown in Exhibit 19.

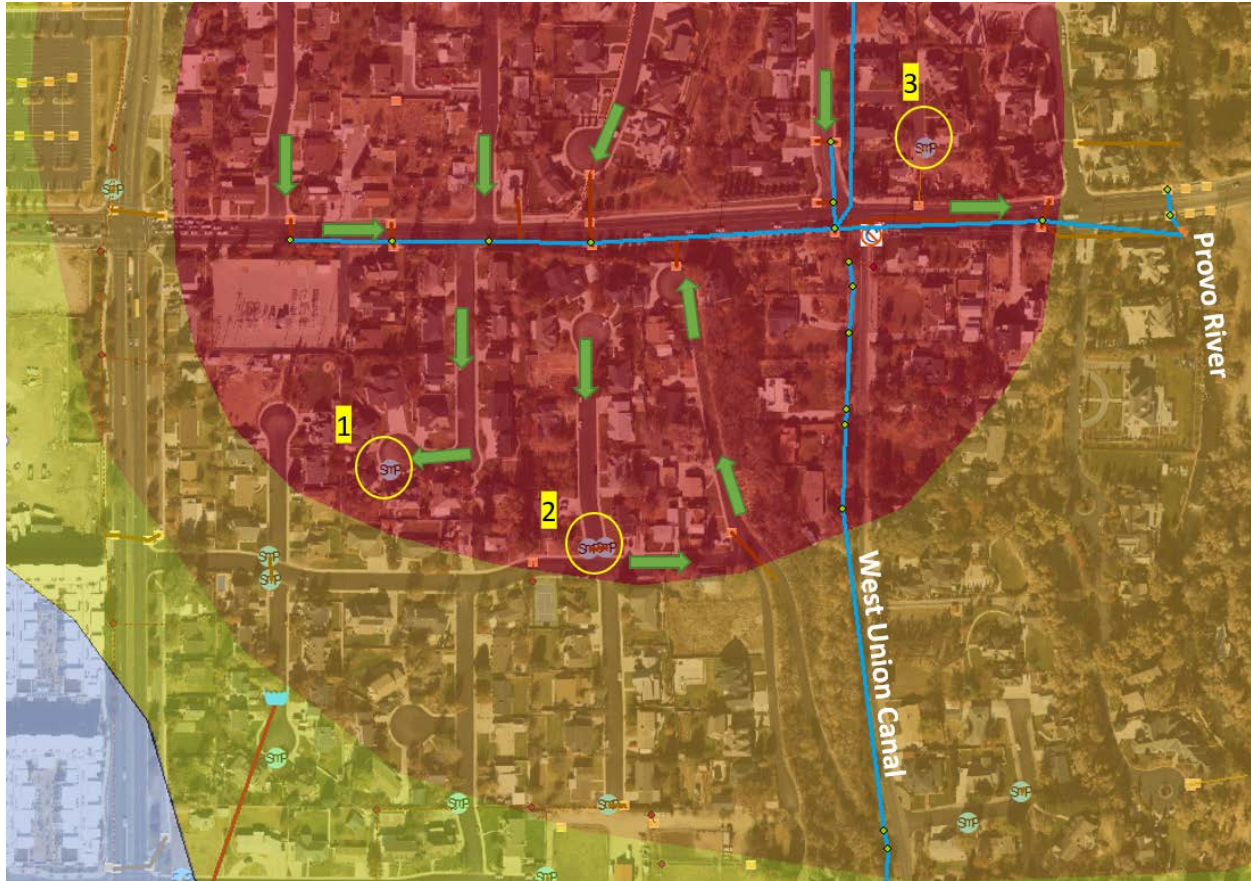


Exhibit 19. WPZ Improvements Near 800 S. and Carterville Road.

The three sumps in the 250-day zone are circled in yellow and numbered. The green arrows show direction of overland flow based on ground elevation contours.

Sump 1 is at the dead-end of a cul-de-sac. It will need to be piped north (590 ft of 12" pipe) against 3 ft of grade to drop into the existing 24" line on 800 S. This will be WPZ8.

Sump 2 can be removed and runoff will gutter flow to east and then north to get picked up by the inlet at the dead-end of 1000 E which is already connected to the 24" line on 800 S.

Sump 3 is at the dead-end of a cul-de-sac. It will need to be piped one of two ways. Ideally it could go south to 800 S. There is already a private line connecting the sump to an inlet on 800 S. This private line may be sloped the wrong way. It would need to be regraded. The recorded inlet and sump invert elevations support flow from north to south. If this is not feasible, then a new line will need to go north from the sump, then west (230 ft of 12" pipe) against 2 ft of grade to connect with the existing line on Carterville Rd that drains south the 800 S and then to the river. The elevation difference is small and there may need to be some adjustments to existing facilities to make this options work. This project will be labeled WPZ9.

Exhibit 20 is a detail of sump 3. The contributing inlet on 800 S could be replaced with a daylight outlet to the gutter embedded in the face of the curb. Runoff would gutter flow east along 800 S. to get picked up by the next inlet about 250 ft down the road, then to Provo River.

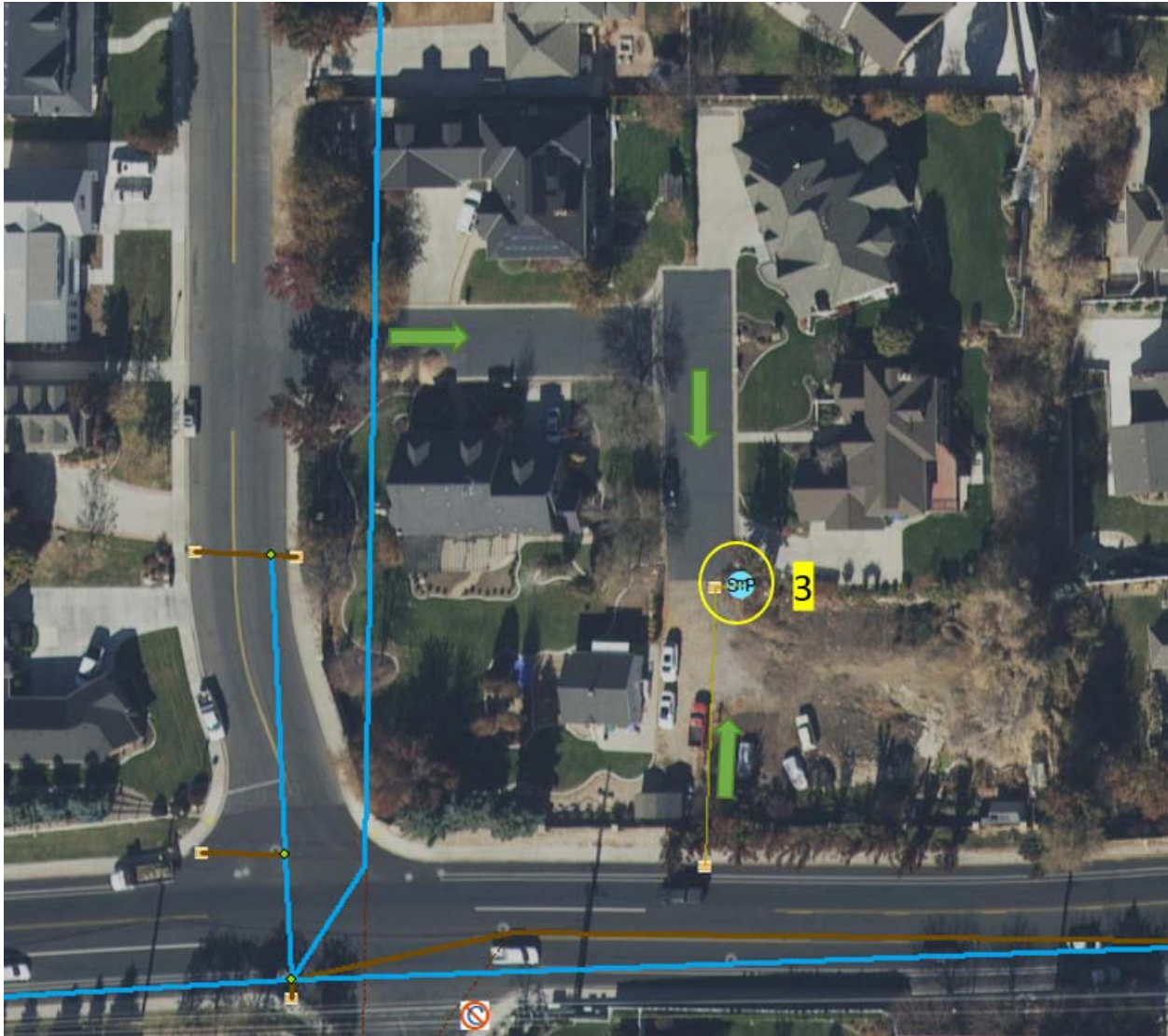


Exhibit 20. Detail of Sump 3 Area.

POTENTIAL COSTS OF PROPOSED IMPROVEMENTS

Because the storm water improvements required to protect the groundwater quality are a high priority to the City, their costs and details are included in the Storm Water Master Plan CIP even if their costs are relatively minor.

Actual project costs may be higher or lower, depending on details discovered during project design. Costs will also vary by market conditions and material prices at the time of bidding. Table 1 provides a planning-level opinion of probable cost that includes 20% contingency, engineering, administrative, permitting, environmental and legal fees.

**Table 1. Opinion of Probable Cost for Storm Water System Improvements
For Drinking Water Protection to be Added to the CIP**

Project ID	Project	OPC in 2020
WPZ1	1560 N Sump Drain	\$160,000
WPZ2	Underground Detention/ Retention Near 1600 N and 400 W	\$664,600
WPZ3	1101 E Near Well 6	\$381,800
WPZ4	N. Lupe Circle and 450 N to 400 E	\$199,700
WPZ6A and 6B	Community Park	\$2.3 M
WPZ7	N. Palisades Drive	\$1.2 M
WPZ8	870/890 E to 800 S.	\$168,200
WPZ9	760 S to 800 S.	\$42,600
	Total	\$5.1 M

APPENDIX D
CANAL ABANDONMENT PROJECTS

TECHNICAL MEMORANDUM

TO: Chris Tschirki, Orem Public Works Director
COPIES: Reed Price, Orem Maintenance Division Manager
FROM: Andrew McKinnon, Roland Rocha
DATE: May 1, 2021
SUBJECT: West Smith Ditch / West Union Canal Abandonment Description
JOB NO.: Orem: A-2020-0126/BCA: 374-20-01-03

INTRODUCTION AND BACKGROUND

The West Smith Ditch is in the process of selling its remaining shares to Central Utah Water Conservancy District or Jordan Valley Water Conservancy District. The West Union Canal Company continues to operate its canal facilities, but Orem City has assumed that it too may eventually discontinue irrigation in the future. As a result, the City has developed plans to accommodate stormwater that historically discharged to the canal. The purpose of the technical memorandum is to provide additional details on how to remove stormwater from the canals.

POINTS OF INTEREST

The attached figures following this page include points of interest along the canals where stormwater historically or currently enters the canals with a brief description of required improvements or changes. The Canal is symbolized with various colors to show the City's long term plan for the canal.

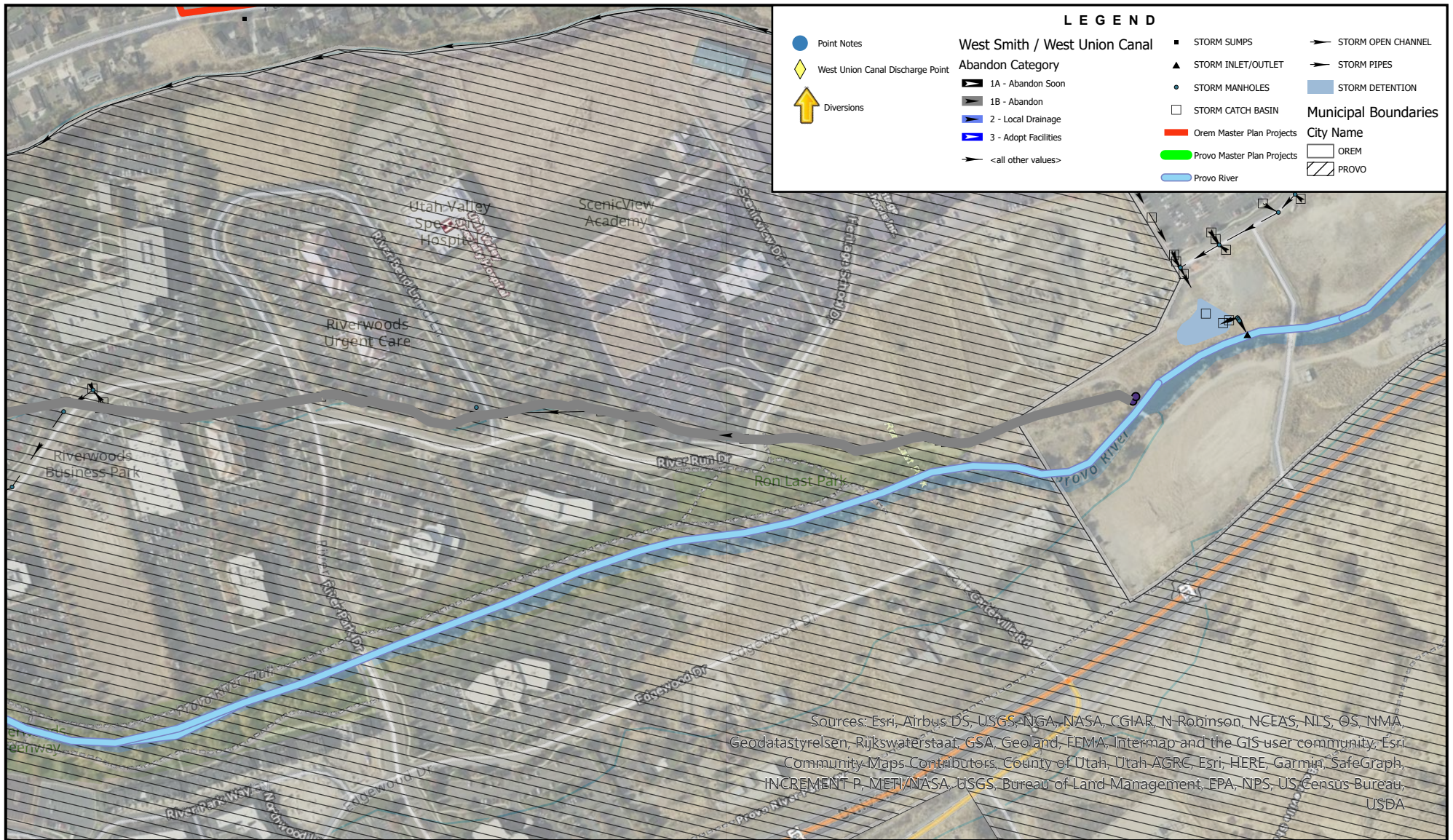
Black – The canal line in black show parts of the canal that the City anticipates will be discontinued in the next year or two.

Gray – The canal line in grey indicate areas of the canal that the City anticipates will eventually be discontinued for irrigation purposes and will not have stormwater conveyed through it long term.

Light Blue – The canal line in light blue indicates “local drainage” are areas that convey private stormwater that the City has no plans to inspect or maintain and contribute to local infiltration facilities or private stormwater concerns.

Dark Blue – The areas in dark blue indicates parts of the canal that the City anticipates will continue to convey public stormwater and that the City intends to inspect and maintain once irrigation operations cease.

A narrative is included after the attached figures that provides additional discussion of each canal connection point with a description of the connection and methods to resolve stormwater connection concerns.



Points Project

None Provo City



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

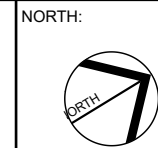
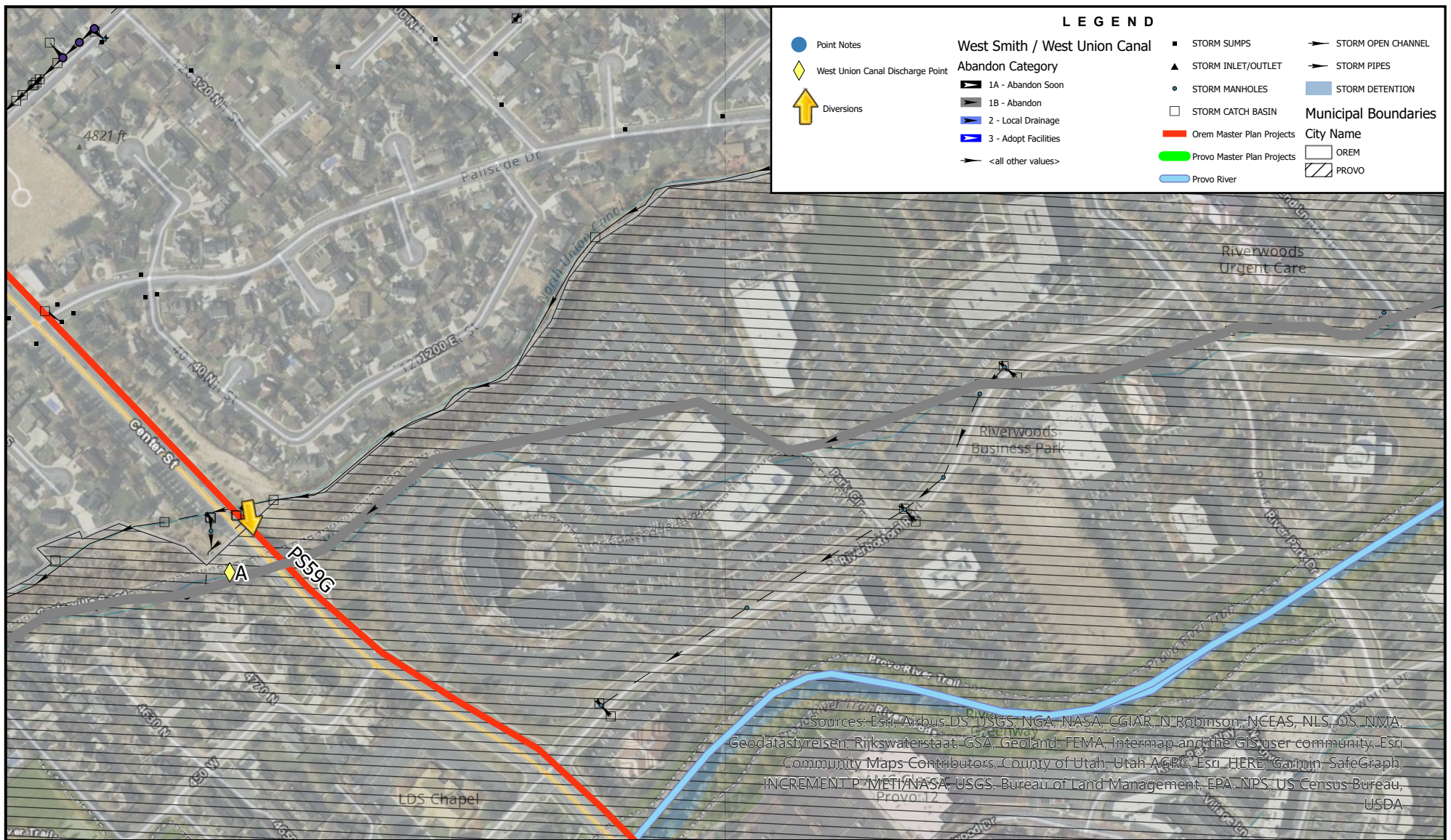


FIGURE NO.
P1



Points Project

None Provo City



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

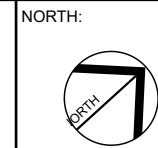
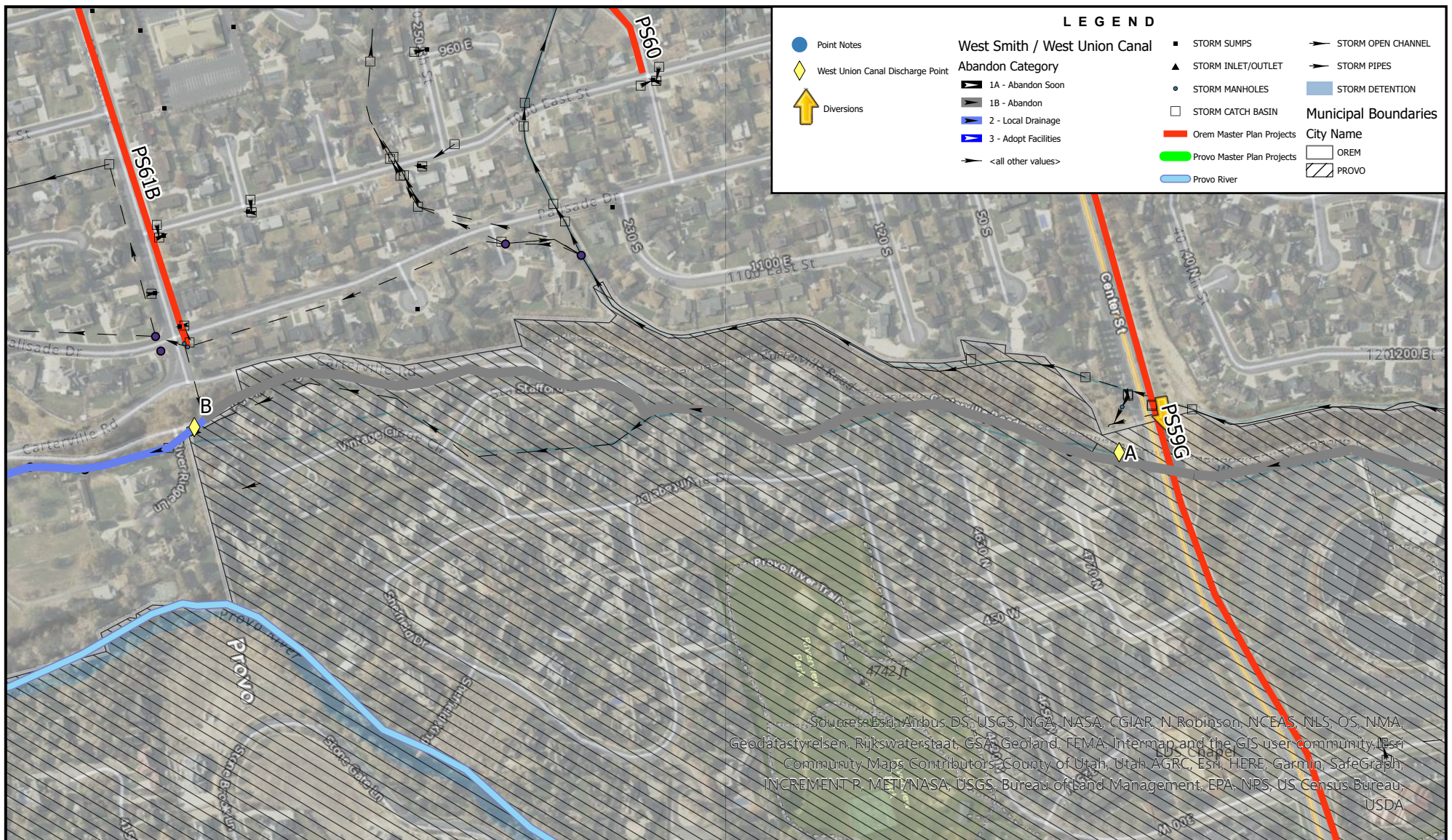


FIGURE NO.
P2



Points Project

- A Project No. PS59G - 1400 ft of Pipe to Provo River
- B Project PS61B



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

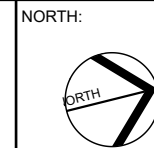
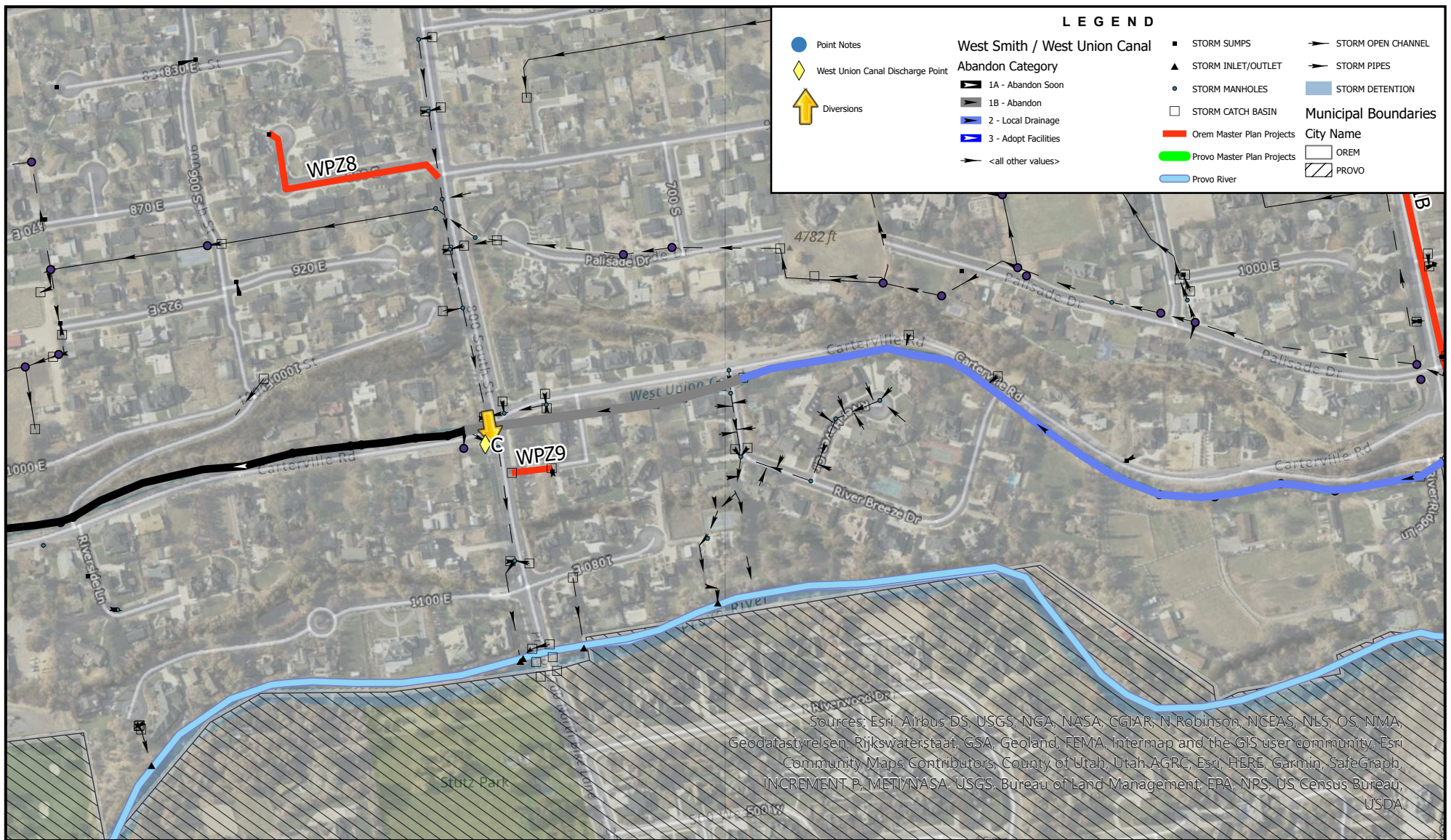


FIGURE NO.
P3



Points Project

C Divert flow east through existing SD to Provo River



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

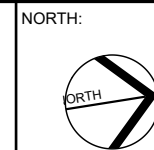
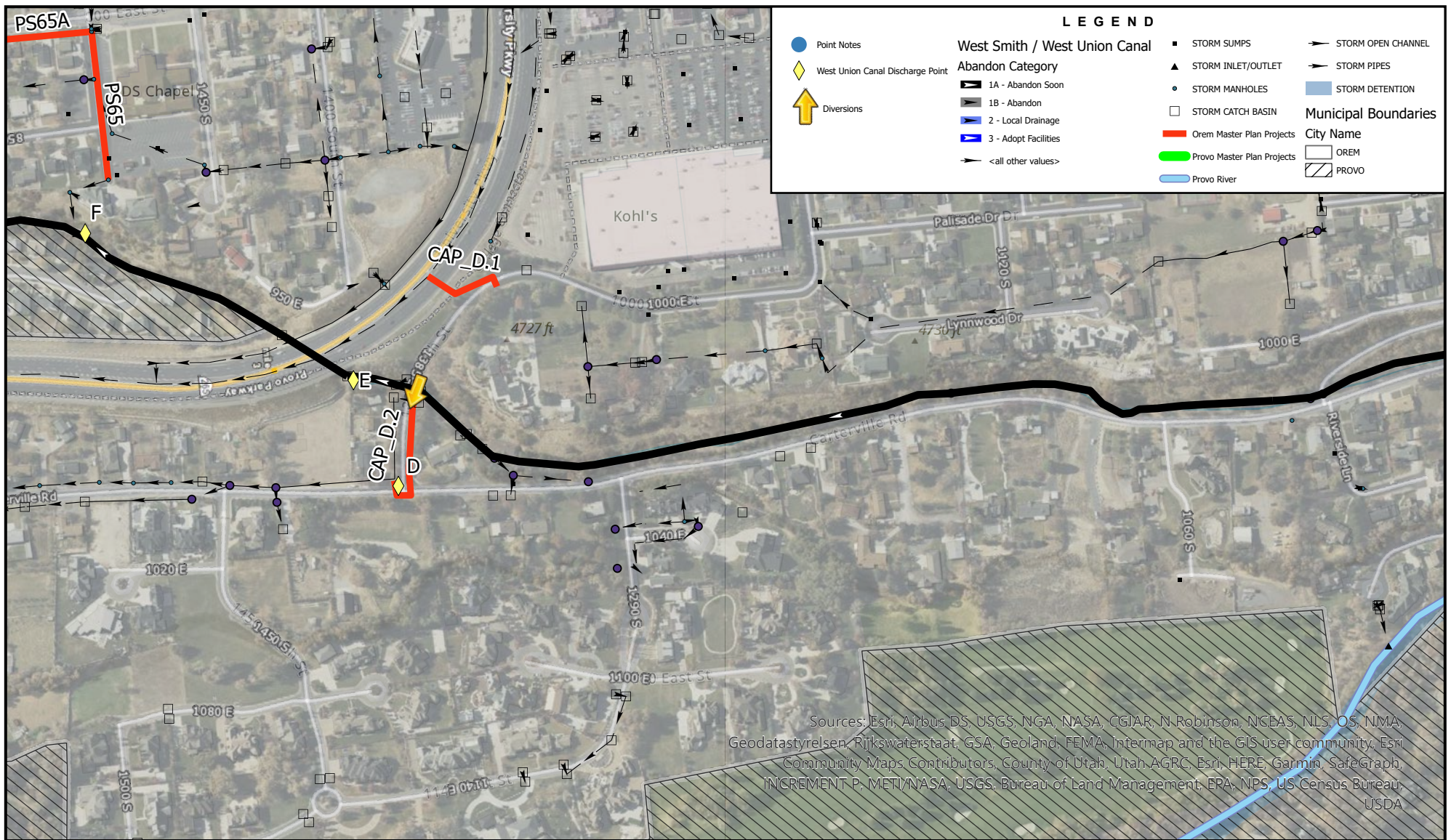


FIGURE NO.
P4



Points Project

- D Pipe to Univ. Pkwy & Pipe to additional sumps
- E BRT Project Eliminated Connection



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

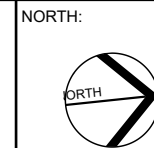
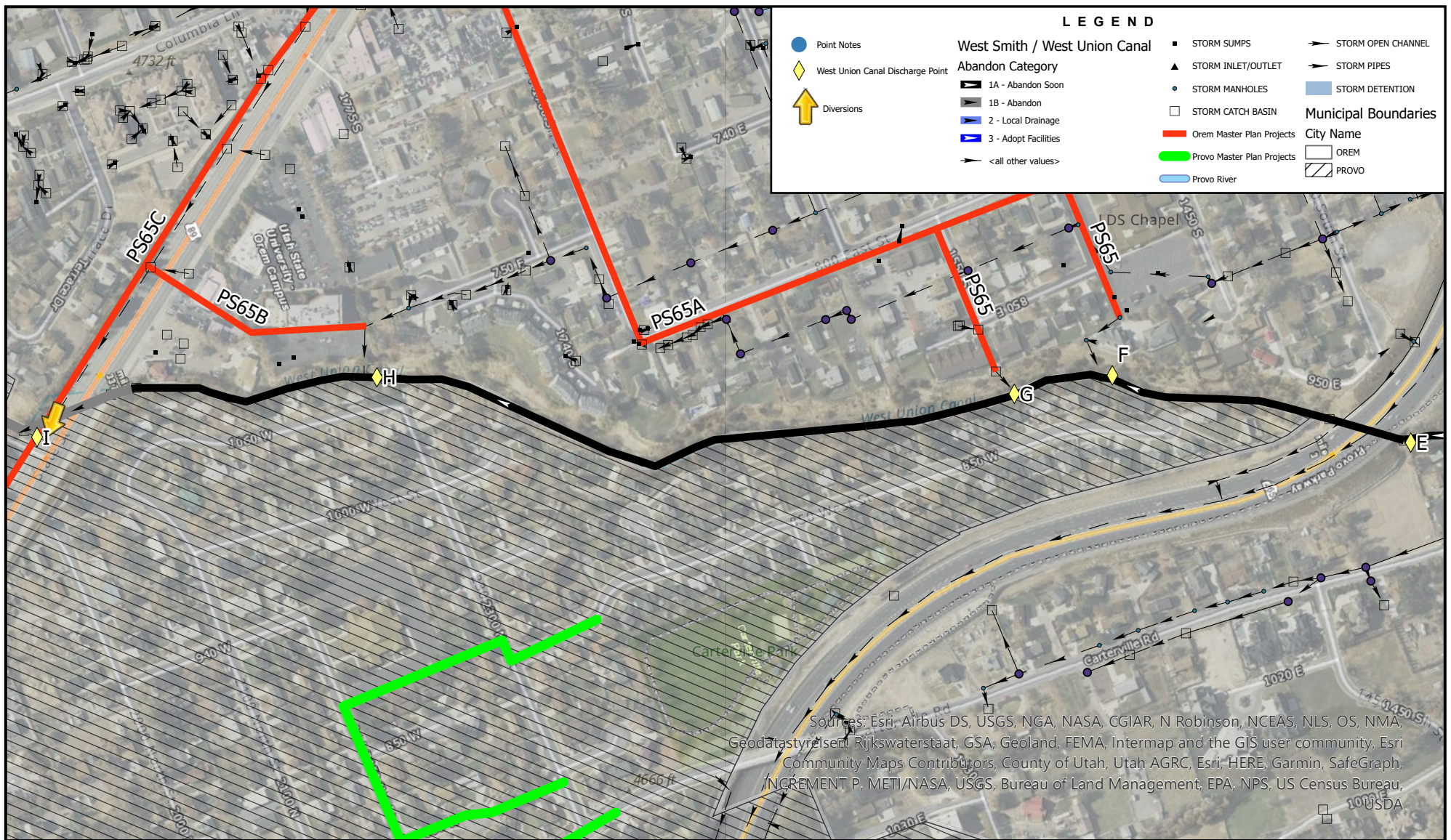


FIGURE NO.
P5



Points Project

- F Project No. PS65A, Take Well Discharge Southwest
- G Project No. PS65A, Pipe west and southwest



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

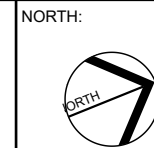
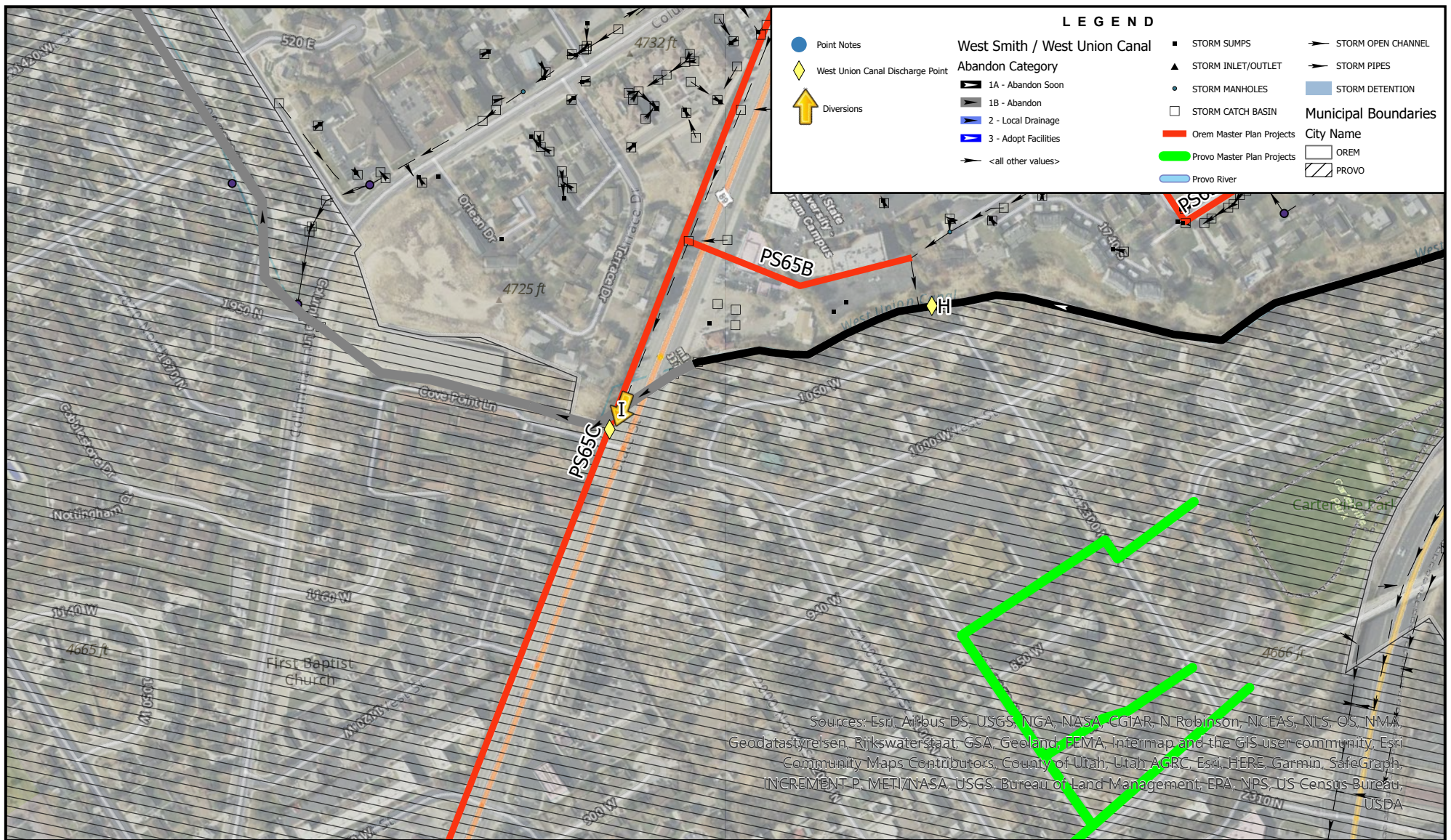


FIGURE NO.
P6



Points Project

- H Project No. PS65B - Pipe West
- I Project No. PS65C - Pipe south to Provo River



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

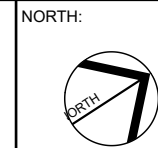
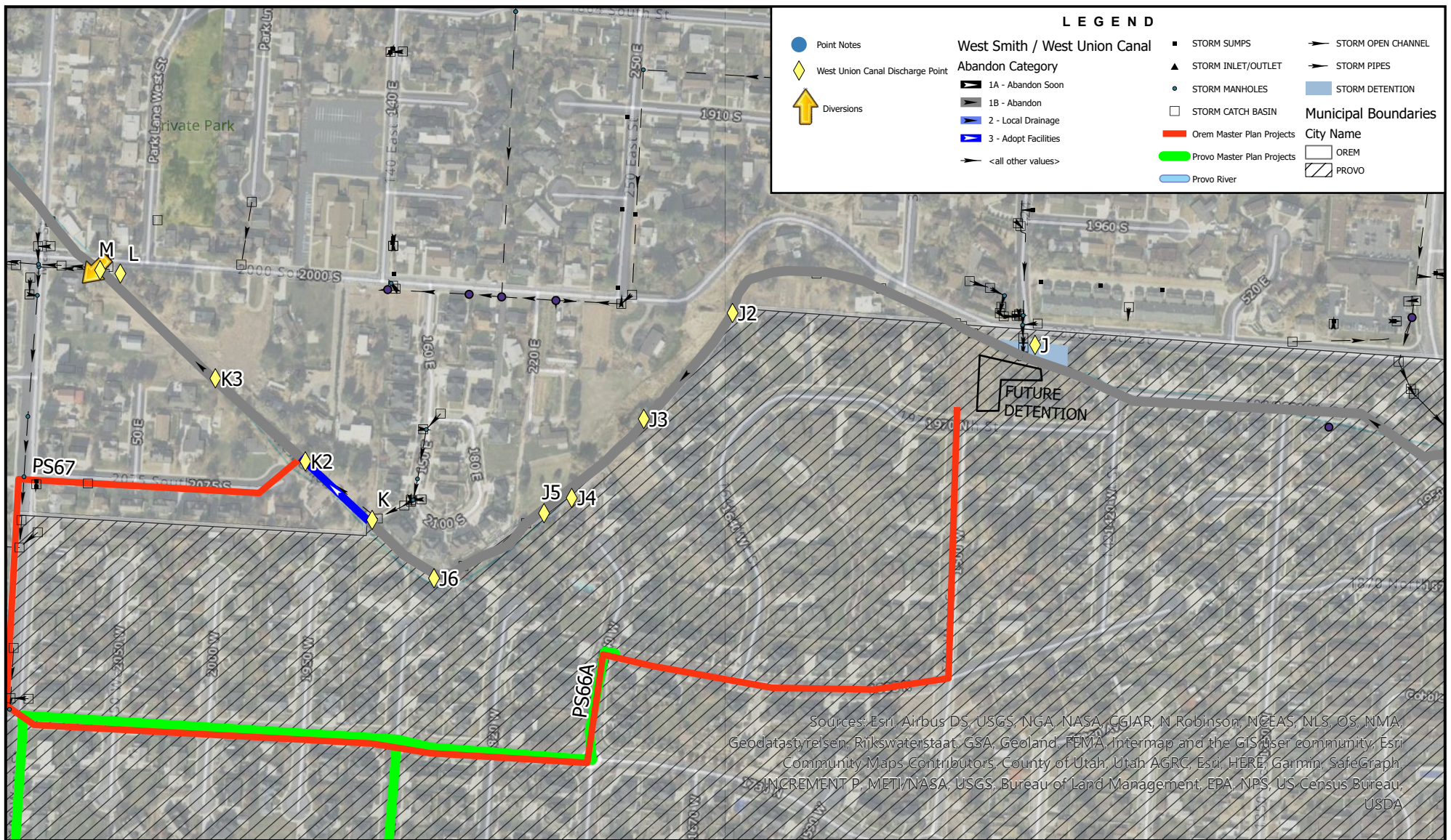


FIGURE NO.
P7



Points Project

- J Divert water to new detention basin and PS66A
- J5 consider cleanout for inspection of abandoned pipe



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

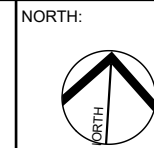


FIGURE NO.
P8



Points Project

- K consider cleanout for inspection of abandoned pipe
- K2 Divert water to PS67

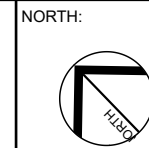
Points Project

- L Existing diversion may need modification
- M New inlets and pipe to remove drainage from canal

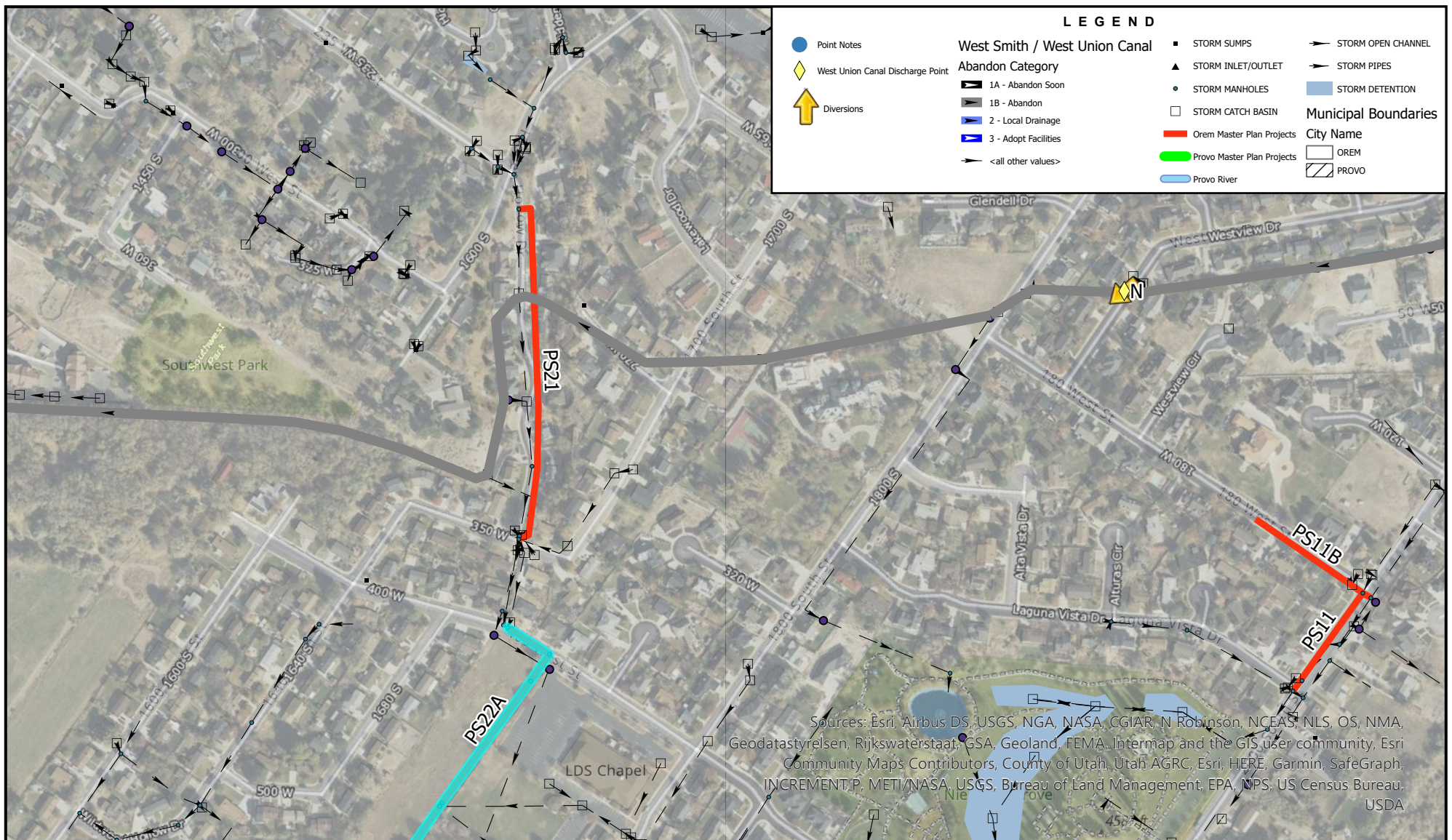


OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**



SCALE:
0 200 400
Feet
FIGURE NO.
P9



Points Project

N Plug Inlets, Surface flow to new inlets on 180W (PS11B)



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

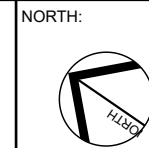
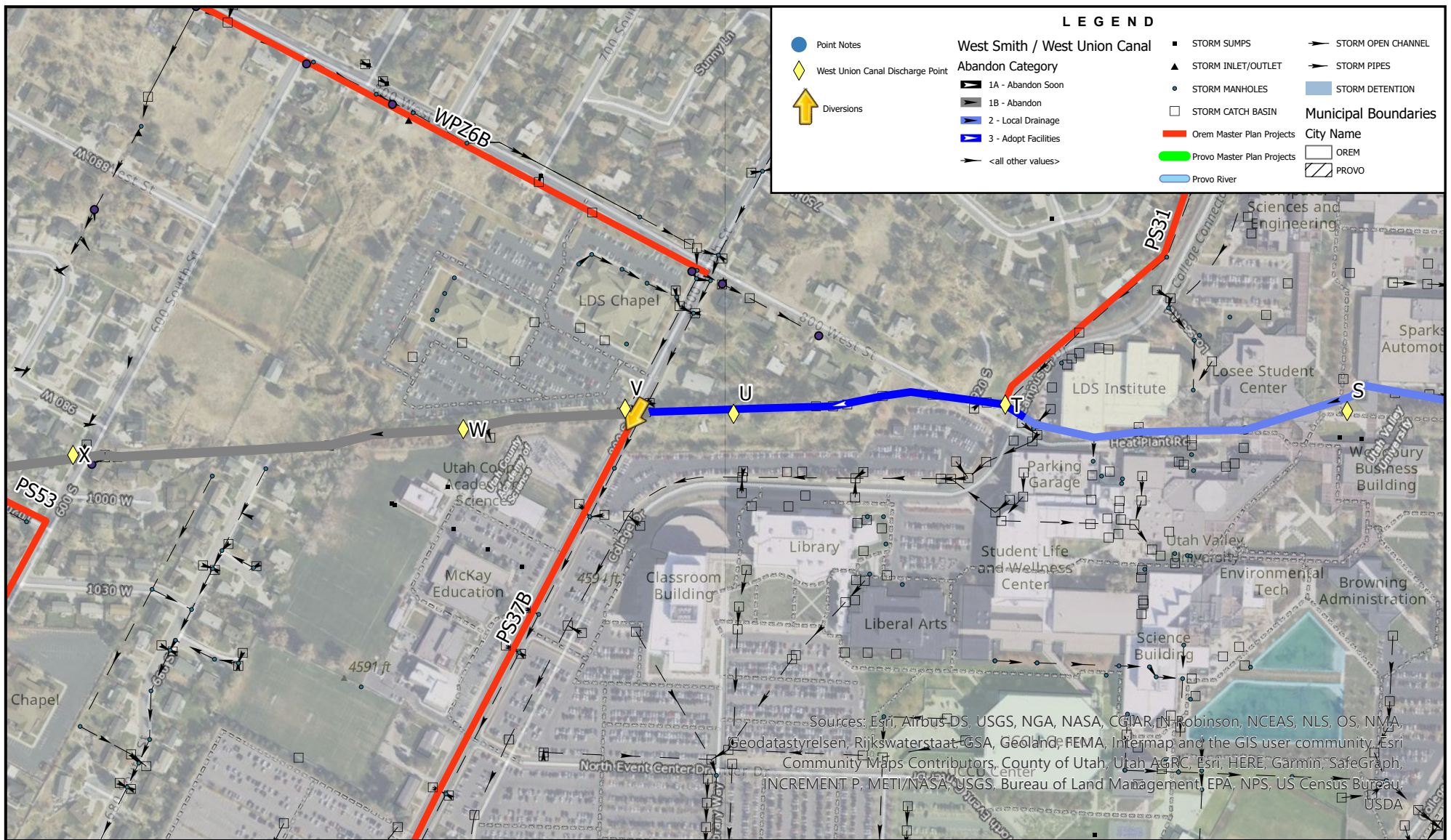


FIGURE NO.
P10



Points Project

- S Local Drainage for UVU
- T City to adopt, maintain canal facilities
- U City to adopt, maintain canal facilities

Points Project

- V Divert all flow to Project No. PS37B
- W Abandon facilities, no project needed



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

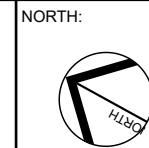
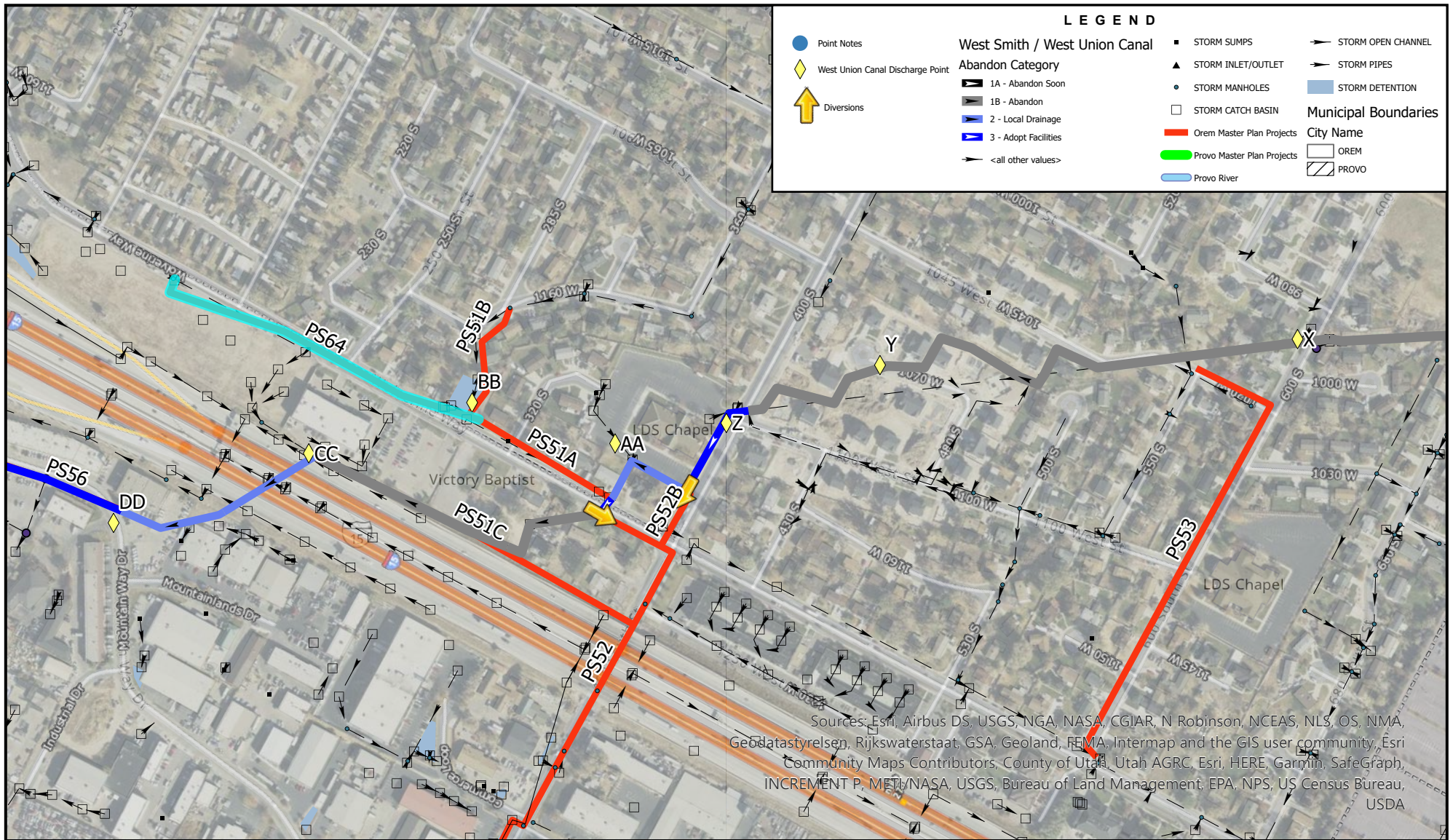


FIGURE NO.
P12



Points Project

- X Inlets abandoned previously, no new project
- Y Abandon facilities
- Z Project No. PS52
- AA Leave for Local Drainage, Intercept at 1200W via PS52

Points Project

- BB Project No. PS51 & PS52
- CC Project PS51C designed to eliminate local drainage issue
- DD City to adopt facilities, eventually rehabilitate



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

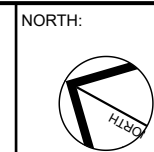
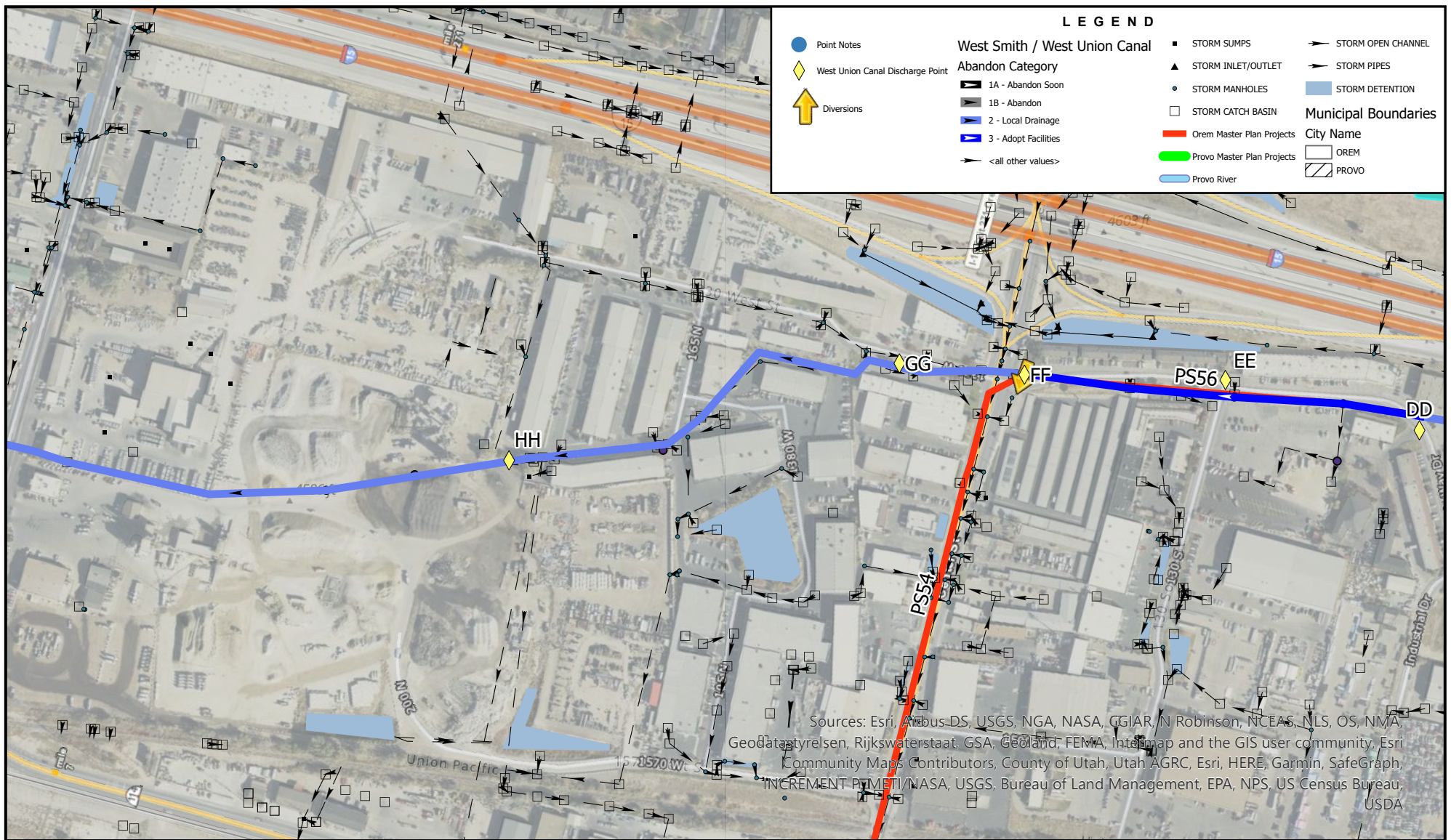


FIGURE NO.
P13



Points Project

- EE City to adopt facilities, eventually rehabilitate
- FF allow local drainage, divert west or realign pipe in future
- GG allow local drainage, realign pipe in future



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

NORTH:



SCALE:

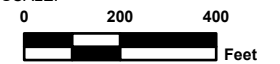
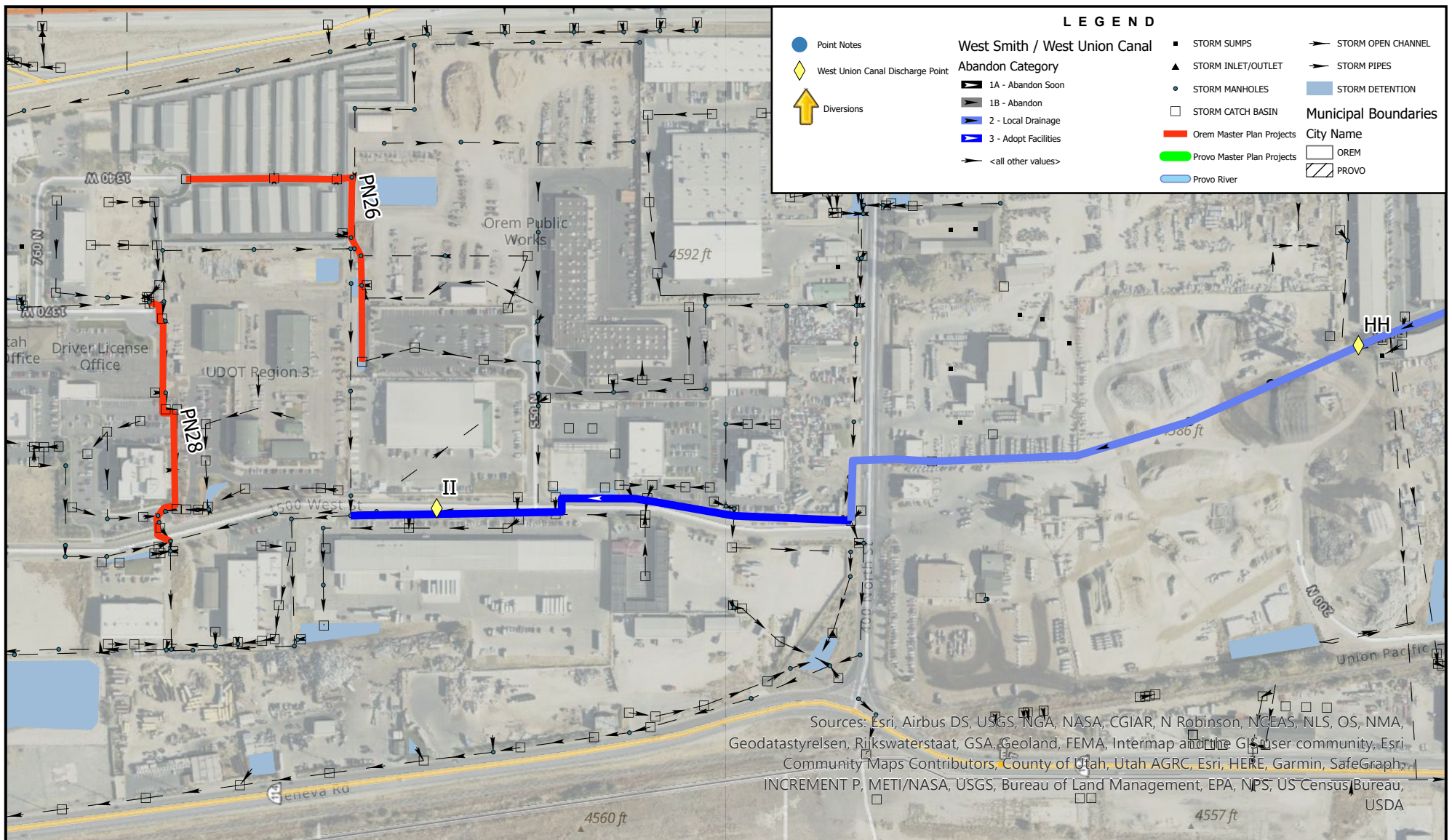


FIGURE NO.

P14



Points Project

- HH allow local drainage, realign pipe in future
- II Take over canal facility.



OREM CITY
**STORM WATER
MASTER PLAN**

**WEST UNION CANAL
IMPROVEMENTS**

NORTH:



SCALE:

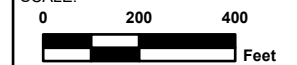


FIGURE NO.

P15

A – Center Street 1300 East

Facility: West Smith Ditch / West Union Canal

Connection: Inlets on the north and south side of Center Street drop flow into the existing West Smith Ditch / West Union Canal open channel at this location.

Resolution: Master Plan Project PS59G will eliminate the inlets the local drainage that is collected by inlets that discharge to the canal. Note that PS59G is also proposed to collect some drainage along 1000 East and discharge to the Provo River. Provo City has stormwater drainage that enters the canal upstream of this location which would need to be diverted into a pipeline to the Provo River at this location. The canal cannot be fully abandoned south of this location until all of the stormwater (Provo City and Orem City) is diverted out of the canal. Improvement costs are included in PS59G.

B – 400 South Palisades Dr

Facility: West Smith Ditch / West Union Canal

Connection: Inlets on the north 400 South at Palisades Dr collect stormwater and discharge to the canal.

Resolution: These inlets needs to be collected and diverted to an alternate location. The Master Plan call for these to drain to Master Plan project PS61 and PS61B. The City is also looking at options to convey the flow east to the Provo River to reduce storm water costs. However, east conveyance options will require easements from private property owners. Local improvements at this location include removing or abandoning the existing storm drain and inlets that discharge to the canal.

C – 800 South Carterville Road

Facility: West Smith Ditch / West Union Canal

Connection: Local drainage along Carterville Road between 400 South and 800 South is currently intercepted by parts of the open channel of the canal.

Resolution: An existing storm drain along 800 South already conveys stormwater to the Provo River. A new structure may be needed to fully divert any remaining stormwater in the facility to the Provo River using the existing 800 South storm water pipes. Eventually, it may be possible to reduce the local drainage into the open channel by filling in the historical channel with a pervious surface to allow local infiltration of local drainage.

D – 1385 South 1400 East

Facility: West Smith Ditch / West Union Canal

Connection: Stormwater collected along 1000 East and 1385 South west of the canal along with inlets adjacent to the canal either discharge into the canal or local West Smith Ditch irrigation pipes.

Resolution: This project is shown as CAP_D.1, CAP_D.2, and CAP_D on the capital improvement figures. The project group is intended to collect much of the drainage along 1000 East and convey it to the storm water pipe in the center of University Parkway that conveys flow to the Provo River. The improvements will also capture any remaining local drainage along 1385 South that run east to

Carterville Road and will add new sumps at the T-intersection (1385 S & Carterville Rd) to accommodate the local drainage.

E – University Parkway at 1400 East

Facility: West Smith Ditch / West Union Canal – There were historically no West Smith Ditch users south of University Parkway. The West Union Canal owned the facilities south of University Parkway.

Connection: Stormwater along University Parkway historically discharged to the canal at this location. This was resolved as part of the UDOT UVX project.

Resolution: No further improvements needed at this location.

F – 1500 South 900 East

Facility: West Union Canal.

Connection: The pump to waste bypass flows from the City’s existing Well No. 1 discharges into the open channel of the historic West Union Canal. Some local inlets are also connected to this bypass line. The West Union Canal Company has already effectively abandoned this section of its historic canal. The section of the canal between University Parkway and State Street is in poor repair and it is urgent that this connection be removed as soon as possible.

Resolution: Well No. 1 will be relocated in the future as part of a rehabilitation project. The inlets at this location will also need to be removed. Project PS65 is intended to pipe the areas around the well to a new discharge to the Provo River in participation with UDOT and/or Orem City. Local inlets will be plugged or connected to these propose facilities. If Well No. 1 is relocated, plugging the local inlets should be done soon to reduce the City’s reliance on the canal as soon as possible. All storm water related improvements are included in PS65. These improvements are dependent on downstream projects being completed first (e.g. PS65A, PS65C). All are included in the CIP and shown on the CIP figures.

G – Jameson Pointe

Facility: West Union Canal.

Connection: Jameson Pointe has some inlets that collect stormwater runoff and direct it to the West Union Canal.

Resolution: Project PS65 is proposed to convey stormwater away from Jameson Point. The storm water pipes would need to extend at least to Jameson Pointe to intercept runoff from the area.

H – 1850 South 750 East

Facility: West Union Canal.

Connection: The “Southeast Ditch” which comes off the “North Union Canal” at approximately 250 South at about 1000 East runs south to approximately 1850 South 750 East where any remaining tailwater or stormwater collected in miscellaneous inlets along the way discharges to the West Union Canal.

Resolution: Project PS65B is proposed to extend a lateral across the Utah State University Orem Campus to intercept any stormwater or tailwater at the south end of 750 East and route it to PS65C on state street. As with all projects identified in the master plan, these are conceptual and other options should be considered during the design phase. In this case, PS65A on 1700 S can pick up runoff and tailwater north of 1700 S. This leaves only the storm water runoff collected on 750 E to be dealt with. Given the small area, the existing sump at the south end of 750 E could be expanded to take the flow from 750 E since it is in the safe sump zone. This would eliminate the need to run storm drain through private property and into state street. The existing irrigation line could be abandoned or removed.

I – State Street

Facility: West Union Canal.

Connection: Orem City has stormwater runoff that is collected in pipes or surface runs to State Street north of the West Union Canal. A lot of the stormwater is also detained in a UDOT detention basin at 1750 South State Street. This stormwater eventually runs south and is connected to the West Union Canal.

Resolution: The City is currently investigating alternatives to infiltrate stormwater runoff east of State Street in new sumps to avoid discharging runoff to facilities in State Street. The City would like to infiltrate as much stormwater as possible. Project PS65C includes a piped solution to construct a new stormwater outfall along State Street to the Provo River. Costs for the project assume infiltration capacity is limited east of State Street, but could be revised if the City identifies additional detention or infiltration options.

J – 424 E 2000 S

Facility: West Union Canal.

Connection: Stormwater runoff from the neighborhood between 2000 South and 1864 South and between 424 East and State Street flows to an existing detention basin on the south side of 2000 South at 424 East that then discharges into the canal.

Resolution: A future detention facility is recommended on the south side of the West Union Canal at 424 East to expand detention capabilities. Project DBS4.1, DBS4.2 and PS66A are proposed to collect stormwater from this location and convey it through Provo City along the path of one of Provo City's storm water master plan projects so that it may outfall west toward Utah Lake through Orem City along 2200 South.

J2 to J6 – 150 East to 300 East

Facility: West Union Canal.

Connection: J2 represents the existing location where the open channel West Union Canal begins to be piped in a 48" RCP pipe along the north side of Provo City. The other points represent manholes or inlets to the pipe where surface runoff can be collected. J6 is the manhole that represents the last bend in the pipe before water begins running north again. The City's goal is to remove all stormwater so that this facility can be completely abandoned. As the undeveloped properties adjacent to 2000 South develop, every effort should be made to prevent stormwater runoff from impacting the canal or Provo City properties south of the canal.

Resolution: Prevent stormwater runoff from Orem City from discharging to the canal. If necessary, Orem City may need to install bulkheads or concrete plugs at these access points to prevent runoff from entering. The City may also need to construct access points at J4 and K to enable inspection and cleaning of the canal facility for any runoff that could impact the canal once the West Union Canal Company ceases irrigation operations.

K – 150 East to 300 East

Facility: West Union Canal.

Connection: The neighborhood south of 2000 South at 160 East drains toward the West Union Canal. There is no opportunity to drain anywhere but toward the canal today. Between K and K2, the canal actually parallels and Orem City storm drain facility. The Orem City pipe then connects to an existing structure at K2 that the canal also connects to.

Resolution: All storm water will exit the canal upstream of this point at point J2 and be routed to PS66A. The canal will be abandoned from points J2 to L. Future developments will not have the canal as a disposal option.

L-M – 2000 South 23 East

Facility: West Union Canal.

Connection: A few inlets connect to the canal at 2000 South at this location.

Resolution: Inlets should be plugged or re-routed to existing Orem City stormwater pipes in 2000 South.

N – 130 E Westview Dr

Facility: West Union Canal.

Connection: A couple inlets drain into the canal at this location.

Resolution: Inlets should be plugged and curb and gutter reconstructed to convey stormwater to 180 West. Stormwater piping may be extended up 180 West to limit stormwater spread in the road.

O – 1430 S 450 W

Facility: West Union Canal.

Connection: The Lakeridge Condominiums has some inlets that are collected and drain to the canal along with Orem City stormwater inlets and pipes.

Resolution: Project PS25C is intended to collect the majority of this stormwater and convey it west. The purpose of this project is to reduce the amount of flow in the canal from location O to location Q. The City has opted to adopt a portion of the canal between location O and location Q, but it would still be considered prudent to remove stormwater at location O because the pipe goes under or through a parking garage for Ventana student housing.

P – La Quinta

Facility: West Union Canal.

Connection: The parking lot and other areas of the La Quinta Inn and Suites drain to the canal at this location. There is no other option for storm water drainage at this location.

Resolution: The City should make efforts to inspect and clean this section of the canal once the West Union Canal Company ceases its irrigation operations.

Q – University Parkway 500 West

Facility: West Union Canal.

Connection: University Parkway has some inlets that connect to the West Union Canal at this location.

Resolution: The existing diversion structure connecting storm pipes to the canal may need modifications to divert all of the water from the canal to the existing storm water pipes in University Parkway once the irrigation company ceases operations.

R – 1200 S 620 W - Mountain Run Apartments

Facility: West Union Canal.

Connection: The Mountain Run apartments has some inlets that connect to the West Union Canal at this location. The City has one inlet that connect to the canal in 1200 South.

Resolution: Project PS30 is intended to divert all stormwater remaining in the canal west at 1200 South. No improvement is identified within Mountain Run Apartments because it is private property.

S – Utah Valley University

Facility: West Union Canal.

Connection: Utah Valley has an unknown number of connections to the canal. The facility itself will remain in place until UVU determines otherwise.

Resolution: The City will accommodate any remaining stormwater in the canal at location T. Any improvements at this location would need to be provided by UVU..

T to U – 800 West Campus Drive

Facility: West Union Canal.

Connection: The City has several stormwater facilities that connect to the canal at location T.

Resolution: The City intends to enclose the open channel between location T and location V and incorporate the canal into the City's facilities once the irrigation company ceases operations. No improvements are identified for these points.

V – 800 South 800 West

Facility: West Union Canal.

Connection: The City has stormwater facilities from the south and from the east that connect to the canal at location V.

Resolution: The City will be upsizing the facilities in 800 South to the west of this location to accommodate City storm water needs. Any flow north will be cutoff and diverted west.

W – 800 South to 600 West

Facility: West Union Canal.

Connection: The areas east of the West Union Canal utilize sumps for drainage and there is little runoff to the canal. The canal is open channel and theoretically would receive some runoff, but it would also act as an infiltration facility.

Resolution: No improvements needed.

X – 600 South 1000 West

Facility: West Union Canal.

Connection: There historically were some inlets connected to the West Union Canal at this location. These inlets have been plugged or removed already.

Resolution: No improvements needed.

Y – 600 South to 400 South

Facility: West Union Canal.

Connection: The West Union Canal is piped through this area of the City with no access points. Pipe condition is unknown and the exact alignment is unknown. No known City stormwater connections exist.

Resolution: No improvements proposed.

Z to AA – 400 South 1100 West

Facility: West Union Canal.

Connection: Some City inlets connect to the canal at this location before the canal goes through private property to the west and north.

Resolution: The City should adopt some of the pipes in this area and construct new pipes to intercept stormwater before it crosses between homes to the west of the property at 1160 West 400 South. PS52B, PS52, and PS51A are all improvements identified in the storm water master plan take the flow from these locations.

BB – 1200 West 300 South

Facility: West Union Canal.

Connection: Some City inlets and pipes connect to the canal at this location.

Resolution: Project PS52 is intended to intercept most of the flow before it runs west through private property and under I-15.

CC – 1200 West 300 South

Facility: West Union Canal.

Connection: Local private property stormwater runoff is collected and connected to the canal before the canal crosses under I-15.

Resolution: Project PS51C is intended to capture this private runoff and convey it south to proposed facilities in 400 South. PS56, PS54, PS55A/B are affected by or may be eliminated by PS51C. See the improvements alternatives discussion in Chapter 6 of the storm water master plan.

DD to FF – Mountain Way Dr, 200 South to Center St

Facility: West Union Canal.

Connection: Local private property and some public right-of-way stormwater runoff is collected and connected to the canal at Mountain Way Dr. This should be very limited once the upstream connections are diverted.

Resolution: For short-term purposes, the canal will continue to flow north of Center Street through private properties. Long-term, the City intends to divert flow west at Center Street to other City facilities.

GG to HH – 1330 West Center St to 400 North

Facility: West Union Canal.

Connection: Local private property stormwater runoff is collected and connected to the canal through private property.

Resolution: If the Geneva Pipe property redevelops in the future, there may be opportunities to re-align the stormwater conveyance path to public right-of-way. There are no short-term solutions to re-align or adopt the irrigation facility. This section may also be adopted by the City to eliminate the need for upstream projects beginning at point CC.

II – 1500 West 400 North

Facility: West Union Canal.

Connection: Private and public stormwater runoff connect to canal facilities at this location.

Resolution: The City intends to adopt and maintain the canal facilities from this point northward. No improvements identified here.

APPENDIX E

2000 SOUTH STORM DRAIN ALTERNATIVE ANALYSIS (MARCH 2026 UPDATE)



TECHNICAL MEMORANDUM

TO: Taggart Bowen, City Engineer
Orem City

COPIES: File

FROM: Andrew McKinnon, P.E., Nathan Davis, P.E.

DATE: April 3, 2026

SUBJECT: 2000 South Storm Drain Alternative Analysis

JOB NO.: 374-20-01

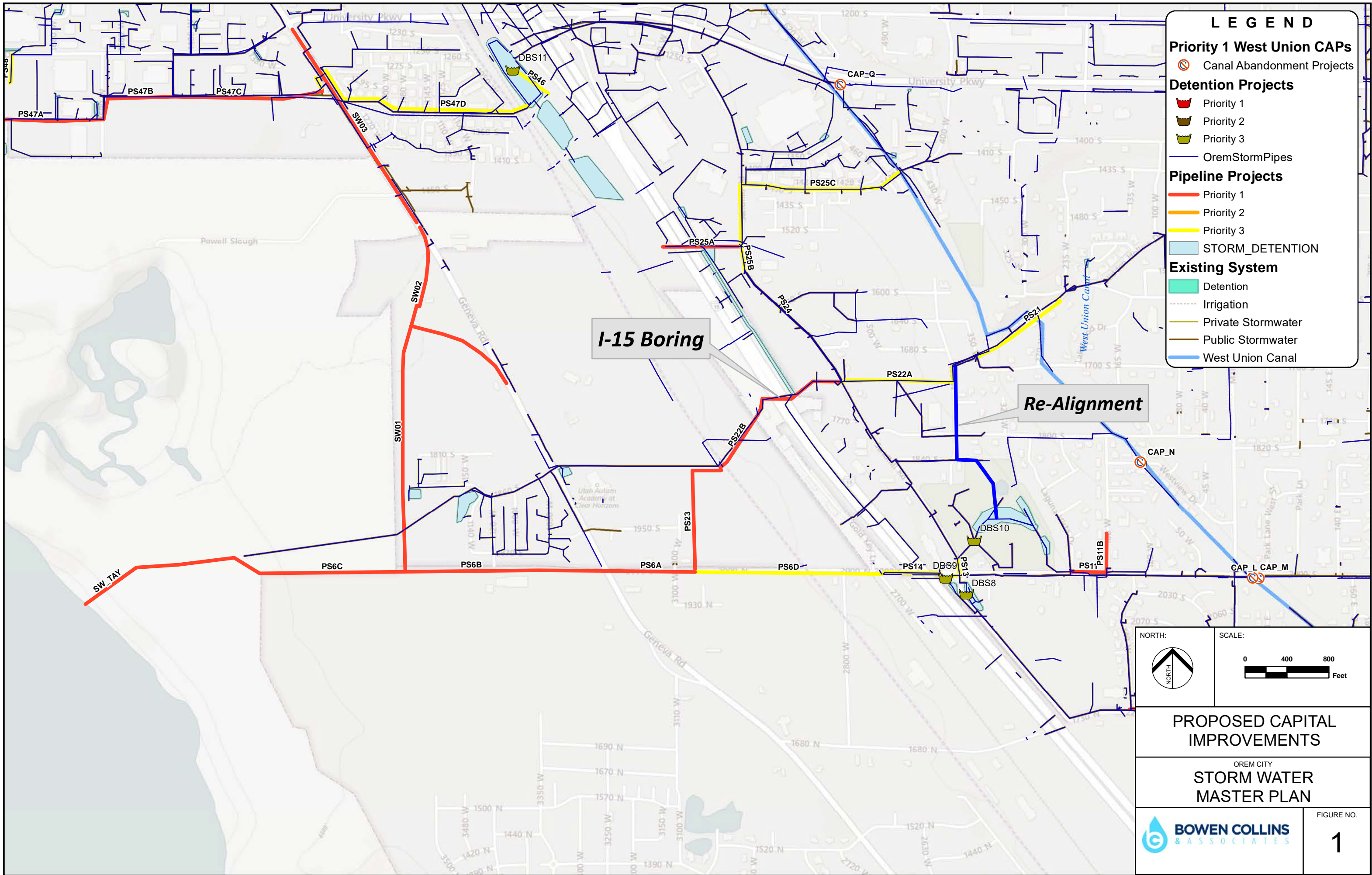
BACKGROUND

The City asked Bowen Collins & Associates to consider combining two storm drain master plan projects identified as Projects PS22A - PS23 and Projects PS14 - PS6D into a single project running down 2000 South. This would potentially be done by intercepting flow upstream of Project PS22A and diverting it south to the Nielsen's Grove detention basin (DBS10 in Storm Water Master Plan). The goal of the diversion would be to avoid a costly I-15 boring and mitigate some private property coordination issues on the westside of I-15. The purpose of this memo is to summarize an analysis of this alternative to determine what effects this will have on facility sizing.

PROPOSED ALTERNATIVE

Figure 1 shows the storm drain pipe capital projects of interest along with the proposed altered alignment to divert flow to the Nielsen's Grove detention basin. To confirm if the re-alignment was possible, the City performed some survey of some critical elevations to determine potential storm water pipe slopes.

The Nielsen's Grove Detention Basin includes a stage storage curve as shown below.



**Table 1
Nielsen's Grove Stage Storage Curve**

Elevation	Area (sf)	Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (acre-ft)
4,580.61	4			
4,581	507	100	100	0.00
4,582	5,922	3,214	3,314	0.08
4,583	22,962	14,442	17,756	0.41
4,584	57,118	40,040	57,796	1.33
4,585	95,678	76,398	134,194	3.08
4,585.3	110,253	30,890	165,083	3.79
4,586	144,263	89,081	254,164	5.83

The outlet structure(s) from the detention basin includes the following features:

- Outlet Pipe: 24" / 15"
- Outlet Invert Elevation: 4575.31
- Outlet Control Device: 12" Waterman gate
- Overflow Weir Elevation: 4585.31

The bottom of the detention basin includes several structures and pipes to convey flow to the outlet structure that would bubble up or surcharge into the detention basin with a restricted outflow from the detention basin. Key details for these detention basin structures include the following:

- Existing structure inverts: 4576.03 → 4575.27
- SD Pipe Size: 30"
- Tie-in Invert Elevation: 4575.51
- Ground Elevation at Tie-in: 4582.19

Diversion Pipe Size Design Criteria

Based on intercepting the flows to PS22A, the pipe to divert flow to Nielsen's Grove would need follow the following design criteria:

- Peak flow – 77 cfs peak flow to the detention basin.
- Critical Elevation @ 400 W 1840 S – The critical elevation that drives slope for the proposed detention basin is at 400 West 1840 South. The ground elevation at the point where the pipeline would need to turn east toward the detention basin is: 4,586.46.
- Minimum Cover – Assumed minimum cover of 1.5 feet over the top of the pipe controls the invert elevation along with the capacity of the pipe.
- Slope from Detention Basin to 400 W 1840 S – Available slope to this location from the invert of the detention basin would be 0.76% based on 775 feet of 42-inch pipe (capacity of 87.8 cfs at 100% gravity flow)

- Slope along 400 West, 1730 S to 1840 S – Available slope for this area is between 1.5% to 1.8%. This requires 900 feet of 36-inch pipe size based on flow (capacity of 81.2 cfs at 100% gravity flow).

Diversion Pipe Conflicts

The proposed storm drain line will have conflicts with gravity sewer mains at 1730 South, 1800 South, and 1840 South. Seven sewer manholes will be needed to resolve these conflicts along with sufficient pipe length to drop the sewer main below the proposed storm drain and to catch grade. At least two sewer laterals will also need to be adjusted to meet the new sewer depth.

The private lane east of 1840 South 400 West would already have easements for utilities. However, reconstructing a larger storm water main over existing utilities will impact the roadway and one driveway. Coordination with property owners for this area should be conducted soon to assess any concerns with this alignment.

The storm drain line will also need to intercept storm drain flow from existing storm drain pipes at 1800 South, 1840 South, and in Nielsen’s Grove Park where the water feature outlet connects to the detention basin.

Detention Basin Alternatives

The City could expand the existing detention basin without making significant alterations to the layout and function of Nielsen’s Grove Park by increasing the slope down from the existing top of the detention basin. By adopting a 5:1 slope approximately from the existing top contour (4586 feet) to the bottom invert elevation, the City could more than double the existing capacity of the detention basin as shown with the following stage-storage curve.

**Table 1
Proposed Nielsen’s Grove Stage Storage Curve**

Elevation	Area (sf)	Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (acre-ft)
4,580.5	3,290	0	0	0
4,581	26,439	7,432	7,432	0.17
4,582	86,208	56,324	63,756	1.46
4,583	98,501	92,355	156,110	3.58
4,584	111,158	104,830	260,940	5.99
4,585	124,425	117,792	378,731	8.69
4,585.3	130,376	38,220	416,951	9.57
4,586	144,263	96,124	513,075	11.78

Assuming the City were able to regulate flow out of the detention basin to optimize flow to a constant rate (possibly with an actuated gate), the City could reduce the peak flow out of the detention basin to:

- 39 cfs for the existing basin size or
- 20 cfs for the proposed basin size.

It may be possible to increase the detention basin volume more by lowering the bottom elevation of the pond further. However, it is unclear if this would be acceptable to City park personnel or residents. Figure 2 shows the simulated flows for pipes given these outlet flow rates.

Overflow Condition

The existing overflow weir for the outlet structure from the Nielsen's Grove detention basin has an existing overflow capacity of about 7.33 cfs before the detention basin begins overtopping its upper contour at 4586 feet. The lowest storm water manhole connection for the proposed diversion pipe has a proposed rim elevation of 4586.50 feet. So the detention basin will begin overflowing toward Sandhill Road before water begins bubbling out at 400 West 1840 South. Overflow from either location will impact Sandhill Road and likely properties on the Westside of Sandhill Road. This is the existing surface flooding direction for much of the existing tributary area, so there should be no difference between proposed conditions and existing conditions. Replacement of this structure will be necessary as part of upgrades from Nielsen's Grove to 2000 South.

Geneva Road Tie-In

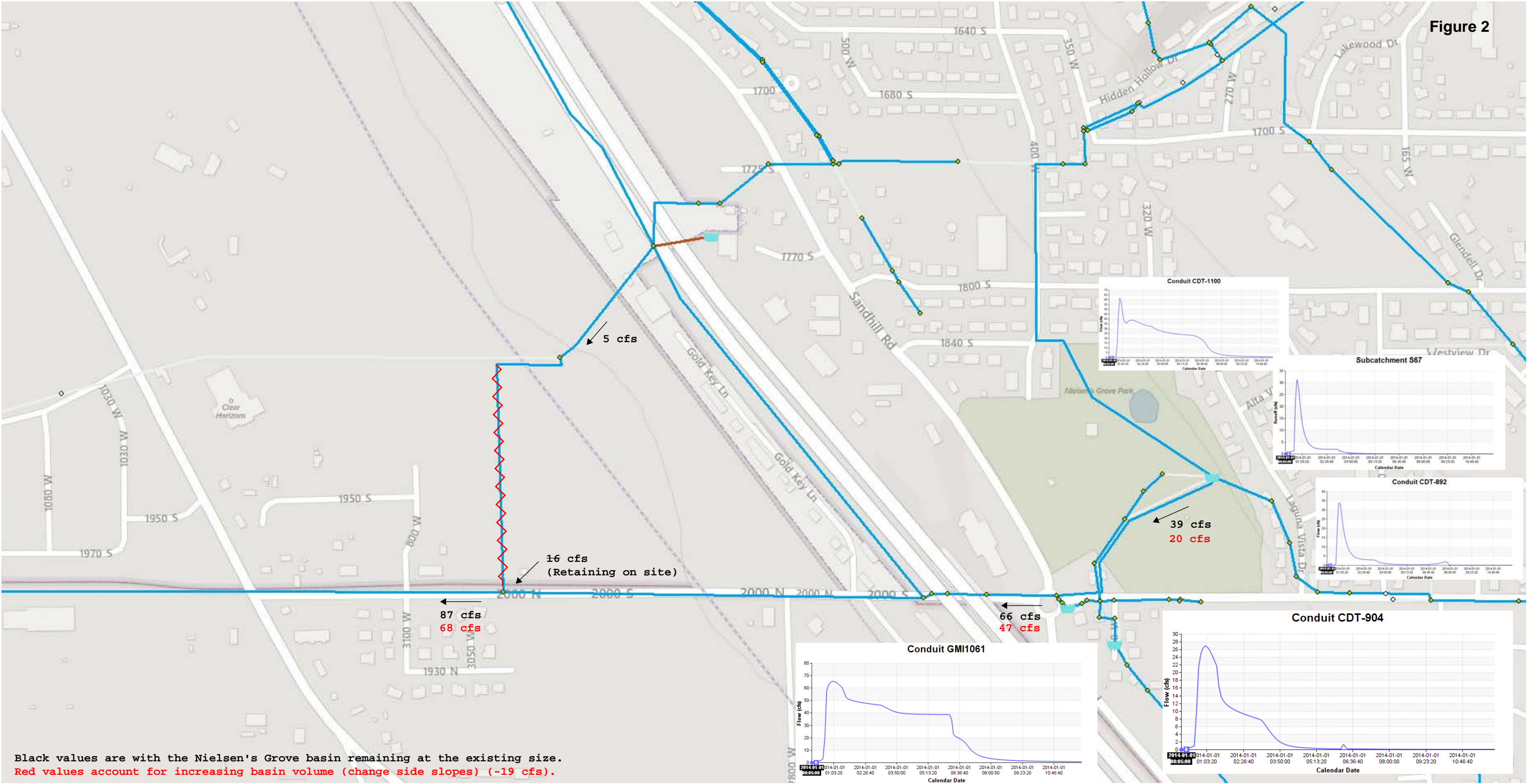
The City has already designed a storm drain outfall from Geneva Road up to 800 West. It is currently planned as a 48-inch pipe constructed at a 0.5 percent slope (capacity of 101.6 cfs at 100% of gravity flow). The City wanted to verify if this pipe size is adequate or if it could be downsized. If the City were to upsize the Nielsen's Grove detention basin, it would be possible to downsize the pipe to 42-inch (71.2 cfs capacity at 100% of gravity flow). However, there are a number of potential reasons to keep the pipe as 48-inch.

- The City's parks department may not agree to changes in the park contours.
- A final design of detention basin adjustments is not complete.
- The pipe is urgently needed for development and there is little time to resolve the previous two concerns.

2000 South, Sandhill Rd to 800 West

The profile between Sandhill Road and 800 West is critical and will need to be designed with consideration of multiple major crossings. The storm drain will need to cross two railway lines, the Lake Bottom Canal, and cross under I-15. Without the survey data for all of these crossings, it is difficult to predict what elevations will be for the pipeline profile. However, the flow rate for design should be 66 cfs from Sandhill Road to the 800 West tie in. Flow rate from developments are anticipated to retain stormwater on site, so it may be possible to further reduce flow from 800 West to Geneva. However, if there are concerns with groundwater levels and the feasibility of retaining on site north of 2000 South at 800 West, the pipe size should be designed for 87 cfs.

Figure 2



Black values are with the Nielsen's Grove basin remaining at the existing size.
 Red values account for increasing basin volume (change side slopes) (-19 cfs).

CONCLUSIONS & RECOMMENDATIONS

Based on this analysis, the proposed alternative to direct flow south to Nielsen's Grove at 400 West appears to be a reasonable and cost effective method to accommodate master plan goals while avoiding an I-15 crossing. Remaining items that need to be resolved:

1. Complete design from Nielsen's Grove to 800 West on 2000 South, including a new outlet structure at Nielsen's Grove and upsized pipelines in Sandhill Road and along 2000 South. Based on available fall from Sandhill Road, this does not appear to be a significant challenge. Additional survey of the Lake Bottom Canal invert is necessary to determine invert elevations and required crossing depths.
2. Nielsen's Grove Park Adjustments. Resolve whether the City parks department would be amenable to enlarging detention capacity within the park.
 - a. If so, how deep or what alterations would be acceptable?
3. Complete sewer loop designs. Because of the significant east to west slope at the conflicting sewer locations, sewer re-alignment should be relatively low cost. It's estimated 7 sewer manholes will be needed with approximately 300 feet of 8-inch sewer main, and 2 lateral loops.
4. Easement Question. The alignment running east along 1840 South follows a private lane that has utility easements already. There may be questions or concerns from property owners about what is allowable and additional coordination with property owners is recommended.

The above questions were not within the scope of this alternative analysis, but will be important to resolve in final design.

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