PREPARED FOR:

OREM

PREPARED BY:

BOWEN COLLINS & ASSOCIATES

STORM WATER MASTER PLAN

MAY 2021

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May 2021

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CHAPTER 1
INTRODUCTION

INTRODUCTION

In 2016, the City of Orem (City) completed a comprehensive storm water master plan. As part of that master plan, the City developed a detailed capital facilities plan for the completion of storm water improvements throughout the City. In 2018 the master plan was revised and updated to reflect the potential of losing the West Union Canal as a part of the storm water system. Since that time, the City has completed some of the identified improvements from the plan, but many others have been delayed. The City has also seen growth and other changes that have affected the applicability of some components of the plan. These include removing storm water discharge from the West Union Canal, updated drinking water source protection zones, and the annexation of a large area to the southwest of the existing city limits. As a result, the City determined that an updated storm water master plan was needed with a revised capital facilities plan that reflected current conditions.

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

Task 1: Update existing InfoSWMM model with new GIS data provided by the City of Orem.

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

Task 3: Developed storm water system improvements to address changes to the well protection areas, areas of flooding concern, and the southwest annexation area.

Task 4: Updated subcatchment boundaries and created new sub catchments for the use of this model. Developed parameters for these subcatchments. Calibrated the model to runoff that is reasonable for the area. Inserted detention basins with their associated stage storage curves.

Task 5: Modified the Existing Conditions Hydraulic model (Task 4) for future conditions based on the City's zoning and land use information. Identified both existing and

future deficiencies. Proposed improvements for each deficiency including cost estimates and a phasing plan for implementing these improvements.

Task 6: Involved the public in the master planning effort by presenting results at city council meetings.

Task 7: Prepared a draft master plan report that was reviewed with City personnel. Incorporated comments into a final master plan report.

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

ACKNOWLEDGMENTS

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

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

Mike Collins	Principal-in-Charge
Keith Larson	Project Manager
Andrew McKinnon	Project Engineer
Roland Rocha	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

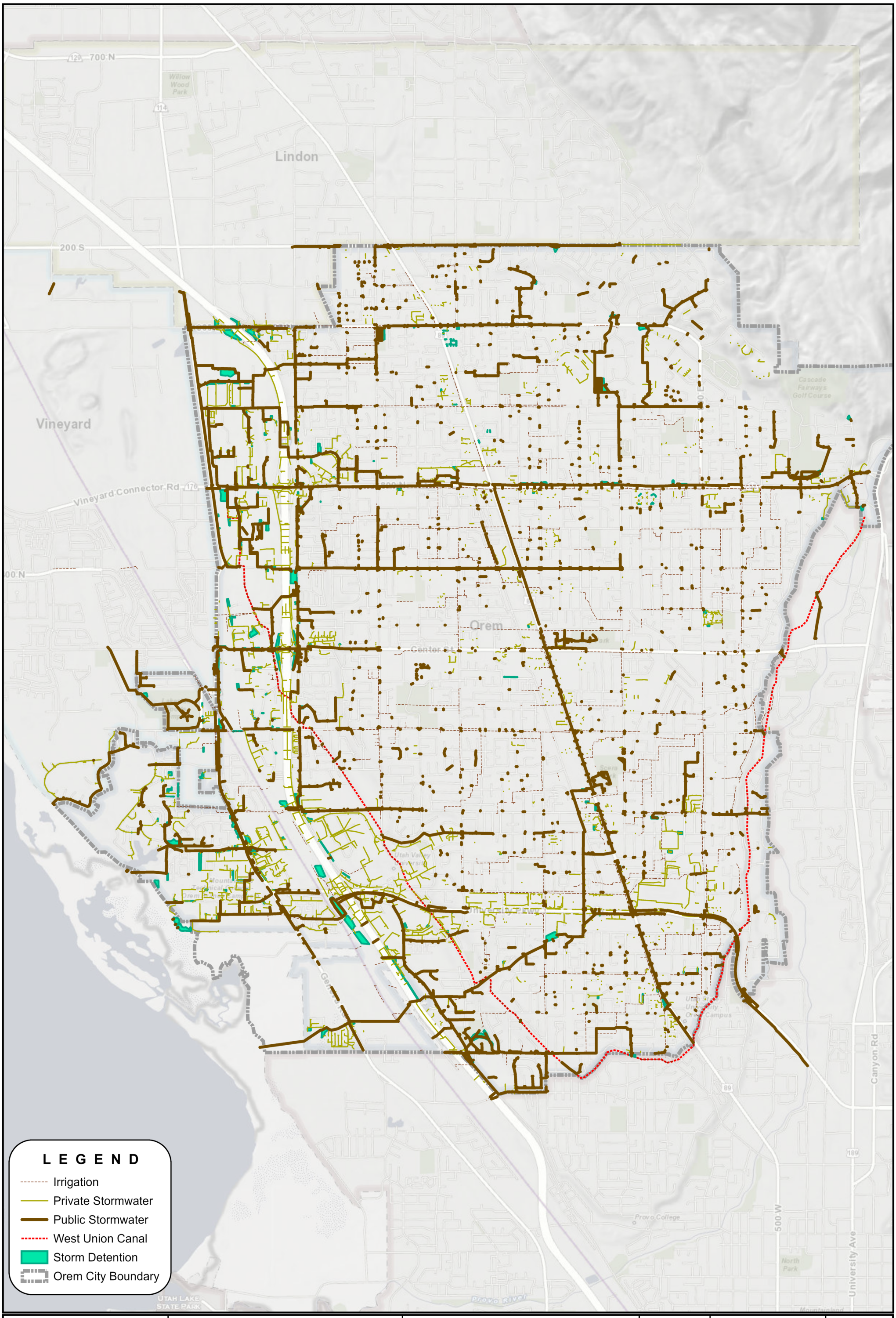
The City of Orem, is located about 30 miles south of Salt Lake City. Most of the City sits on a bench of the old Lake Bonneville. As a result, much of the City has relatively mild slopes with few major drainage channels. The Provo River runs along the eastern edge of the City, but only collects a small 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 149 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"	2.47	20.31	22.78
12"-17"	27.93	20.43	48.36
18"-23"	15.61	4.42	20.03
24"-29"	12.27	3.06	15.33
30"-35"	10.13	1.37	11.5
36"-41"	6.69	0.57	7.26
42"-47"	1.3	0.40	1.7
48"	2.09	0.20	2.29
>48"	1.17	0.14	1.31
Unknown	*11.38*	*35.39*	*46.77*
Total	**91.04**	**86.29**	**177.33**



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OREM CITY
STORM WATER MASTER PLAN

EXISTING STORM WATER SYSTEM

NORTH:

SCALE: 0 1,250 2,500 Feet

FIGURE NO. 2-1

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DETENTION FACILITIES

There are 353 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.

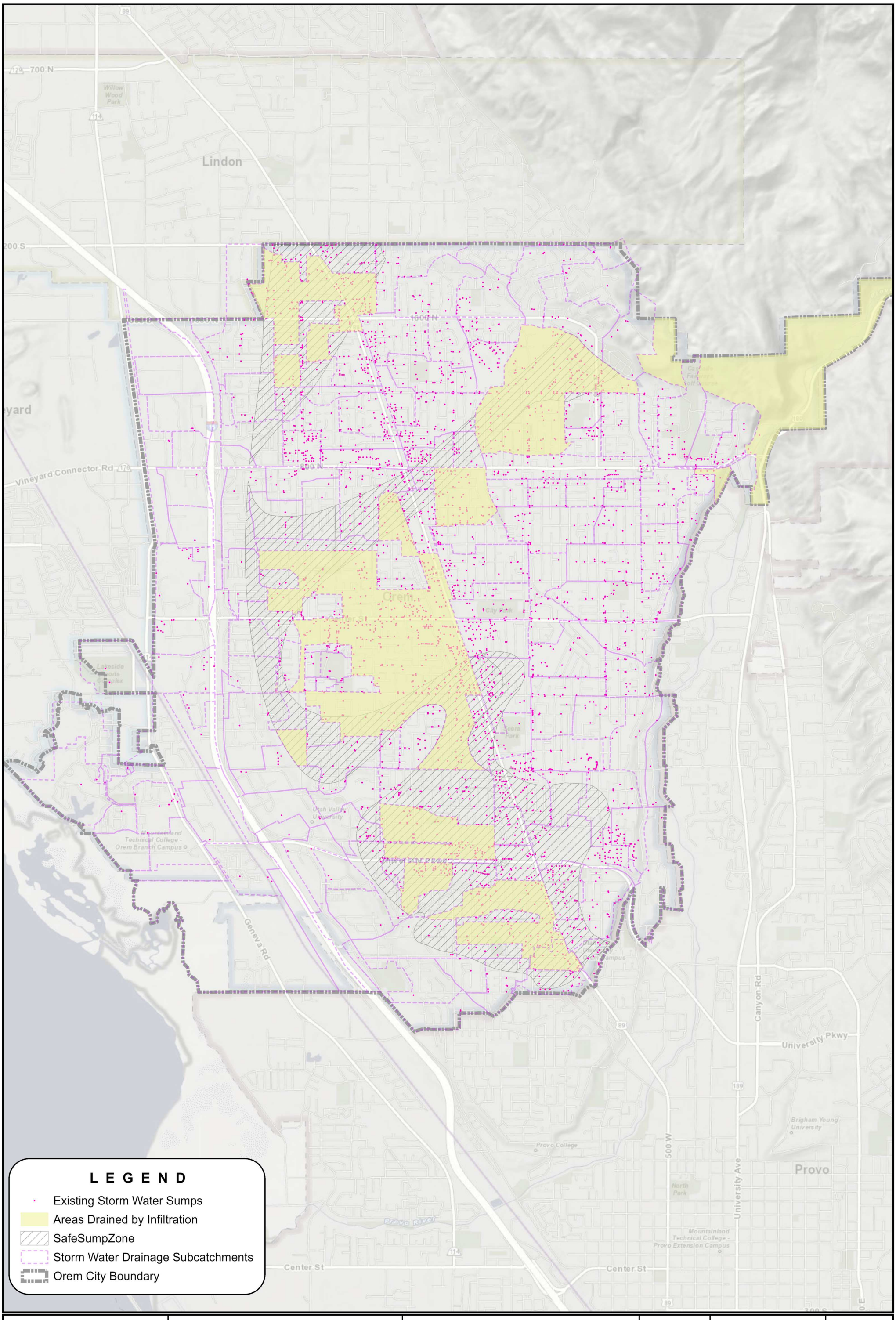
SUMPS AND INFILTRATION BASINS

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 3,830 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 reported nuisance flooding in these areas, the effectiveness of the local sumps is assumed to be effective at capturing the 10-year design storm event. Correspondingly, it is not expected that these areas will produce runoff to surrounding subbasins during the 10-year event. Areas where this assumption has been made are shown in 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. To be conservative, the infiltration of sumps in areas connected to the collection system was not modeled.

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



BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

EXISTING SUMP STORM WATER SYSTEM

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 2-2

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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

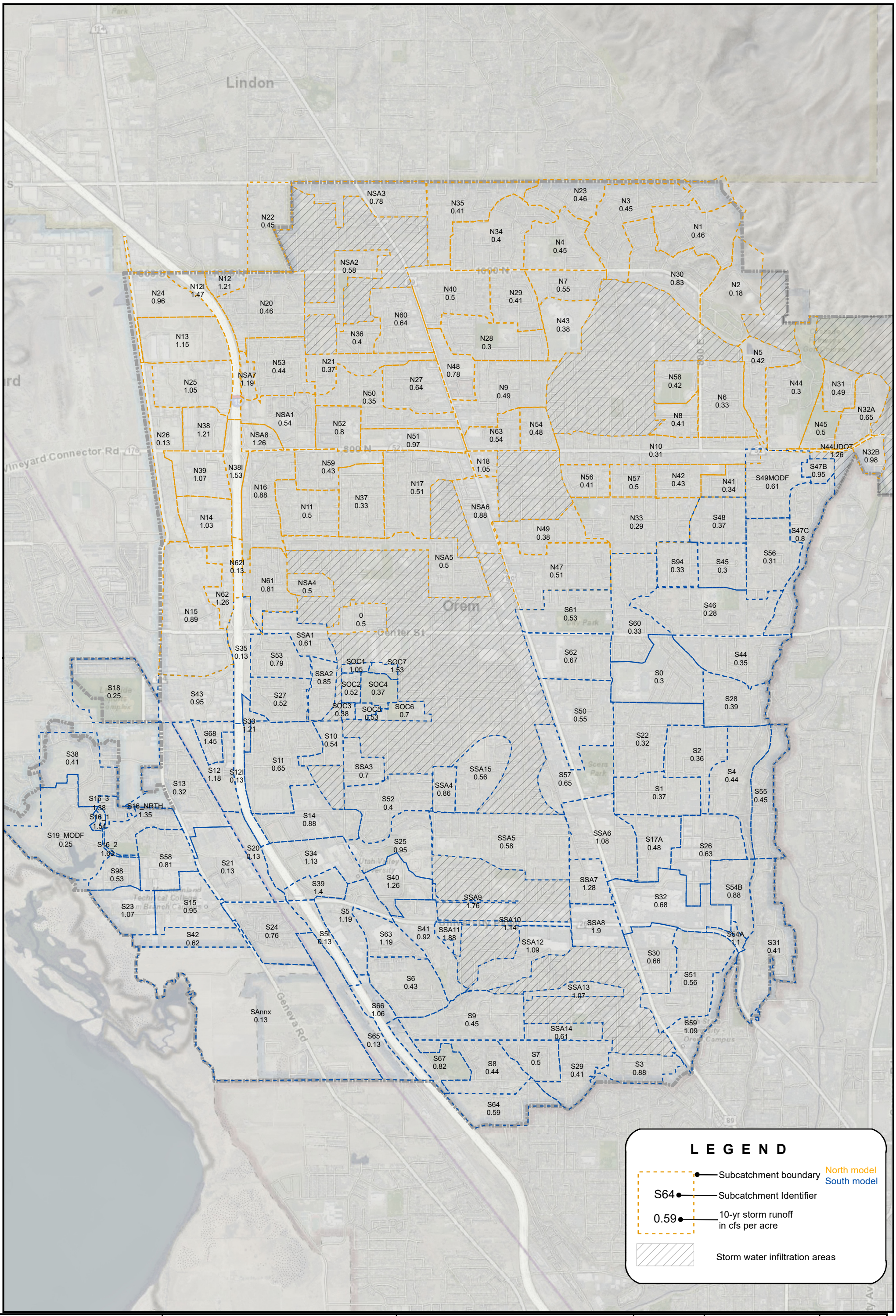
The City of Orem was divided into two hydrologic study areas for the purposes of this master plan update, a North Study Area and a South Study Area. A hydrologic computer model was developed for both study areas using the most current version of InfoSWMM. InfoSWMM uses an Environmental Protection Agency 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 aerially across the service area, an important requirement when evaluating the capacity of individual facilities.

Two InfoSWMM models were developed for this study – a North Study Area and a South Study Area are shown in Figure 3-1. 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.



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OREM CITY
STORM WATER MASTER PLAN

SUBCATCHMENTS AND RUNOFF PER ACRE

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-1

C:\Users\rrocha\Documents\Orem\GIS\Figures\MstrPlan\Figure3-1_Subcatchment_Boundaries.mxd rrocha 2/3/2021

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:

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

  Where:

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

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

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

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

Required hydrologic parameters for this approach are as follows:

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

Table 3-1
SCS Curve Number

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

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

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

Table 3-2
Average Imperviousness Based on Land Use

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

- ***Slope.*** The slope for each subcatchment was calculated using 2' contour data provided by 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.

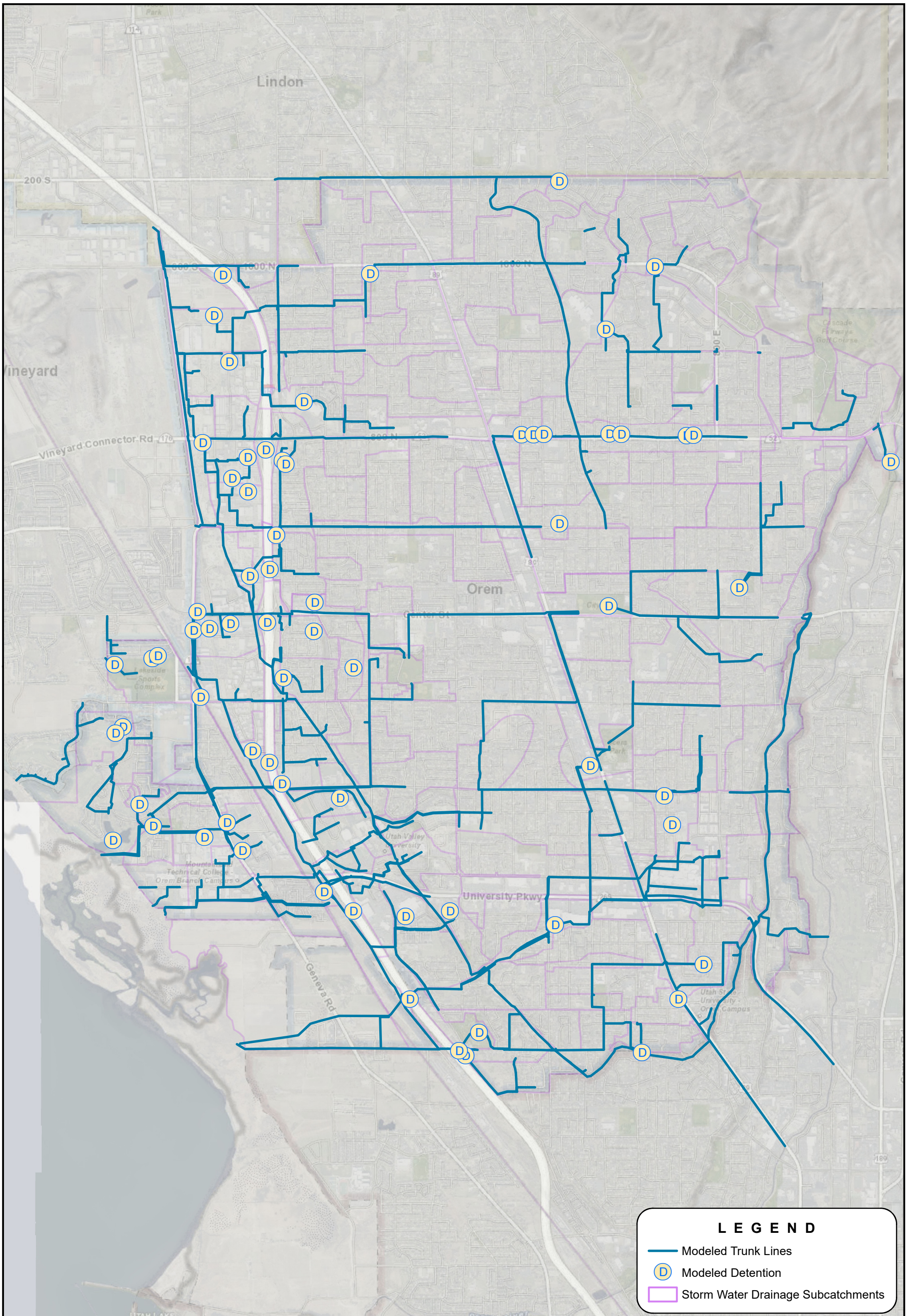
GEOMETRIC MODEL DEVELOPMENT

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 2016 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.



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OREM CITY
STORM WATER MASTER PLAN

STORM WATER MODEL TRUNKLINES& STORAGE

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 4-1

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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.

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 which historically shared the same open channel as the West Union Canal from the Provo River to University Parkway will be abandoned soon 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. If there are new discharge points or locations where discharges are significantly increased, it will be necessary to contact the floodplain manager and obtain the necessary permits.

Culverts

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

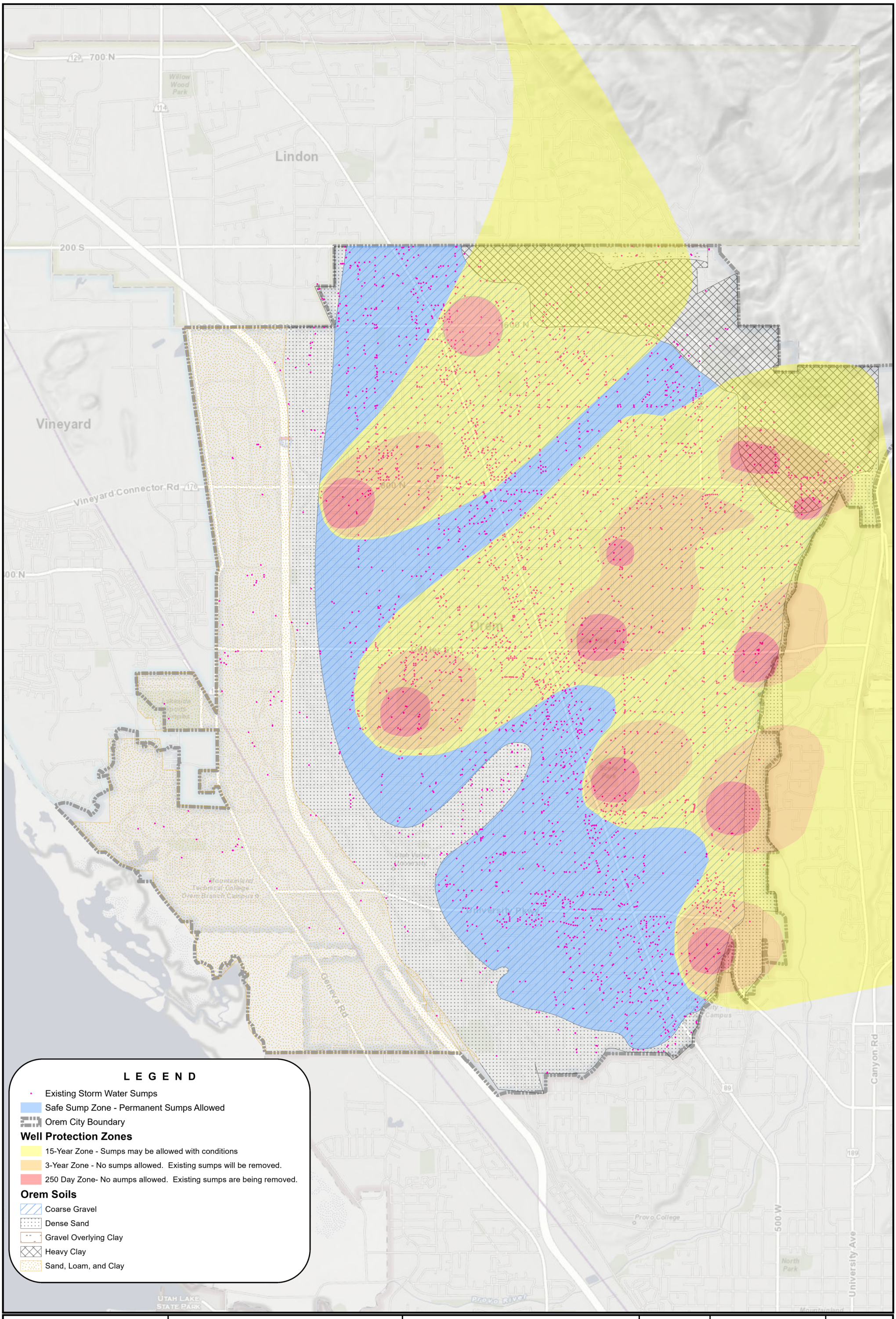
Detention Basins

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

Sumps and Infiltration Basins

There are currently 3,830 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.



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OREM CITY
STORM WATER MASTER PLAN

WELL PROTECTION ZONES & SAFE SUMP ZONE

NORTH:

SCALE: 0 1,250 2,500 Feet

FIGURE NO. 5-1

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- ***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 –** Removal of sumps in the 3-year WPZs is also desirable for water quality reasons, but is a lower priority than the 250-day WPZs. Correspondingly, this plan does not detail all required improvements associate with the 3-year WPZs, but allocates a fixed annual budget amount for either water quality improvements or elimination of existing sumps where practical in the 3-year WPZs[1]. The City's policy also generally prohibits construction of future sumps in the 3-year WPZs but may allow temporary sumps where infrastructure doesn't exist to capture and convey stormwater. Where this occurs, the system must be designed with the ability to easily connect to future conveyance facilities when they become available.
- **15-Year Drinking Water Source Protection Zones –** Because of their larger extents, the 15-year WPZs present 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). To balance these two competing water quality goals, this master plan takes a hybrid approach to sumps in these areas. For the majority of the City, this master plan assumes that the sumps will remain for the foreseeable future and projects do not include capacity for their removal at this time. However, some extra capacity has been included for removing a limited number of sumps in the 15-year WPZs at the northwest corner of the City (where this flow may be able to be conveyed to the Safe Sump Zone a short distance away) and eastern edge (where flow may be conveyed toward the Provo River). Since all of the projects serving these areas are lower priority, this strategy can be revisited as the City obtains more information on the future WPZs of new wells planned at 1600 North and near Community Park. Construction of future sumps in the

[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.

15-year WPZs is allowed on a temporary basis, but sumps may be approved by the City Engineer.

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

FUTURE CONVEYANCE SYSTEM ANALYSIS

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

LEGEND

Detention Results

- No Overtopping
- Overtopping

Node Results

- No flooding
- Flooding
- Pipes

NORTH:

SCALE: 0 1,000 2,000 Feet

EXISTING NORTH MODEL RESULTS

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5-2a

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LEGEND

Detention Results

- No Overtopping
- Overtopping

Node Results

- No flooding
- Flooding

Pipes

NORTH:

SCALE: 0 1,000 2,000 Feet

EXISTING SOUTH MODEL RESULTS

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5-2b

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CHAPTER 6
RECOMMENDED SYSTEM IMPROVEMENTS

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

TYPES OF RECOMMENDED IMPROVEMENTS

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

- **Major Conveyance Facilities** – Major storm water conveyance facilities include pipelines or major channels that typically service multiple developments. Local facilities include smaller storm water conveyance facilities that typically only serve one small development, and are used to convey storm water runoff from the 10-yr design storm to the major conveyance facilities.
- **Regional Detention Facilities** – Major storm water detention facilities (also referred to as regional detention facilities) are those facilities that collect runoff from multiple developments and attenuate peak runoff to levels as necessary to support the master plan capacities of downstream facilities. In addition to regional detention facilities, 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 2018 Master Plan's recommended improvements as a starting point for developing the recommended improvements outlined in this chapter. With the updated model results, BC&A and City personnel then modified the historic improvement plan to take advantage of opportunities to increase performance and minimize costs. This included considerable time identifying likely pipeline corridors and potential detention basin properties, and then balancing the cost of detention against the cost of conveyance.

This chapter documents 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 2021 dollars. The costs are intended to be planning level and all-inclusive. For more detailed mapping and model results associated with each

pipeline project, see Appendix B. For a detailed cost estimate of each of the pipelines and all other types of recommended improvements, see Appendix C.

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. 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 66, 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 in Provo City (near 1500 West 1970 North, Provo). This detention basin will be routed to flow through storm water pipes running through Provo City. As a result, there may 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.

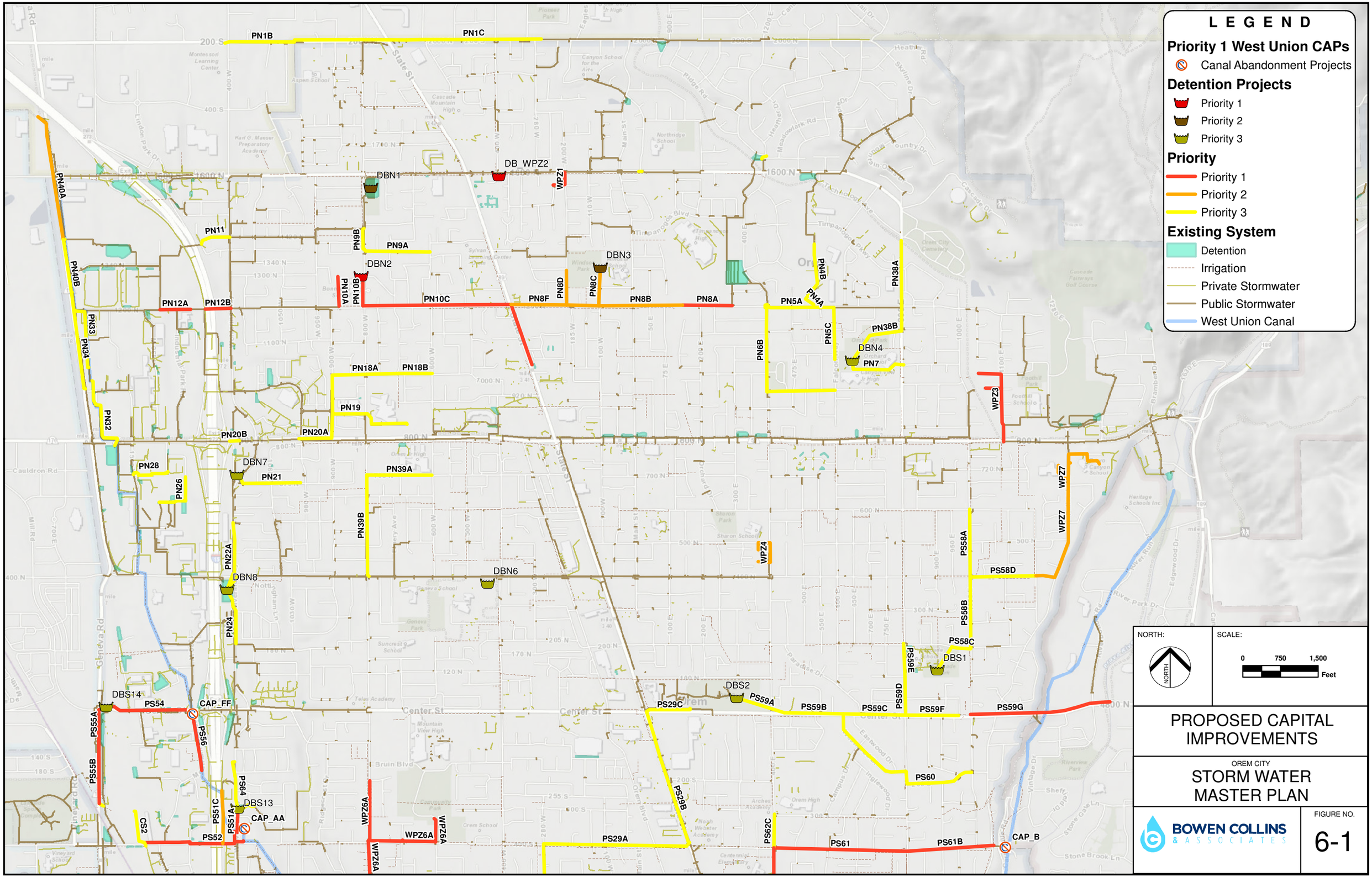
A few alternatives to recommended improvements are listed here for consideration and further investigation.

PS61B, PS61, PS62B, PS62A to DBS3 – If an alternative route east to the Provo River through private property can be secured, this would be less costly than the currently proposed route. PS61B and PS61 would not be necessary, and the downstream improvements could be resized accordingly.

WPZ6A, WPZ6B, PS35, PS37B, PS37A - WPZ6A could continue west on 400 S instead of turning south on 800 W. It could also terminate at a retention site on 800 W instead of continuing to 800 S.

PS30 could be coordinated with the 1200 S Road Project scheduled for 2023. This would greatly reduce the estimated project cost from what is shown in this plan leaving resources for other higher priority projects. It is recommended that upcoming road projects be overlayed with all utility master plan CIP maps. Projects may need to be shifted if they can be accomplished at substantially lower costs by coordinating with other improvements.

PS51C is intended to pull runoff from the WUC and rerouted it to Lake Bottom Canal (LBC) Facilities. However, this requires use and maintenance of drains running beneath the Freeway. Alternatively, PS54, PS55A, and PS55B could take runoff from WUC at CAP_FF. This would also be potentially routed to LBC facilities. If the LBC facilities cannot receive the runoff, it could potentially be routed to the existing detention at 400 S and Geneva Road or to Lakeside Park. Another alternative is that the WUC could be improved maintained by the City to keep runoff following the route it follows today through Geneva Pipe property. There are likely other options or combinations to be discovered during the design phase of this project. The plan currently calls for both PS51C and the PS54/PS55A/ PS55B projects. The intent is to identify the need to for improvements to the area and identify a potential cost.



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See inset detail, lower left corner

LEGEND

Priority 1 West Union CAPs
- Canal Abandonment Projects

Detention Projects
- Priority 1
- Priority 2
- Priority 3

Pipeline Projects
- Priority 1
- Priority 2
- Priority 3

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

Detail: 400 S and Wolverine Way

NORTH:

SCALE: 0 750 1,500 Feet

PROPOSED CAPITAL IMPROVEMENTS

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 6-2

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Table 6-1
Storm Water Trunkline Improvements

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
SW_TAY	Southwest Taylor Drain	0	0	$2,700,000	1	2022		New
PS59G	WSD - Center Str (G) to Provo	2801	24	$1,038,700	1	2022	5	New
PS30	1200 S, WUC @ 620 W add new Diversion from WUC	300	18	$151,100	1	2022		
PS62A	WSD -Scera Park (B)	1824	36	$821,300	1	2023	69	New Parallel (2)
PS62B	WSD - 400 E (C) to Scera Park	1360	30	$528,700	1	2023	69	New Parallel (2)
PS61	WSD Exit - 800 E to 400 E	2660	30	$1,037,000	1	2023	24	New
PS61B	400 S (D)	1720	24	$593,000	1	2023	24	New
CAP_B	Abandon pipe from 400 S to WUC			$50,000	1	2023		New
CAP_C	WUC Diversion Structure at 800 S			$50,000	1	2023		New
CAP_D	Univ 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 berm to Univ Prkwy	621	24	$369,400	1	2023		New
PS42A	800 S (A)	4090	42	$2,064,800	1	2024	105	New
PS42B	800 S (B)	510	42	$254,900	1	2024	108	Upsize
WPZ6A	Community Park WPZ - Near Park	3741	30	$0	1	2024		New
WPZ6B	Community Park WPZ - 800 W, 400 S to 800 S	1950	36	$0	1	2024		New
PS37A	WUC exit, Campus Dr to DBS16 (A)	263	42	$130,100	1	2024	105	Upsize
PS37B	WUC exit, 800 S to Campus Dr (F)	2132	36	$956,300	1	2024	72	Upsize
WPZ3	1101 E Near Well 6	1071	18	$0	1	2024		New
WPZ1	1560 N Sump Drain	500	8	$0	1	2024	0.7	New

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
DB_WPZ2	Underground Retention or lining of pond near 1600 N and 400 W			$0	1	2024		Modify existing
PS65A	Well 1 Bypass Drain	3271	42	$1,649,500	1	2025	27	New
PS65B	750 E Tailwater	675	24	$235,400	1	2025	11	New
PS65	Well 1 Bypass	870	18	$282,600	1	2025		
PS65C	WUC exit, State St and Columbia Ln to Provo River	3850	42	$2,008,100	1	2025	95	Upsize
PS67	WUC - 2075 S & 2200 S	2500	30	$1,107,300	1	2026		
PS66A	WUC - Provo 1730 N Alignment	3776	24	$1,370,400	1	2026	4.6	New
CAP_J2	424 E 2000 S at WUC			$50,000	1	2026		New
CAP_L	Diversion,2000 S @ WUC			$50,000	1	2026		New
CAP_M	2000 S Main St at WUC			$50,000	1	2026		New
CAP_N	WUC from 2000 S to 1430 S. Plug and surface drain to PS11B			$10,000	1	2026		New
CAP_Q	University Pkwy @ WUC			$50,000	1	2026		New
PS53	543 S 1020 W	1423	18	$445,800	1	2027		New
PS52	400 S (B), 1200 W to 1500 W	2065	24	$712,900	1	2027	12	Upsize
PS52B	400 S, 1150 W to 1200 W	187	18	$57,200	1	2027		
PS51A	1200 W (C)/Wolverine Way, 300 S	450	24	$156,300	1	2027	28	Upsize
CAP_AA	400 S 1165 W and WUC			$20,000	1	2027		New
PS54	Pipe WUC from CAP_FF to outfall	1800	48	$1,064,400	1	2028	44	New
CAP_FF	Divr @ Ctr St and 1330 W @ WUC			$50,000	1	2028		New
PS56	Rehabilitate WUC pipe from DD to FF			$240,000	1	2028		New
PS55A	Geneva Rd (G)	710	54	$467,300	1	2028	96	Upsize

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PS55B	Geneva Rd (H)	1290	60	$989,100	1	2028	111	Upsize
PS31	900 S	3240	18	$1,062,600	1	2029	8	New/Upsize
PN10A	Bonneville School	590	18	$187,000	1	2031	4	New
PN10B	800 W	680	48	$401,300	1	2031	75	New
PN10C	1200 N (A)	4230	42	$2,141,000	1	2033	75	New
PN12A	1200 N (F)	620	36	$282,000	1	2033	87	Upsize
PN12B	1200 N (G)	520	24	$177,000	1	2033	47	Upsize
PN8A	1200 N (B)	990	24	$341,300	1	2033	17	New
PS11	2000 S, 180 W to Nielsen's Grove	380	36	$168,800	1	2033	36	Upsize
PS11B	180 W, 2000 S	400	24	$141,400	1	2033		
PN8B	1200 N (C)	1670	30	$652,000	2	2034	17	New
PN8C	100 W	770	24	$263,600	2	2034	12	New
PN8E	1200 N (D)	690	18	$227,300	2	2036	5	New
PN8F	1200 N (E)	1110	24	$382,000	2	2036	9	New
PN8D	200 W	700	18	$230,100	2	2036	4	New
PN40A	Geneva Rd (A)	90	36	$106,000	2	2036	185	Parallel (2)
WPZ4	Drain N. Lupe Circle to 500 N. and E.450 N to 400 E.	756	12	$199,700	2	2038		New
PS25A	I-15 & 1500 S	750	42	$376,600	2	2040	67	Upsize
WPZ8	Remove sump from 870 S, pipe north to 800 S	638	12	$168,200	2	2040	1.7	New
WPZ9	Plug sump, regrade existing pipe, daylight outlet to 800 S gutter	114	12	$42,600	2	2041	0.5	New
WPZ7	N. Palisades Dr	3904.578	mixed	$1,320,400	2	2042	mixed	New

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PS51C	WUC, Point BB to 400 S	1060	18	$347,900	2	2042		
PS63	Lake Ridge Jr. High	2400	36	$1,080,600	3	2043	148	New Parallel (2)
PS6B	2000 S (B) - Phase 1	4450	36	$2,056,700	3	2043	90	New
PS23	Taylor Drain Outlet	1280	42	$647,900	3	2043	47	New
PS26A	800 S (C)	3130	42	$1,580,200	3	2043	74	New
PN34	Geneva Rd (B)	2400	36	$1,080,600	3	2043	21	Upsize
PN40B	Geneva Rd (C)	1070	66	$840,300	3	2043	123 (154)	Parallel
PN33	1200 N (H)	1370	42	$688,900	3	2043	67 (145)	Parallel
PN32	800 N (C)	1550	54	$1,021,000	3	2043	136	Upsize
PS6A	2000 S (A) - Phase 2	1780	30	$689,500	3	2043	54	New
PN1A	2000 N (A)	103	36	$46,200	3	2043	94	Upsize
PN1B	2000 N (B)	3551	30	$1,383,200	3	2043	66	Upsize
PN1C	2000 N(C)	2689	30	$1,046,900	3	2043	42	Upsize
PN2	Moore Ln	120	30	$46,100	3	2043	51	Upsize
PN3	1600 N	70	24	$25,900	3	2043	14 (29)	Parallel
PN4A	Research Way (A)	640	24	$225,100	3	2043	13	Upsize
PN4B	Research Way (B)	800	24	$277,700	3	2043	13	Upsize
PN5A	1200 N (I)	950	36	$425,800	3	2043	27	Upsize
PN5B	1200 N (J)	410	30	$162,500	3	2043	16	Upsize
PN5C	Falcon Way	1030	18	$339,600	3	2043	7	New
PN6A	400 E (A)	120	30	$46,100	3	2043	18	New

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PN6B	400 E (B)	3040	24	$1,057,100	3	2043	18	New
PN7	Orchard Park (B)	1010	30	$397,000	3	2043	25	New
PN9A	1360 N (A)	1340	36	$598,600	3	2043	41	New
PN9B	1360 N (B)	880	36	$390,600	3	2043	50	Upsize
PN11	1420 N	640	36	$290,000	3	2043	95	Upsize
PN18A	1000 N (A)	2040	42	$1,029,100	3	2043	64	New
PN18B	1000 N (B)	670	36	$301,900	3	2043	39	New
PN19	Timpanogas Hospital	1700	30	$662,200	3	2043	21	Upsize
PN20A	800 N (E)	1160	42	$580,800	3	2043	80	New/Parallel
PN20B	800 N (F)	400	30	$159,100	3	2043	87	Parallel
PN21	675 N	1240	18	$410,500	3	2043	18	New
PN22A	1200 W (A)	340	36	$152,900	3	2043	73	Upsize
PN22B	Orem Skate Park (B)	350	30	$136,900	3	2043	52 (76)	Parallel
PN24	1200 W (B)	1130	36	$502,600	3	2043	37	Upsize
PN26	1340 E	1050	18	$345,200	3	2043	15	Upsize
PN28	1370 W	800	24	$277,700	3	2043	22	Upsize
PN30A	800 N (B)	140	48	$80,500	3	2043	136	Upsize
PN35	Geneva Rd (J)	20	60	$18,500	3	2043	18	Connect Parallel Lines
PN36	Geneva Rd (K)	40	60	$31,800	3	2043	16	Connect Parallel Lines
PN37	Geneva Rd (L)	60	60	$45,100	3	2043	21	Connect Parallel Lines
PN38A	800 E (B)	1310	24	$453,800	3	2043	15	New

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PN38B	Orchard Park (A)	1740	30	$675,800	3	2043	14	New
PN39A	Orem Jr. High (A)	1140	36	$506,500	3	2043	26	New
PN39B	Orem Jr. High (B)	2030	18	$665,600	3	2043	4	New
PS13	Nielson Grove Park	300	36	$137,000	3	2043	43	Upsize
PS14	2000 S (D)	570	30	$217,000	3	2043	18	Upsize
PS16	1200 S to 800 E to Univ. Prkwy or west to sumps	917	36	$412,600	3	2043	43	New
PS19	Main Str.	1870	30	$732,600	3	2043	11	Upsize
PS20	Hidden Hollow Dr. (A)	1130	36	$502,600	3	2043	17 (55)	Parallel
PS21	Hidden Hollow Dr. (B)	1010	36	$454,800	3	2043	60	Upsize
PS22A	400 W (A)	1210	36	$546,900	3	2043	77	Upsize
PS22B	400 W (B)	1530	36	$686,600	3	2043	62	Upsize
PS24	Sandhill Rd (B)	40	24	$17,100	3	2043	4	Connect Parallel Lines
PS25B	Sandhill Rd (A)	240	36	$105,900	3	2043	35	Upsize
PS25C	1430 S, Canal outfall	2200	36	$988,500	3	2043	31.146	New
PS26B	800 S (D)	4600	30	$1,800,800	3	2043	24	New/Upsize
PS27	Scera Park (A)	390	24	$133,300	3	2043	13	New
PS28	Orem Blvd	1100	42	$553,500	3	2043	39 (54)	Parallel
PS29A	400 S (A)	11720	30	$4,582,600	3	2043	64	New Parallel (2)
PS29B	State Str	4360	36	$1,950,700	3	2043	38	Parallel
PS29C	Center Str (A)	1490	30	$578,200	3	2043	36	Upsize
PS38	College Dr (B)	50	36	$25,100	3	2043	61	Upsize

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PS43B	Springwater Park Ln	1440	36	$643,600	3	2043	39 (62)	Parallel
PS44	Geneva Rd (E)	1180	36	$522,400	3	2043	27	Upsize
PS45	Geneva Rd (F)	500	24	$171,100	3	2043	17	Reroute
PS46	Kent Drain	410	60	$295,800	3	2043	73	Reroute
PS47A	1330 S	940	60	$673,500	3	2043	147	Upsize
PS47B	1300 S (A)	830	54	$545,500	3	2043	137	Upsize
PS47C	1300 S (B)	1460	48	$856,500	3	2043	93	Upsize
PS47D	1300 S (C)	2360	36	$1,052,200	3	2043	52	Upsize
PS48	Business Park Dr (A)	280	36	$121,800	3	2043	24	Upsize
PS49	Business Park Dr (B)	520	24	$242,000	3	2043	11	Upsize
PS51B	1200 W (D)/Wolverine Way, 300 S	360	24	$124,400	3	2043	17	Upsize
PS58A	1000 E (A)	1350	36	$602,600	3	2043	40	New
PS58B	1000 E (B)	2820	36	$1,265,300	3	2043	100	New Parallel (2)
PS58C	Cascade Park	1880	36/42	$962,300	3	2043	52/70 (132)	New Parallel
PS58D	400 N (B)	1310	36	$586,600	3	2043	45	New
PS59A	City Park In	2000	42	$1,010,900	3	2043	125	New Parallel (2)
PS59B	Center Str (D)	2360	36	$1,052,200	3	2043	107	New Parallel (2)
PS59C	Center Str (E)	1880	30/36	$1,054,100	3	2043	35/50 (85)	New Parallel
PS59D	800 E (D)	760	36	$337,700	3	2043	37	New
PS59E	800 E (E)	670	30	$263,600	3	2043	25	New
PS59F	Center Str (F)	1810	24	$632,200	3	2043	19	New

Project Id	Project Description	Pipe Length (ft) [3]	Diameter (in) [4]	Opinion of Probable Cost[5]	Priority Level	Build Year	Design Flow Rate (cfs)[1]	Status[2]
PS60	Westwood Dr	3500	36	$1,566,000	3	2043	25	New
PS62C	400 E (D)	680	24	$236,900	3	2043	18	New
PS64	1200 W (D)	900	24	$314,600	3	2043	22	Upsize
CS1	Geneva Rd			$138,800	3	2043		
CS2	400 S, 1500 W			$1,000,200	3	2043		

Notes:
1. First number is design flow for the proposed parallel pipe. Value in parentheses is the total combined design flow.
2. Values in parenthesis represent the number of new parallel pipes.
3. Lengths account for the total length of all barrels even when multiple barrels are present
4. 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.
5. Fiscal Year 2021 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 2021	Volume (acre-ft)	Discharge Rate (cfs)	Status**	Priority (year)
DBS4.1	424 E West Union Canal – Land Purchase	$373,000	TBD	TBD	New	1 (2022)
DBS3	Scera Park (A)	$740,900	3.6	9.5	New	1 (2023)
DBS16	8th S & 12th W	$60,000	0	110	Modify	1 (2024*)
DB_WPZ2	Underground detention or lining of existing detention	$0	Match existing	Match existing	Modify	1 (2024*)
DBS4.2	424 E West Union Canal – Construction	$392,900	TBD	TBD	New	1 (2026)
DBN2	Bonneville School	$593,300	2.8	3.5	New	1 (2031)
DBS5	Lakeridge Jr. High	$1,231,000	6.3	6.5	New	1 (2038)
WPZ_DBN1	Bonneville Park	$60,000	0	8	Modify	2
DBN3	Windsor Park	$668,400	3.2	7.5	New	2
DBN6	Orem Community Hospital	$559,400	2.6	5	New	3
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	$940,700	4.7	15.5	New	3
DBS2	City Park	$1,739,100	9.1	18	New	3
DBN4	Orchard Park	$323,600	1.3	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 Str.	$60,000	0	47	Modify	3

*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 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 2021
CS1	Geneva Rd	$138,800
CS2	400 South, 1500 West	$1,000,200

SOUTHWEST TAYLOR DRAIN IMPROVEMENTS

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 improvements to make it more accessible for regular maintenance. Details regarding this improvement can be found in the Appendix E.

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, removal of sumps, and other miscellaneous improvements.

As outlined in Chapter 6, there are several high priority projects related to existing conveyance deficiencies, sump removal, and deficiencies associated with future growth. Based on these high priority projects, City personnel identified problem areas which they plan to resolve in the next 10-years.

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.
    - **West Union Canal –** The first projects in the 10-year plan include major conveyance projects needed to remove storm water from open channel portions of the canal that could potentially overtop. The canal company itself has already discontinued use of these reaches of the canal, so these projects are considered highest priority.
- **Detention/Infiltration Basins –** This budget item includes both improvements to existing detention facilities and construction of new detention facilities. Detention facilities are designed to detain flows in order to reduce downstream pipe sizes. When facilities are located in the "Safe Sump Zone" infiltration was accounted for to further reduce downstream flows.
- **Drinking Water Source Protection Zones –** Storm water sumps can be a source of drinking water pollution if they are in the drinking water source protection zones (or well protection

zones - WPZs). This budget item focuses on improvements needed to address existing sumps in these zones. WPZ projects in the 250-day zone are in the CIP and projects in the 3-year zone will be addressed at a rate of $200,000 per year. There are some older projects carried over from previous plans intended to remove sumps from the 15-year zone, but these are placed in the lowest priority group and are likely to be removed in future revisions of the storm water master plan. The WPZ projects for the new wells at Community Park and on 1600 N are listed in this CIP but with no associated costs. The cost will appear in Orem's water master plan report and CIP.

- **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 $225,000 (adjusted for inflation) has been established for maintenance and miscellaneous repairs based on historic costs. This will include regularly scheduled maintenance and repair on pipes, detention facilities, sumps, or other storm water facilities.
- **Unplanned Repairs** – In addition to the regularly scheduled maintenance items identified in the budget item above, 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 $225,000 (adjusted for inflation) has been established for this purpose based on historic costs as reported by City personnel.
- **Fleet Replacement** – City personnel have developed a schedule for vehicle replacement based on approximate use, depreciation, and reliability for maintenance vehicles in the City. Average expenditures under this category are expected to be approximately $300,000 per year.

Table 7-1
10-Year Capital Improvement Plan

Project ID	Project Description	OPC 2021	OPC Build Year	Build Year
DBS4.1	424 E West Union Canal (Provo) - Land Purch	$373,000	$384,190	2022
SW_TAY	Southwest Taylor Drain	$2,700,000	$2,781,000	2022
PS59G	WSD - Center Str (G) to Provo	$1,038,700	$1,069,861	2022
PS30	1200 S, WUC @ 620 W add new Diversion from WUC	$151,100	$155,633	2022
DBS3	Scera Park (A)	$740,900	$786,021	2023
PS62A	WSD - Scera Park (B)	$821,300	$871,317	2023
PS62B	WSD - 400 E (C) to Scera Park	$528,700	$560,898	2023
PS61	WSD - 400 S, Palisades to 800 E (C)	$1,037,000	$1,100,153	2023
PS61B	400 S (D)	$593,000	$629,114	2023
CAP_B	Abandon pipe from 400 S to WUC	$50,000	$53,045	2023
CAP_C	WUC Diversion Structure at 800 S	$50,000	$53,045	2023
CAP_D	University Pkwy/WUC, 1385 S at Carterville Rd. Includes Bore and 2 new deep wells. Plug current inlet/install new inlets and pipe. D.1 and D.2 on map.	$369,400	$391,896	2023
PS42A	800 S (A)	$2,064,800	$2,256,263	2024
PS42B	800 S (B)	$254,900	$278,536	2024
WPZ6A*	Community Park WPZ - Near Park	$0	$0	2024
WPZ6B*	Community Park WPZ - 800 W, 400 S to 800 S	$0	$0	2024
DBS16	8th S & 12th W	$60,000	$65,564	2024
PS37A	WUC exit, Campus Dr to DBS16 (A)	$130,100	$142,164	2024
PS37B	WUC exit, 800 S to Campus Dr (F)	$956,300	$1,044,975	2024
WPZ3*	1101 E Near Well 6	$0	$0	2024
WPZ1*	1560 N Sump Drain	$0	$0	2024
DB_WPZ2*	Underground Retention or lining of pond near 1600 N and 400 W	$0	$0	2024
PS65A	Well 1 Bypass Drain	$1,649,500	$1,856,527	2025
PS65B	751 E Tailwater	$235,400	$264,945	2025
PS65	Well 1 Bypass Drain	$282,600	$318,069	2025
PS65C	WUC exit, State St and Columbia Ln to Provo River	$2,008,100	$2,260,134	2025

Project ID	Project Description	OPC 2021	OPC Build Year	Build Year
PS67	WUC - 2075 S & 2200 S	$1,107,300	$1,283,664	2026
PS66A	WUC - Provo 1730 N Alignment	$1,370,400	$1,588,669	2026
DBS4.2	424 E West Union Canal (Provo) - Construct	$392,900	$455,479	2026
CAP_J2	424 E 2000 S at WUC	$50,000	$57,964	2026
CAP_L	Diversion, 2000 S @ WUC	$50,000	$57,964	2026
CAP_M	2000 S Main St. WUC	$50,000	$57,964	2026
CAP_N	WUC from 200 S to 1430 S. Plug and surface drain to PS11B	$10,000	$11,593	2026
CAP_Q	University Pkwy @ WUC	$50,000	$57,964	2026
PS53	543 S 1020 W	$445,800	$532,309	2027
PS52	400 S (B), 1200 W to 1500 W	$712,900	$851,240	2027
PS52B	400 S, 1150 W to 1200 W	$57,200	$68,300	2027
PS51A	1200 W (C)/Wolverine Way, 300 S	$156,300	$186,630	2027
CAP_AA	400 S 1165 W and WUC	$20,000	$23,881	2027
PS54	Pipe WUC from CAP_FF to outfall	$1,064,400	$1,309,078	2028
CAP_FF	Diversion @ Ctr St and 1330 W @ WUC	$50,000	$61,494	2028
PS56	Rehabilitate WUC pipe from DD to FF	$240,000	$295,170	2028
PS55A	Geneva Rd (G)	$467,300	$574,720	2028
PS55B	Geneva Rd (H)	$989,100	$1,216,468	2028
PS31	900 S	$1,062,600	$1,346,070	2029
DBN2	Bonneville School	$593,300	$797,346	2031
PN10A	Bonneville School	$187,000	$251,312	2031
PN10B	800 W	$401,300	$539,314	2031
PN10C	1200 N (A)	$2,141,000	$3,052,554	2033
PN12A	1200 N (F)	$282,000	$402,065	2033
PN12B	1200 N (G)	$177,000	$252,360	2033

*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.

In 2017, the City of Orem Council endorsed a funding plan to adjust storm water rates to aggressively fund critical system improvement, and the City has continued to follow the recommended financing plan for the short-term and long-term needs of the system. This plan is outlined in Table 7-2.

Table 7-2
Storm Water Budget Spending Plan for Critical Projects

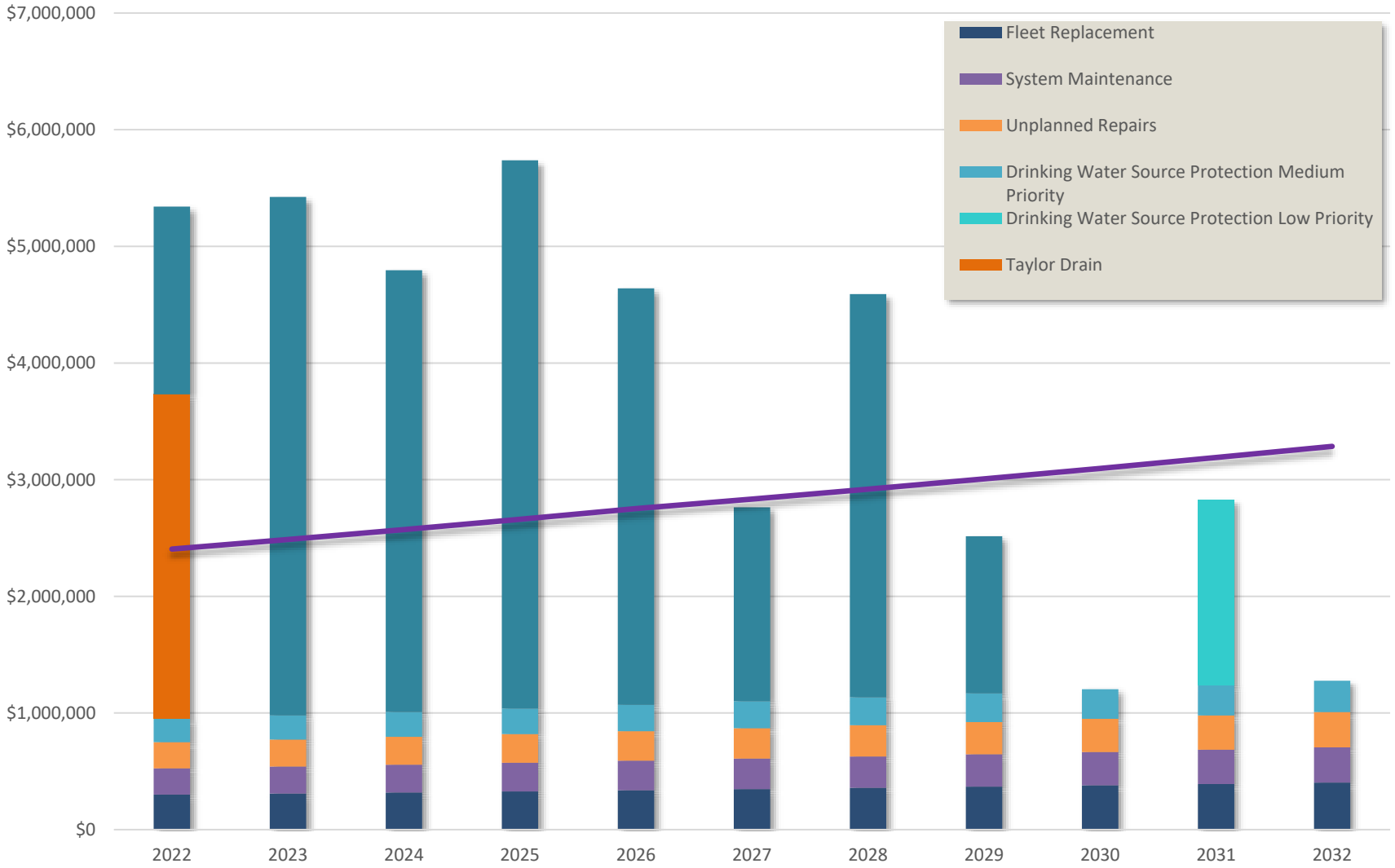
Year	Project Spending	Year	Project Spending
2020	$2,132,752	*2032*	$3,285,400
2021	$2,307,660	*2033*	$3,383,962
2022	$2,405,017	*2034*	$3,485,480
2023	$2,487,312	*2035*	$3,590,045
2024	$2,572,421	*2036*	$3,697,746
2025	$2,660,441	*2037*	$3,808,679
2026	$2,751,470	*2038*	$3,922,939
2027	$2,834,015	*2039*	$4,040,627
2028	$2,919,035	*2040*	$4,161,846
2029	$3,006,606	*2041*	$4,286,701
2030	$3,096,804	*2042*	$4,415,302
2031	$3,189,708	*2043*	$4,547,761

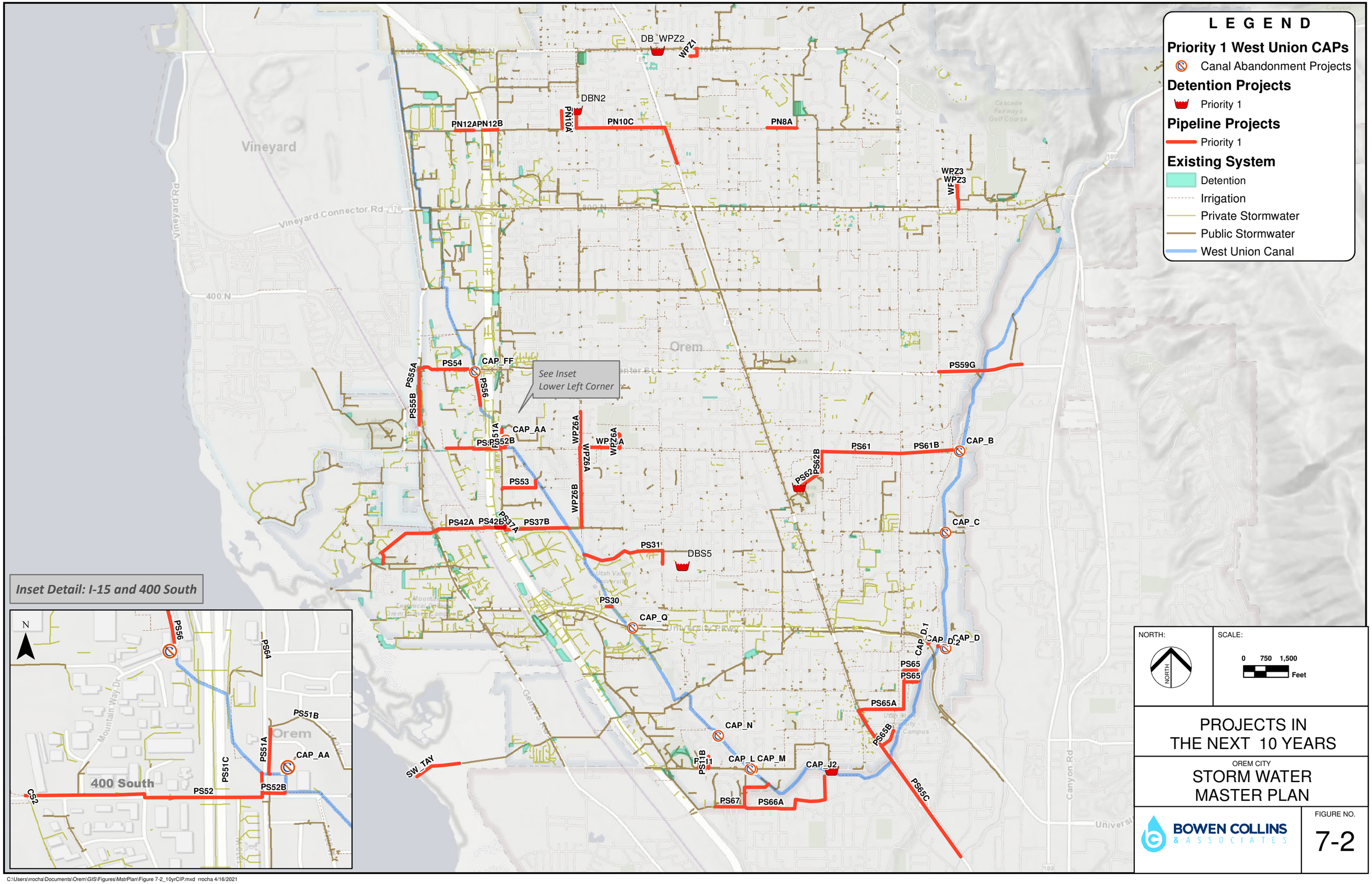
In addition to funding from rates, the City will apply roughly $3 million dollars from existing storm water cash reserves to accelerate the completion of the most urgent system improvements.

Because both the rates and the cash reserve fall short, a $2 million dollar storm water bond is anticipated in 2021 and a second $13 million dollar storm water bond is anticipated in 2024. These amounts are uncertain and will depend on the success of the bonding effort. Although the bond funds will still fall short of funding the most critical projects in the next ten years, it will allow for significant progress.

Figure 7-1 illustrates the spending from all funding sources combined through 2042. Figure 7-2 shows the location of projects listed in Table 7-1.

Figure 7-1
City of Orem Storm Drain Capital Improvement Plan 2020





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

NORTH:

SCALE: 0 750 1,500 Feet

PROJECTS IN THE NEXT 10 YEARS

OREM CITY
STORM WATER MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 7-2

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APPENDIX A

SOILS AND IDF DATA

L E G E N D

Subcatchment Boundary

Hydrologic Soil Type

A

B

C

D

Unknown

Future Orem City Boundary

BOWEN COLLINS & ASSOCIATES

OREM CITY

STORM WATER MASTER PLAN

HYDROLOGIC SOIL GROUP

NORTH:

NORTH

SCALE:

0 1,500 3,000 Feet

FIGURE NO.

A-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\FigureA-1_Soils_Map.mxd amckinnon 1/27/2021

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

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

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

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

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

Please refer to NOAA Atlas 14 document for more information.

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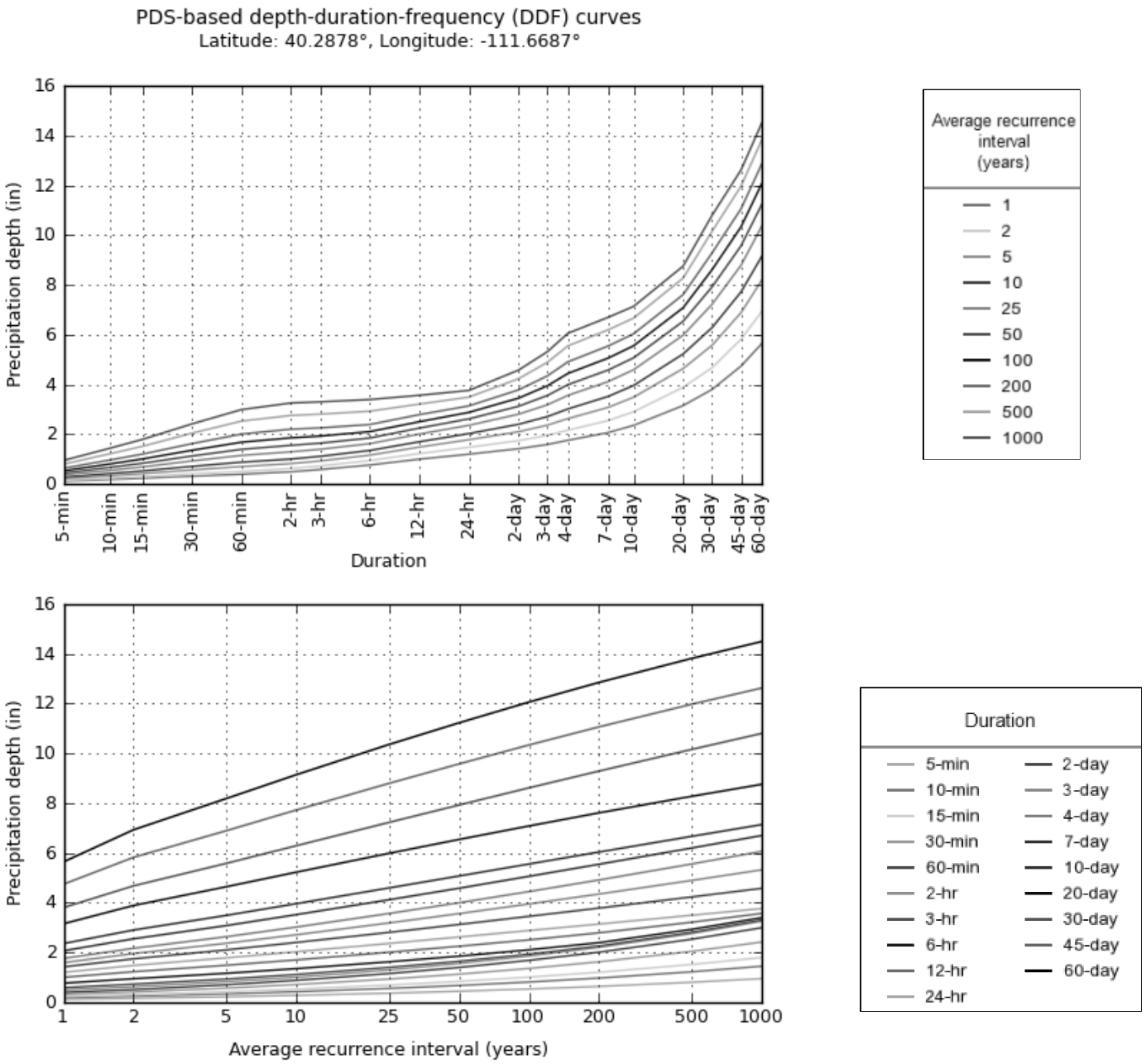
PF graphical



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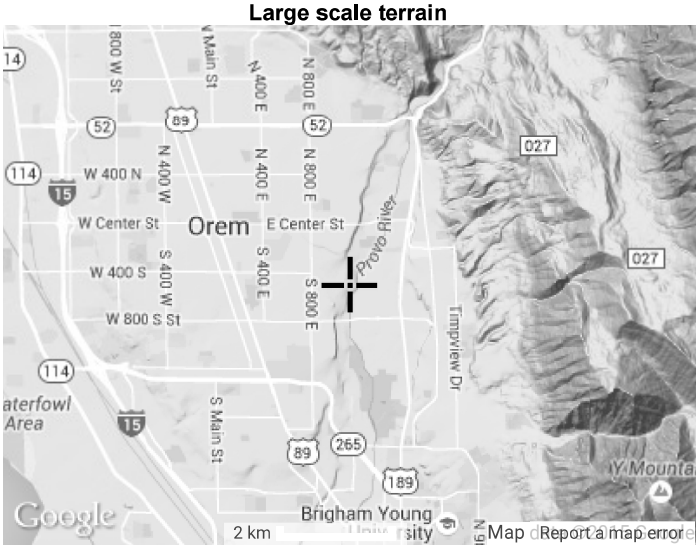
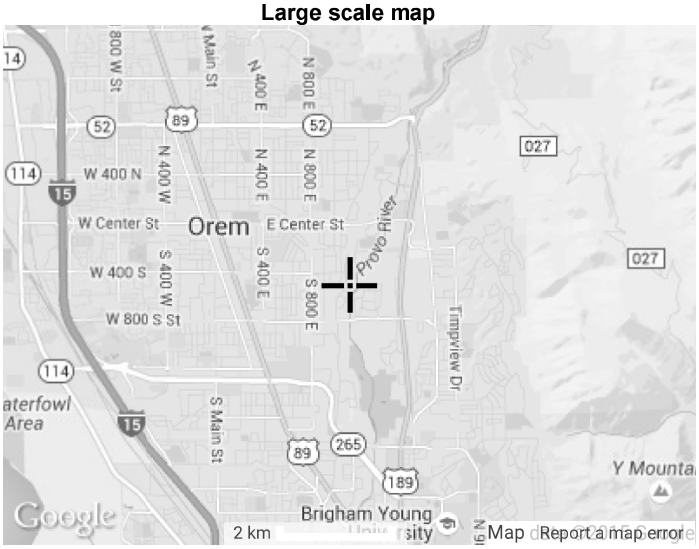
Maps & aerials

Small scale terrain

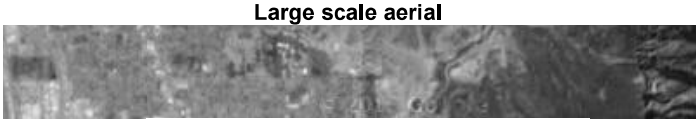
Large scale terrain



Large scale map



Large scale aerial



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

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APPENDIX B

COST DATA

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

Project Identifier	Project Name	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)
PN1A		103	36	1	0	0	$ 35,518	$ 1,776	$ 37,294	$ 7,104	$ 3,552	$ 46,200
PN1B		3,551	30	18	11	0	$ 1,063,962	$ 53,198	$ 1,117,160	$ 212,792	$ 106,396	$ 1,383,200
PN1C		2,689	30	14	8	0	$ 805,318	$ 40,266	$ 845,584	$ 161,064	$ 80,532	$ 1,046,900
PN2		120	30	1	0	0	$ 35,440	$ 1,772	$ 37,212	$ 7,088	$ 3,544	$ 46,100
PN3		70	24	1	0	0	$ 19,960	$ 998	$ 20,958	$ 3,992	$ 1,996	$ 25,900
PN4A		640	24	4	2	0	$ 173,120	$ 8,656	$ 181,776	$ 34,624	$ 17,312	$ 225,100
PN4B		800	24	5	2	0	$ 213,600	$ 10,680	$ 224,280	$ 42,720	$ 21,360	$ 277,700
PN5A		950	36	5	3	0	$ 327,500	$ 16,375	$ 343,875	$ 65,500	$ 32,750	$ 425,800
PN5B		410	30	3	1	0	$ 125,020	$ 6,251	$ 131,271	$ 25,004	$ 12,502	$ 162,500
PN5C		1,030	18	6	3	0	$ 261,220	$ 13,061	$ 274,281	$ 52,244	$ 26,122	$ 339,600
PN6A		120	30	1	0	0	$ 35,440	$ 1,772	$ 37,212	$ 7,088	$ 3,544	$ 46,100
PN6B		3,040	24	16	10	0	$ 813,120	$ 40,656	$ 853,776	$ 162,624	$ 81,312	$ 1,057,100
PN7		1,010	30	6	3	0	$ 305,420	$ 15,271	$ 320,691	$ 61,084	$ 30,542	$ 397,000
PN8A		990	24	5	3	0	$ 262,520	$ 13,126	$ 275,646	$ 52,504	$ 26,252	$ 341,300
PN8B		1,670	30	9	5	0	$ 501,540	$ 25,077	$ 526,617	$ 100,308	$ 50,154	$ 652,000
PN8C		770	24	4	2	0	$ 202,760	$ 10,138	$ 212,898	$ 40,552	$ 20,276	$ 263,600
PN8D		700	18	4	2	0	$ 177,000	$ 8,850	$ 185,850	$ 35,400	$ 17,700	$ 230,100
PN8E		690	18	4	2	0	$ 174,860	$ 8,743	$ 183,603	$ 34,972	$ 17,486	$ 227,300
PN8F		1,110	24	6	3	0	$ 293,880	$ 14,694	$ 308,574	$ 58,776	$ 29,388	$ 382,000
PN9A		1,340	36	7	4	0	$ 460,440	$ 23,022	$ 483,462	$ 92,088	$ 46,044	$ 598,600
PN9B		880	36	5	2	0	$ 300,480	$ 15,024	$ 315,504	$ 60,096	$ 30,048	$ 390,600
PN10A		590	18	3	1	0	$ 143,860	$ 7,193	$ 151,053	$ 28,772	$ 14,386	$ 187,000
PN10B		680	48	4	2	0	$ 308,720	$ 15,436	$ 324,156	$ 61,744	$ 30,872	$ 401,300
PN10C		4,230	42	22	14	0	$ 1,646,900	$ 82,345	$ 1,729,245	$ 329,380	$ 164,690	$ 2,141,000
PN11		640	36	4	2	0	$ 223,040	$ 11,152	$ 234,192	$ 44,608	$ 22,304	$ 290,000
PN12A		620	36	4	2	0	$ 216,920	$ 10,846	$ 227,766	$ 43,384	$ 21,692	$ 282,000
PN12B		520	24	3	1	0	$ 136,160	$ 6,808	$ 142,968	$ 27,232	$ 13,616	$ 177,000
WPZ7		3905	21	20	13	0	$ 1,015,712	$ 50,786	$ 1,066,497	$ 203,142	$ 101,571	$ 1,320,400
WPZ3	also has 1211 ft of 12-inch pipe	1071	18	6	3	0	$ 269,994	$ 13,500	$ 283,494	$ 53,999	$ 26,999	$ 381,800
PN18A		2040	42	11	6	0	$ 791,600	$ 39,580	$ 831,180	$ 158,320	$ 79,160	$ 1,029,100
PN18B		670	36	4	2	0	$ 232,220	$ 11,611	$ 243,831	$ 46,444	$ 23,222	$ 301,900
PN19		1700	30	9	5	0	$ 509,400	$ 25,470	$ 534,870	$ 101,880	$ 50,940	$ 662,200
PN20A		1160	42	6	3	0	$ 446,800	$ 22,340	$ 469,140	$ 89,360	$ 44,680	$ 580,800
PN20B		400	30	3	1	0	$ 122,400	$ 6,120	$ 128,520	$ 24,480	$ 12,240	$ 159,100
PN21		1240	18	7	4	0	$ 315,760	$ 15,788	$ 331,548	$ 63,152	$ 31,576	$ 410,500
PN22A		340	36	2	1	0	$ 117,640	$ 5,882	$ 123,522	$ 23,528	$ 11,764	$ 152,900
PN22B		350	30	2	1	0	$ 105,300	$ 5,265	$ 110,565	$ 21,060	$ 10,530	$ 136,900
PN24		1130	36	6	3	0	$ 386,580	$ 19,329	$ 405,909	$ 77,316	$ 38,658	$ 502,600
PN26		1050	18	6	3	0	$ 265,500	$ 13,275	$ 278,775	$ 53,100	$ 26,550	$ 345,200
PN28		800	24	5	2	0	$ 213,600	$ 10,680	$ 224,280	$ 42,720	$ 21,360	$ 277,700
PN30A		140	48	1	0	0	$ 61,960	$ 3,098	$ 65,058	$ 12,392	$ 6,196	$ 80,500
PN32		1550	54	8	5	0	$ 785,400	$ 39,270	$ 824,670	$ 157,080	$ 78,540	$ 1,021,000
PN33		1370	42	7	4	0	$ 529,900	$ 26,495	$ 556,395	$ 105,980	$ 52,990	$ 688,900
PN34		2400	36	13	8	0	$ 831,200	$ 41,560	$ 872,760	$ 166,240	$ 83,120	$ 1,080,600
PN35		20	60	1	0	0	$ 14,240	$ 712	$ 14,952	$ 2,848	$ 1,424	$ 18,500
PN36		40	60	1	0	0	$ 24,480	$ 1,224	$ 25,704	$ 4,896	$ 2,448	$ 31,800
PN37		60	60	1	0	0	$ 34,720	$ 1,736	$ 36,456	$ 6,944	$ 3,472	$ 45,100
PN38A		1310	24	7	4	0	$ 349,080	$ 17,454	$ 366,534	$ 69,816	$ 34,908	$ 453,800
PN38B		1740	30	9	5	0	$ 519,880	$ 25,994	$ 545,874	$ 103,976	$ 51,988	$ 675,800
PN39A		1140	36	6	3	0	$ 389,640	$ 19,482	$ 409,122	$ 77,928	$ 38,964	$ 506,500
PN39B		2030	18	11	6	0	$ 512,020	$ 25,601	$ 537,621	$ 102,404	$ 51,202	$ 665,600
PN40A		90	36	1	0	1	$ 81,540	$ 4,077	$ 85,617	$ 16,308	$ 8,154	$ 106,000
PN40B		1070	66	6	3	0	$ 646,420	$ 32,321	$ 678,741	$ 129,284	$ 64,642	$ 840,300
PS6A		1780	30	9	5	0	$ 530,360	$ 26,518	$ 556,878	$ 106,072	$ 53,036	$ 689,500
PS6B		4450	36	23	14	1	$ 1,582,100	$ 79,105	$ 1,661,205	$ 316,420	$ 158,210	$ 2,056,700
PS11		380	36	2	1	0	$ 129,880	$ 6,494	$ 136,374	$ 25,976	$ 12,988	$ 168,800
PS11B		400	24	3	1		$ 108,800	$ 5,440	$ 114,240	$ 21,760	$ 10,880	$ 141,400
PS13		300	36	2	1	0	$ 105,400	$ 5,270	$ 110,670	$ 21,080	$ 10,540	$ 137,000
PS14		570	30	3	1	0	$ 166,940	$ 8,347	$ 175,287	$ 33,388	$ 16,694	$ 217,000
WPZ9		114	12	2	1	0	#N/A	#N/A	#N/A	#N/A	#N/A	$ 42,600
PS16		917	36	5	3	0	$ 317,402	$ 15,870	$ 333,272	$ 63,480	$ 31,740	$ 412,600
WPZ8		638	12	3	2		#N/A					$ 168,200
CAP_D		621	24	4	2		$ 168,788	$ 8,439	$ 177,227	$ 183,758	$ 16,879	$ 369,400
PS56	Rehab existing WUC pipe						#N/A					$ 240,000
PS19		1870	30	10	6	0	$ 563,540	$ 28,177	$ 591,717	$ 112,708	$ 56,354	$ 732,600
PS20		1130	36	6	3	0	$ 386,580	$ 19,329	$ 405,909	$ 77,316	$ 38,658	$ 502,600
PS21		1010	36	6	3	0	$ 349,860	$ 17,493	$ 367,353	$ 69,972	$ 34,986	$ 454,800
PS22A		1210	36	7	4	0	$ 420,660	$ 21,033	$ 441,693	$ 84,132	$ 42,066	$ 546,900
PS22B		1530	36	8	5	0	$ 528,180	$ 26,409	$ 554,589	$ 105,636	$ 52,818	$ 686,600
PS23		1280	42	7	4	0	$ 498,400	$ 24,920	$ 523,320	$ 99,680	$ 49,840	$ 647,900
PS24		40	24	1	0	0	$ 13,120	$ 656	$ 13,776	$ 2,624	$ 1,312	$ 17,100
PS25A		750	42	4	2	0	$ 289,700	$ 14,485	$ 304,185	$ 57,940	$ 28,970	$ 376,600
PS25B		240	36	2	0	0	$ 81,440	$ 4,072	$ 85,512	$ 16,288	$ 8,144	$ 105,900
PS25C		2200	36	12	7	0	$ 760,400	$ 38,020	$ 798,420	$ 152,080	$ 76,040	$ 988,500
PS26A		3130	42	16	10	0	$ 1,215,500	$ 60,775	$ 1,276,275	$ 243,100	$ 121,550	$ 1,580,200
PS26B		4600	30	24	15	0	$ 1,385,200	$ 69,260	$ 1,454,460	$ 277,040	$ 138,520	$ 1,800,800
PS27		390	24	2	1	0	$ 102,520	$ 5,126	$ 107,646	$ 20,504	$ 10,252	$ 133,300
PS28		1100	42	6	3	0	$ 425,800	$ 21,290	$ 447,090	$ 85,160	$ 42,580	$ 553,500
PS29A		11720	30	59	39	0	$ 3,525,040	$ 176,252	$ 3,701,292	$ 705,008	$ 352,504	$ 4,582,600
PS29B		4360	36	22	14	0	$ 1,500,560	$ 75,028	$ 1,575,588	$ 300,112	$ 150,056	$ 1,950,700
PS29C		1490	30	8	4	0	$ 444,780	$ 22,239	$ 467,019	$ 88,956	$ 44,478	$ 578,200
PS30		300	18	2	1		$ 77,800	$ 3,890	$ 81,690	$ 15,560	$ 7,780	$ 151,100
PS31		3240	18	17	10	0	$ 817,360	$ 40,868	$ 858,228	$ 163,472	$ 81,736	$ 1,062,600
PS54		1800	48	10	6	0	$ 818,800	$ 40,940	$ 859,740	$ 163,760	$ 81,880	$ 1,064,400
PS37A		263	42	2	0	0	$ 100,050	$ 5,003	$ 105,053	$ 20,010	$ 10,005	$ 130,100
PS37B		2132	36	11	7	0	$ 735,592	$ 36,780	$ 772,372	$ 147,118	$ 73,559	$ 956,300
PS38		50	36	1	0	0	$ 19,300	$ 965	$ 20,265	$ 3,860	$ 1,930	$ 25,100
WPZ6A		3741	30	19	12	1	$ 1,173,342	$ 58,667	$ 1,232,009	$ 234,668	$ 117,334	$ 1,525,300
WPZ6B		1950	36	10	6	2	$ 770,300	$ 38,515	$ 808,815	$ 154,060	$ 77,030	$ 1,001,400
PS42A		4090	42	21	13	0	$ 1,588,300	$ 79,415	$ 1,667,715	$ 317,660	$ 158,830	$ 2,064,800
PS42B		510	42	3	1	0	$ 196,100	$ 9,805	$ 205,905	$ 39,220	$ 19,610	$ 254,900

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

Project Identifier	Project Name	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)
PS43B		1440	36	8	4	0	$ 495,040	$ 24,752	$ 519,792	$ 99,008	$ 49,504	$ 643,600
PS44		1180	36	6	3	0	$ 401,880	$ 20,094	$ 421,974	$ 80,376	$ 40,188	$ 522,400
PS45		500	24	3	1	0	$ 131,600	$ 6,580	$ 138,180	$ 26,320	$ 13,160	$ 171,100
PS46		410	60	3	1	0	$ 227,520	$ 11,376	$ 238,896	$ 45,504	$ 22,752	$ 295,800
PS47A		940	60	5	3	0	$ 518,080	$ 25,904	$ 543,984	$ 103,616	$ 51,808	$ 673,500
PS47B		830	54	5	2	0	$ 419,640	$ 20,982	$ 440,622	$ 83,928	$ 41,964	$ 545,500
PS47C		1460	48	8	4	0	$ 658,840	$ 32,942	$ 691,782	$ 131,768	$ 65,884	$ 856,500
PS47D		2360	36	12	7	0	$ 809,360	$ 40,468	$ 849,828	$ 161,872	$ 80,936	$ 1,052,200
PS48		280	36	2	0	0	$ 93,680	$ 4,684	$ 98,364	$ 18,736	$ 9,368	$ 121,800
PS49		520	24	3	1	1	$ 186,160	$ 9,308	$ 195,468	$ 37,232	$ 18,616	$ 242,000
PS51A		450	24	3	1	0	$ 120,200	$ 6,010	$ 126,210	$ 24,040	$ 12,020	$ 156,300
PS51B		360	24	2	1	0	$ 95,680	$ 4,784	$ 100,464	$ 19,136	$ 9,568	$ 124,400
PS51C		1060	18	6	3	0	$ 267,640	$ 13,382	$ 281,022	$ 53,528	$ 26,764	$ 347,900
PS52		2065	24	11	6	0	$ 548,420	$ 27,421	$ 575,841	$ 109,684	$ 54,842	$ 712,900
PS52B		187	18	1	0	0	$ 44,018	$ 2,201	$ 46,219	$ 8,804	$ 4,402	$ 57,200
PS53	543 S 1020 W, West Union Canal Exit	1423	18	4	4	0	$ 342,922	$ 17,146	$ 360,068	$ 68,584	$ 34,292	$ 445,800
PS55A		710	54	4	2	0	$ 359,480	$ 17,974	$ 377,454	$ 71,896	$ 35,948	$ 467,300
PS55B		1290	60	7	4	1	$ 760,880	$ 38,044	$ 798,924	$ 152,176	$ 76,088	$ 989,100
PS58A		1350	36	7	4	0	$ 463,500	$ 23,175	$ 486,675	$ 92,700	$ 46,350	$ 602,600
PS58B		2820	36	15	9	0	$ 973,320	$ 48,666	$ 1,021,986	$ 194,664	$ 97,332	$ 1,265,300
PS58C		1880	36/42	10	6	1	$ 740,240	$ 37,012	$ 777,252	$ 148,048	$ 74,024	$ 962,300
PS58D		1310	36	7	4	0	$ 451,260	$ 22,563	$ 473,823	$ 90,252	$ 45,126	$ 586,600
PS59A		2000	42	11	6	0	$ 777,600	$ 38,880	$ 816,480	$ 155,520	$ 77,760	$ 1,010,900
PS59B		2360	36	12	7	0	$ 809,360	$ 40,468	$ 849,828	$ 161,872	$ 80,936	$ 1,052,200
PS59C		1880	30/36	14	8	0	810800	40540	851340	162160	81080	1054100
PS59D		760	36	4	2	0	$ 259,760	$ 12,988	$ 272,748	$ 51,952	$ 25,976	$ 337,700
PS59E		670	30	4	2	0	$ 202,740	$ 10,137	$ 212,877	$ 40,548	$ 20,274	$ 263,600
PS59F		1810	24	10	6	0	$ 486,280	$ 24,314	$ 510,594	$ 97,256	$ 48,628	$ 632,200
PS59G		2801	24	15	9	1	$ 799,028	$ 39,951	$ 838,979	$ 159,806	$ 79,903	$ 1,038,700
PS60		3500	36	18	11	0	$ 1,204,600	$ 60,230	$ 1,264,830	$ 240,920	$ 120,460	$ 1,566,000
PS61		2660	30	14	8	0	$ 797,720	$ 39,886	$ 837,606	$ 159,544	$ 79,772	$ 1,037,000
PS61B		1720	24	9	5		$ 456,160	$ 22,808	$ 478,968	$ 91,232	$ 45,616	$ 593,000
PS62A		1824	36	10	6	0	$ 631,744	$ 31,587	$ 663,331	$ 126,349	$ 63,174	$ 821,300
PS62B		1360	30	7	4	0	$ 406,720	$ 20,336	$ 427,056	$ 81,344	$ 40,672	$ 528,700
PS62C		680	24	4	2	0	$ 182,240	$ 9,112	$ 191,352	$ 36,448	$ 18,224	$ 236,900
PS63		2400	36	13	8	0	$ 831,200	$ 41,560	$ 872,760	$ 166,240	$ 83,120	$ 1,080,600
PS64		900	24	5	3	0	$ 242,000	$ 12,100	$ 254,100	$ 48,400	$ 24,200	$ 314,600
PS65		870	18	5	2		$ 217,380	$ 10,869	$ 228,249	$ 43,476	$ 21,738	$ 282,600
PS65A		3271	42	17	10	0	$ 1,268,850	$ 63,443	$ 1,332,293	$ 253,770	$ 126,885	$ 1,649,500
PS65B		675	24	4	2	0	$ 181,100	$ 9,055	$ 190,155	$ 36,220	$ 18,110	$ 235,400
PS65C		3850	42	20	12	1	$ 1,544,700	$ 154,470	$ 1,699,170	$ 308,940	$ 154,470	$ 2,008,100
PS66A		3776	24	19	12	1	$ 1,054,128	$ 52,706	$ 1,106,834	$ 210,826	$ 105,413	$ 1,370,400
PS67		2500	30	13	8	2	$ 851,800	$ 42,590	$ 894,390	$ 170,360	$ 85,180	$ 1,107,300
SW_TAY							#N/A					$ 2,700,000
CS1		100	60	0	1	1	$ 106,800	$ 5,340	$ 112,140	$ 21,360	$ 10,680	$ 138,800
CS2		810	96	0	2	0	$ 769,360	$ 38,468	$ 807,828	$ 153,872	$ 76,936	$ 1,000,200
											Pipe Subtotal:	**$ 102,116,700**

Description	Unit	Size	Unit Cost
Detention Basins			
Property Acquisition	Acre		$201,000
Excavation and Hauling	Cubic Yard		$20
Landscaping (Non-irrigated Native)	Square Foot		$0.40
Landscaping (Irrigated Turfgrass)	Square Foot		$3.50
Inlet Apron	Lump Sum		$16,000
Outlet Structure	Lump Sum		$50,000
Emergency Spillway	Lump Sum		$7,000
Riprap	Lump Sum		$27,000
Storm Water Pipelines			
Permanent Easement Acquisition	Acre		$13,000
12-inch RCP	Linear Foot	12	$125
18-inch RCP	Linear Foot	18	$130
21-inch RCP	Linear Foot	21	$135
24-inch RCP	Linear Foot	24	$140
30-inch RCP	Linear Foot	30	$170
36-inch RCP	Linear Foot	36	$210
42-inch RCP	Linear Foot	42	$250
48-inch RCP	Linear Foot	48	$310
54-inch RCP	Linear Foot	54	$360
60-inch RCP	Linear Foot	60	$400
66-inch RCP	Linear Foot	66	$450
72-inch RCP	Linear Foot	72	$510
78-inch RCP	Linear Foot	78	$590
84-inch RCP	Linear Foot	84	$660
90-inch RCP	Linear Foot	90	$740
96-inch RCP	Linear Foot	96	$800
Manhole	Each		$5,600
Catch Basin	Each		$4,000
Traffic Control	Linear Foot		$24
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		$80,000
Headwalls	Lump Sum		$6,400
Riprap	Lump Sum		$86,000
Traffic Control	Lump Sum		$7,100
Asphalt Road Repair	Linear Foot		(Pipe Diameter [in feet] + 5') * $7
Channel Construction			
Excavation and Hauling	Cubic Yard		$19
Landscaping (Non-irrigated Native)	Square Yard		$3
Riprap	Cubic Yard		$47
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

APPENDIX C

WELL PROTECTION ZONES

BOWEN COLLINS & ASSOCIATES

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:

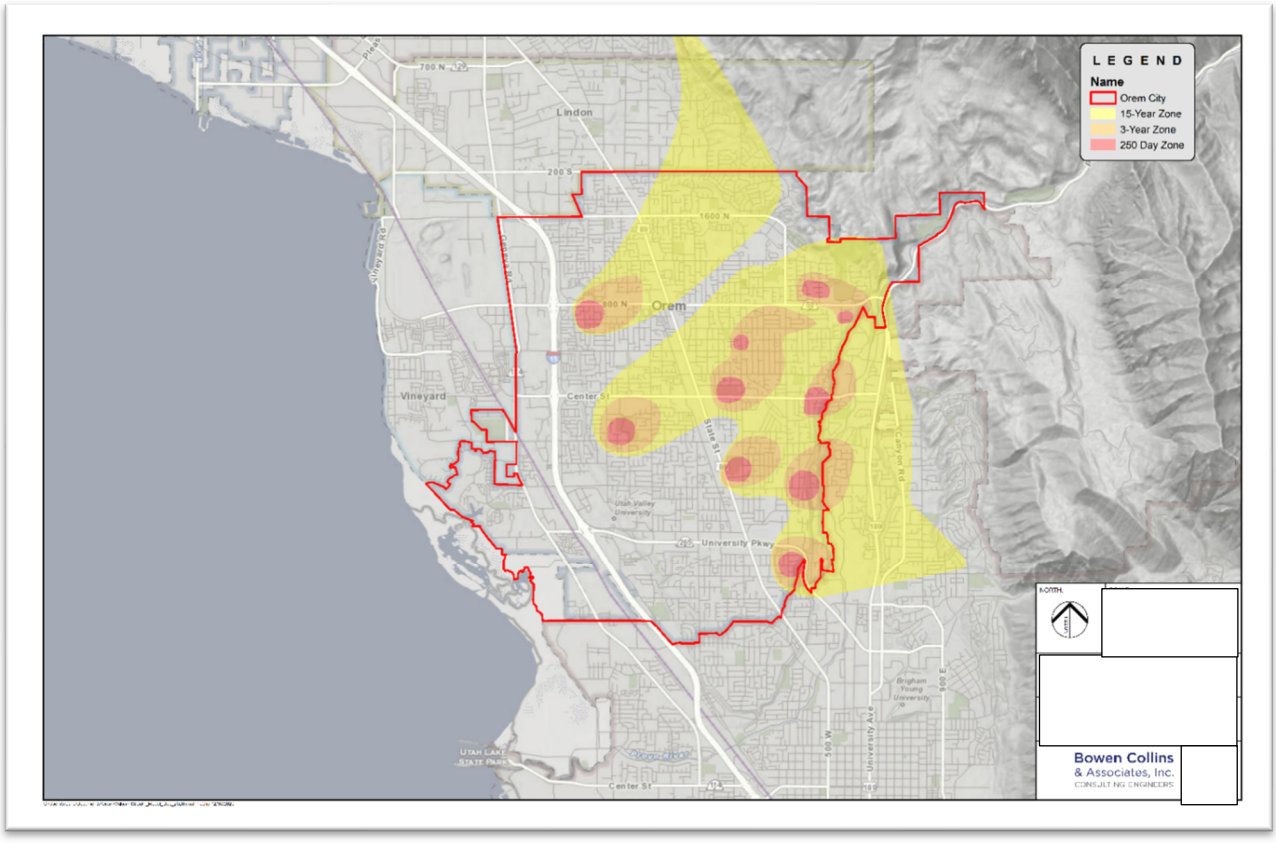


Exhibit 1. Well Protection Zones, Orem, Utah 2020.

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.

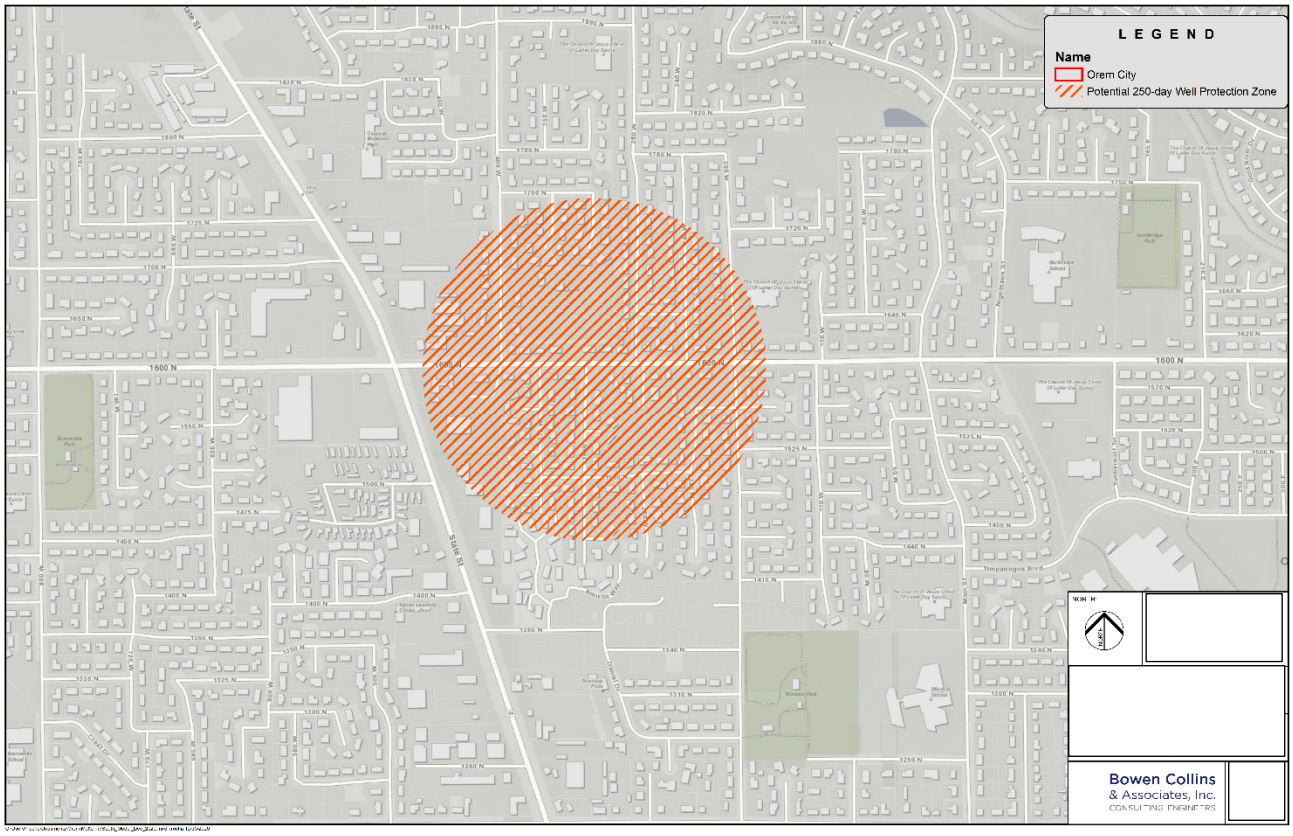


Exhibit 2. Potential Future Well Protection Zone.

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.

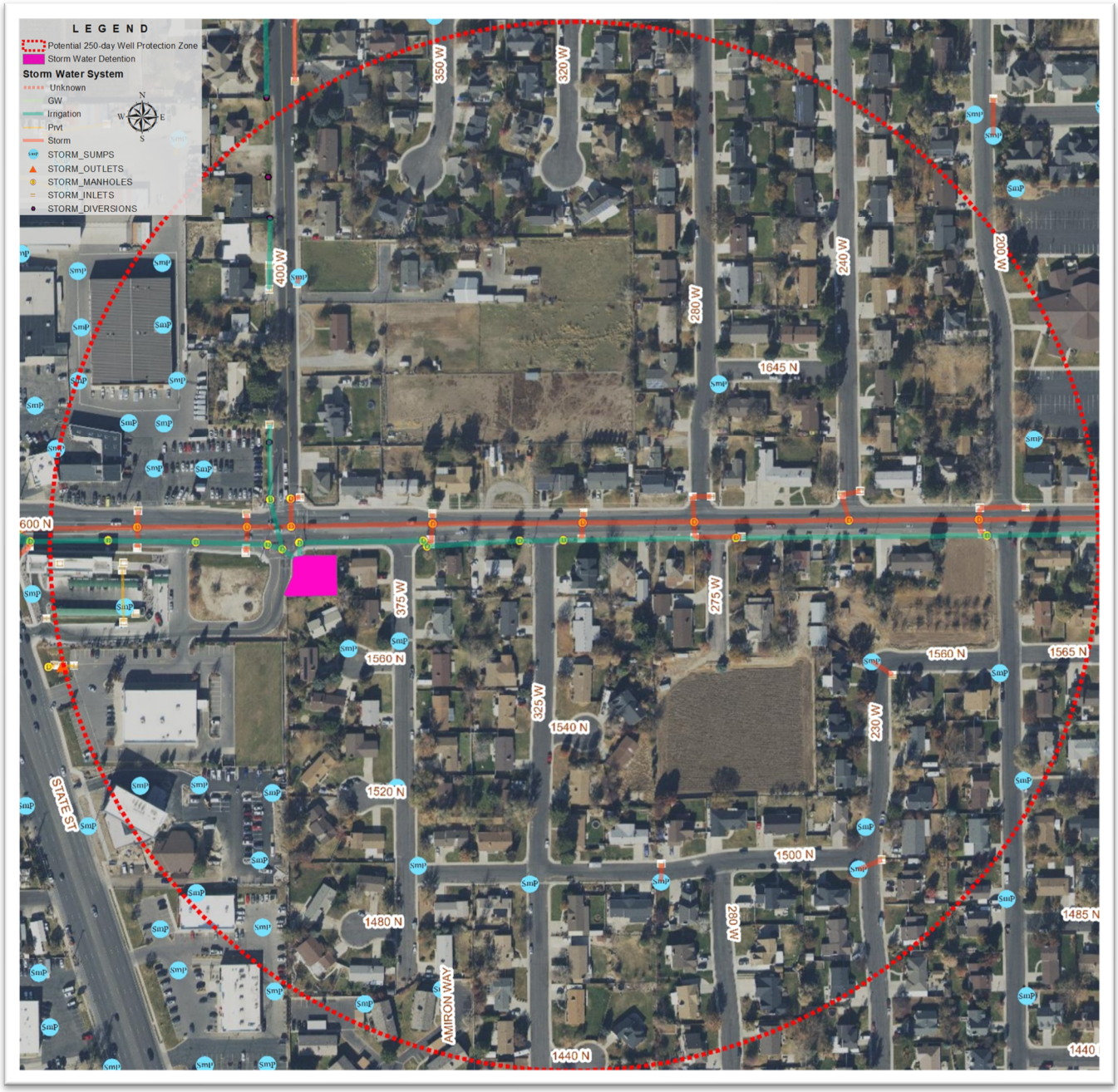


Exhibit 3. Future Well Protection Zone Storm Infrastructure.

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 threating 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.

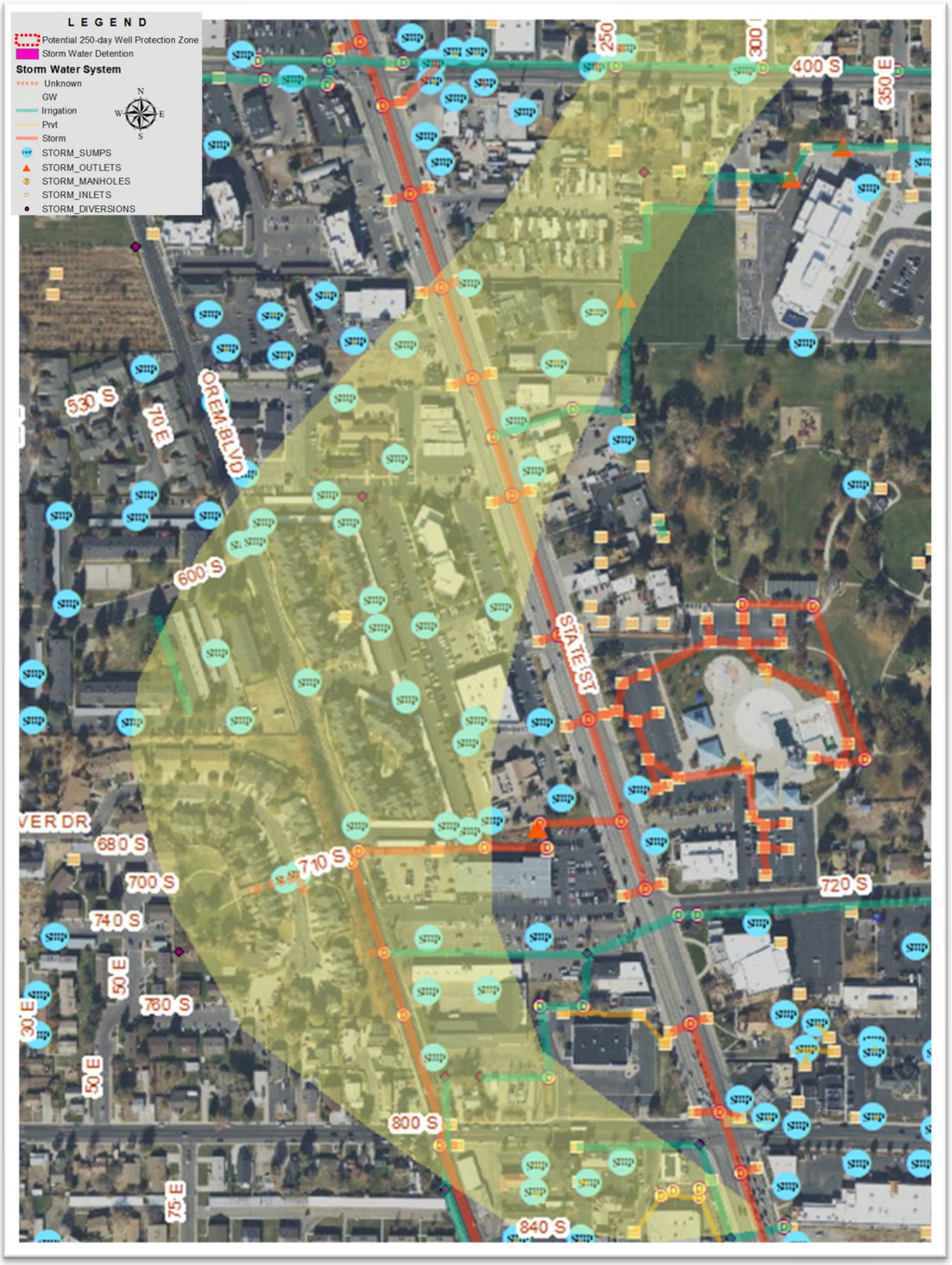


Exhibit 8. New Area Added to the Safe Sump Zone.

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.

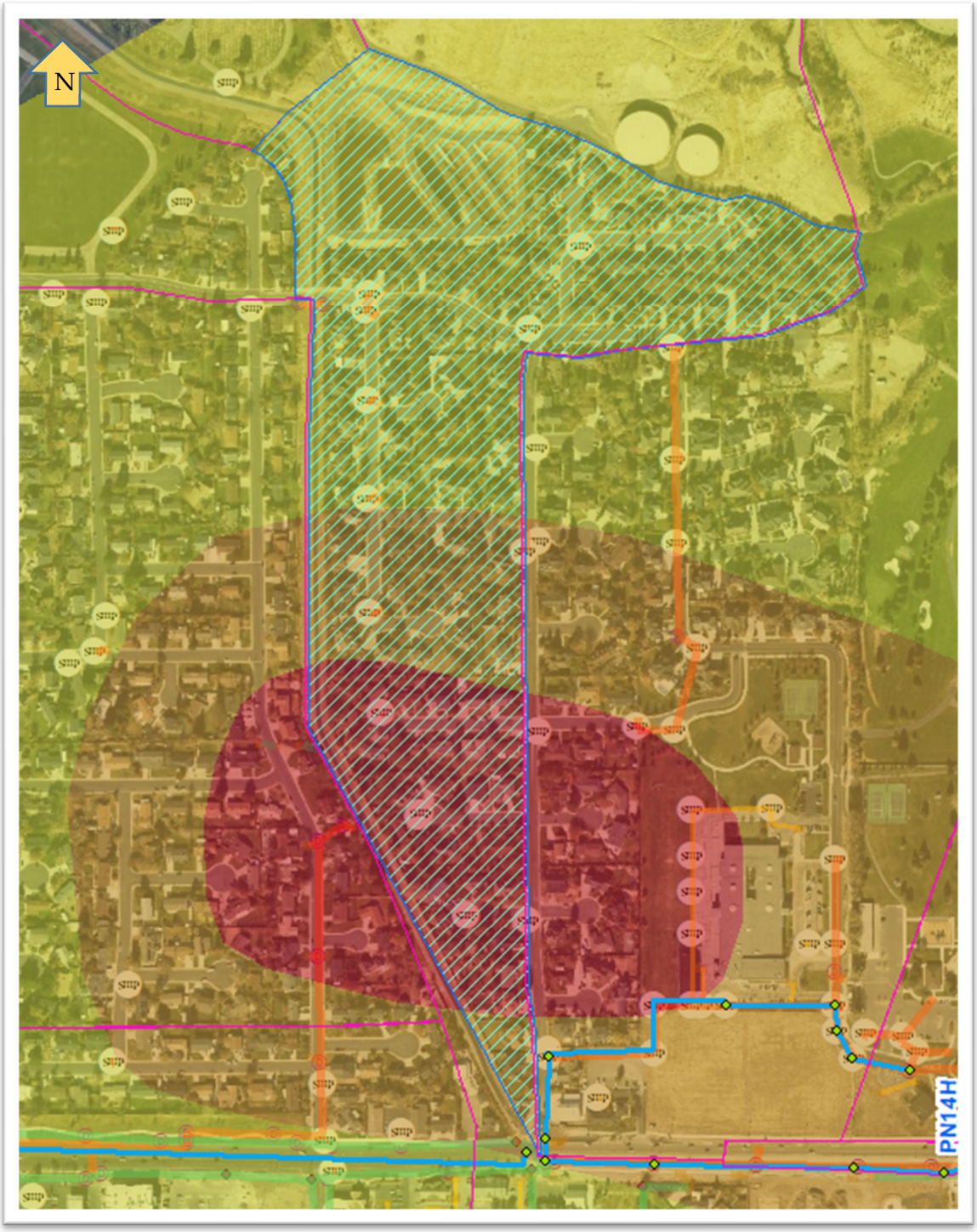


Exhibit 10. Well 6 Protection Zone.

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.

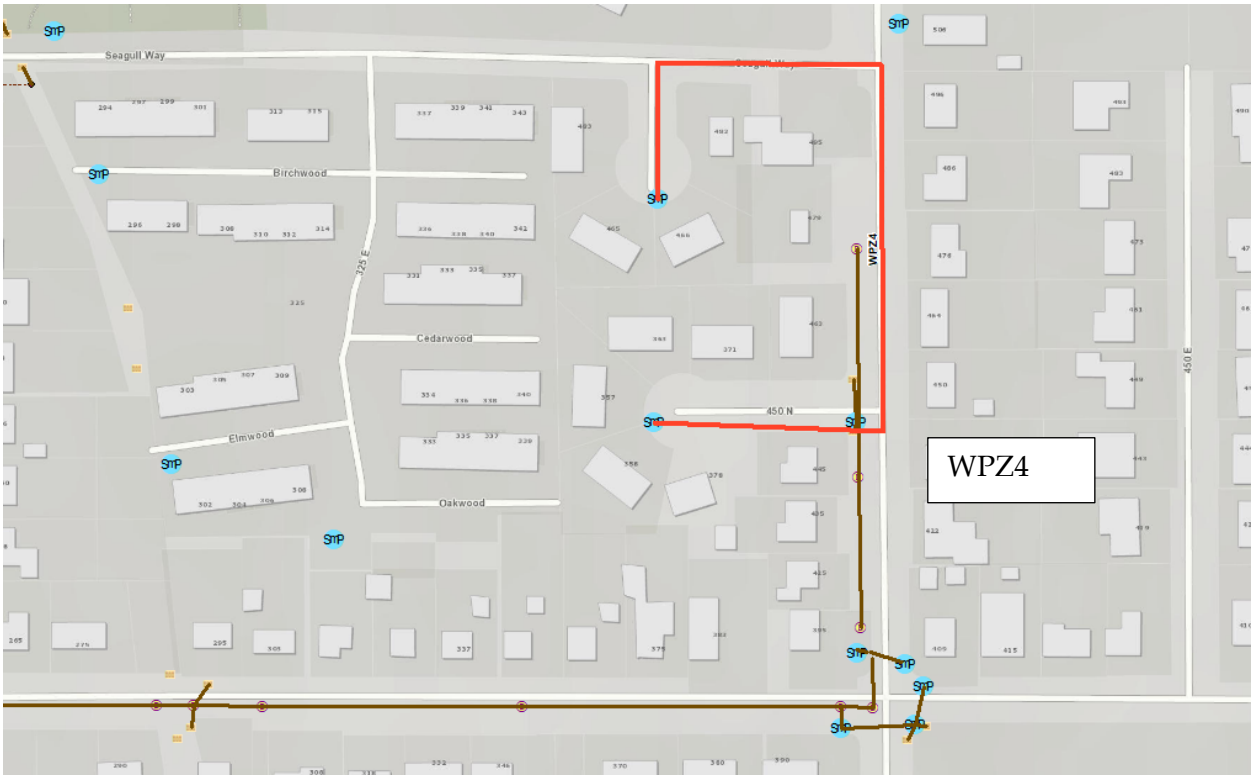


Exhibit 18. WPZ Improvements Near 400 E and 500 N.

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.

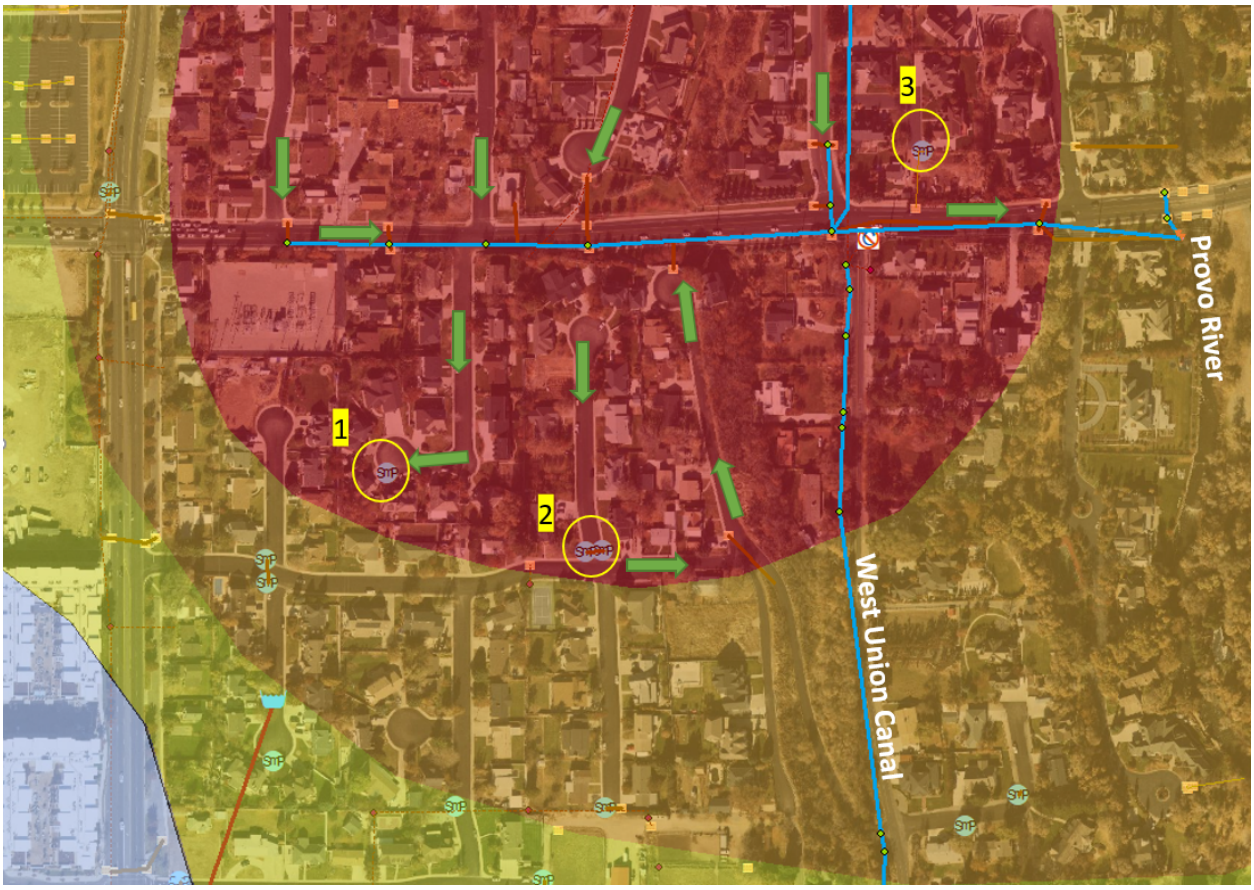


Exhibit 19. WPZ Improvements Near 800 S. and Carterville Road.

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.

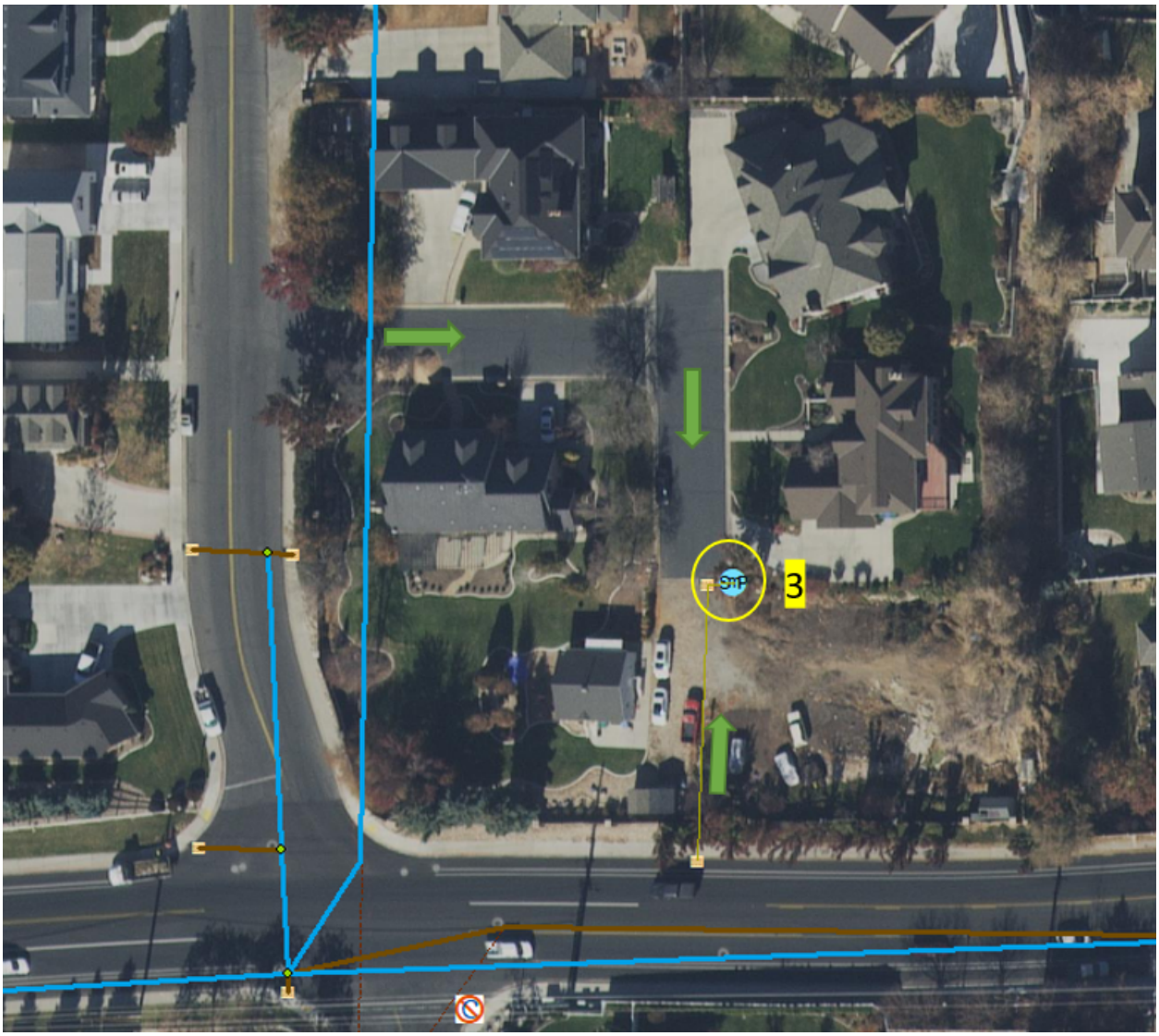


Exhibit 20. Detail of Sump 3 Area.

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

BOWEN COLLINS & ASSOCIATES

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.

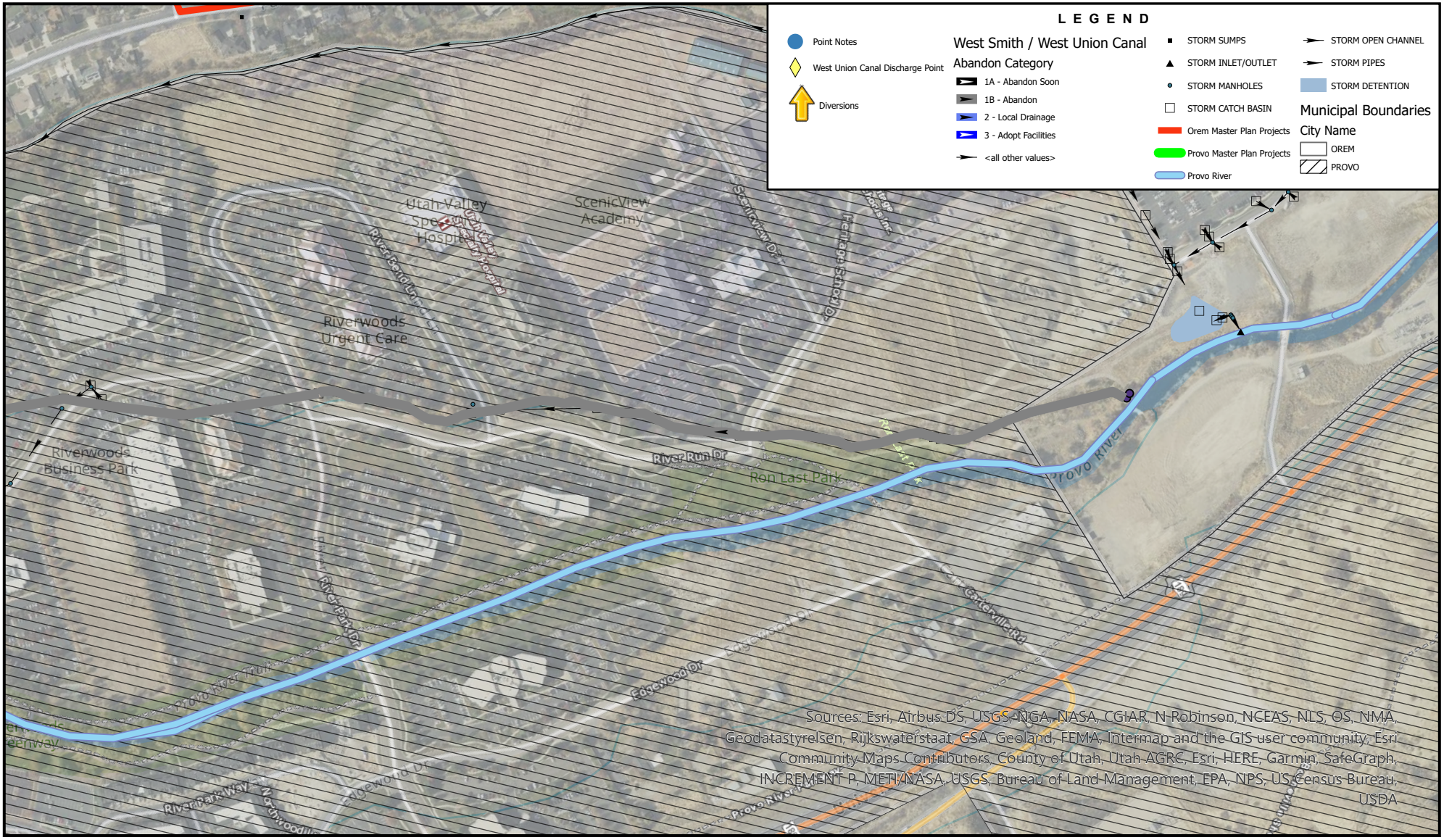
Black – The canal line in black show parts of the canal that the City anticipates will be discontinued in the next year or two.

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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

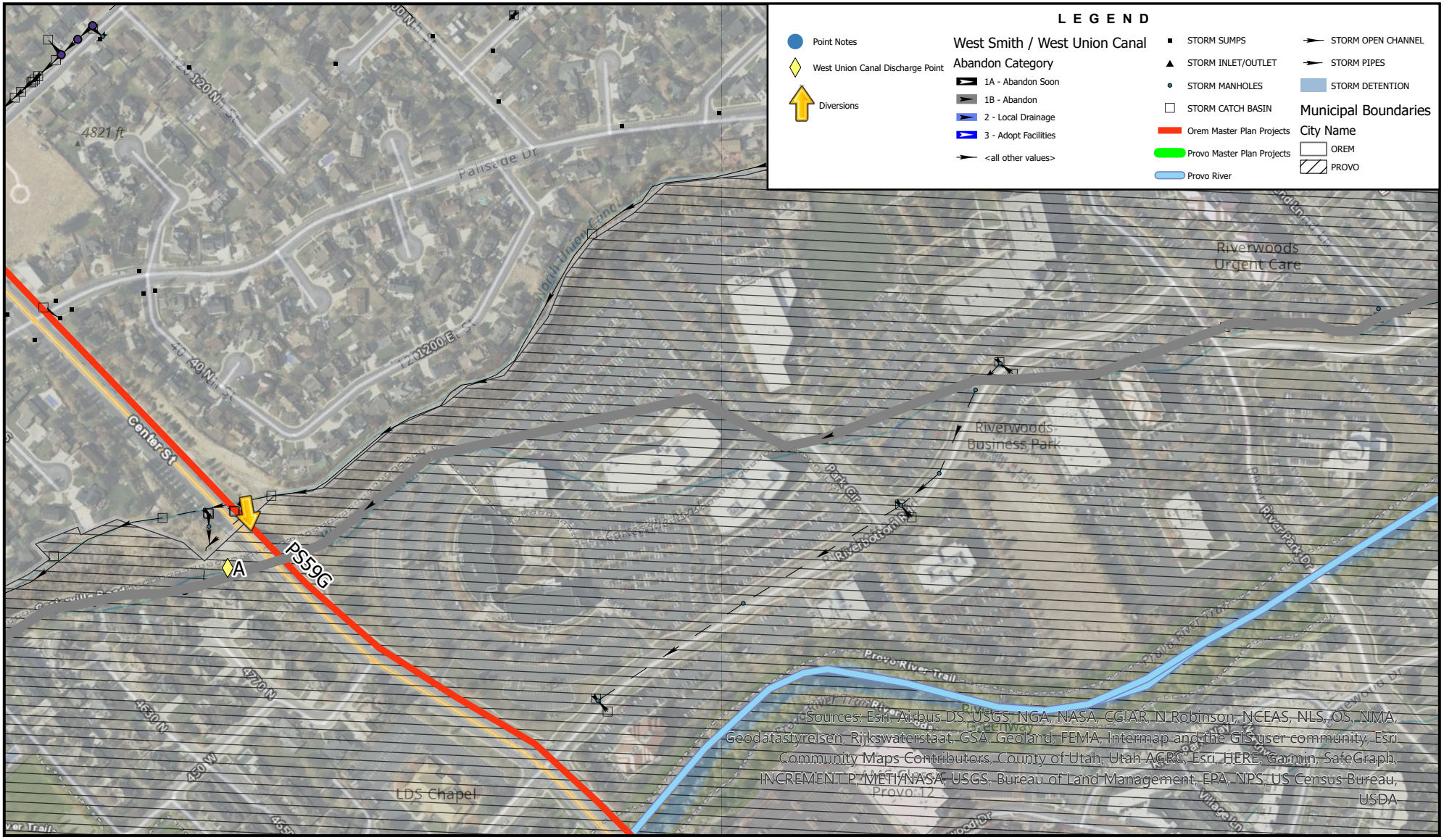
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



Points Project

None Provo City

BOWEN COLLINS & ASSOCIATES

OREM CITY

STORM WATER MASTER PLAN

WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P2

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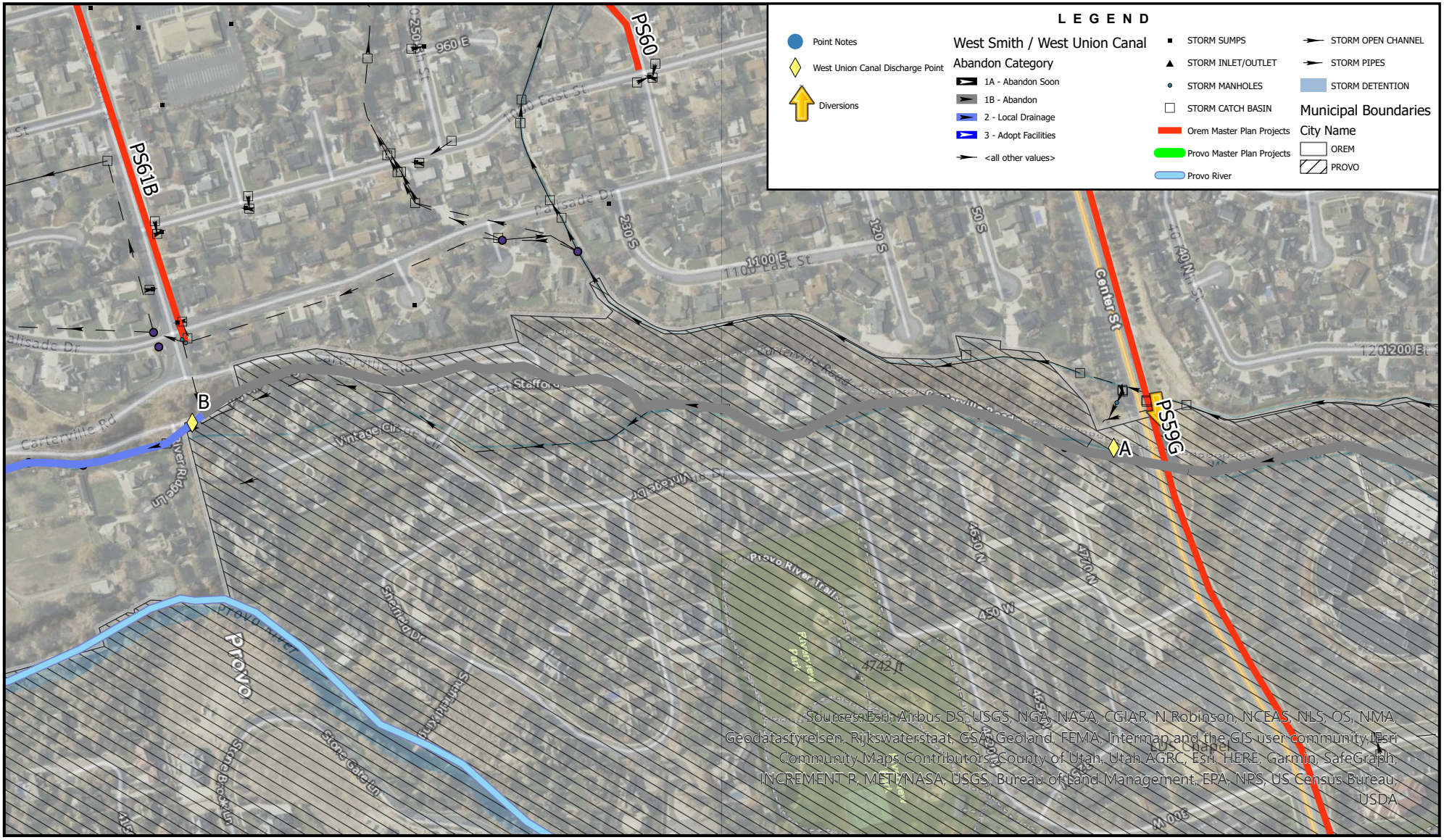

Points	Project
A	Project No. PS59G - 1400 ft of Pipe to Provo River
B	Project PS61B

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P3

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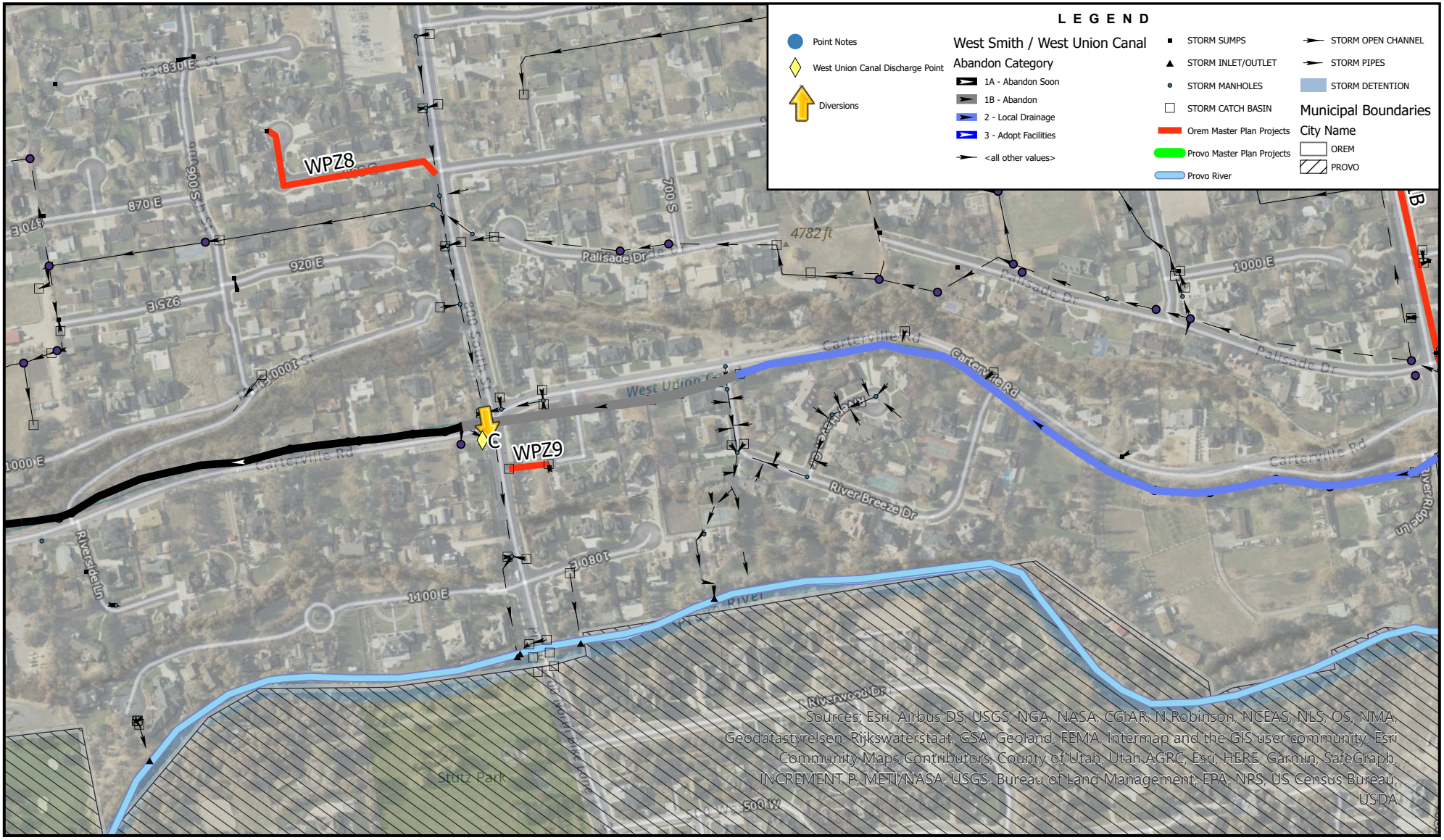


Points	Project
C	Divert flow east through existing SD to Provo River

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

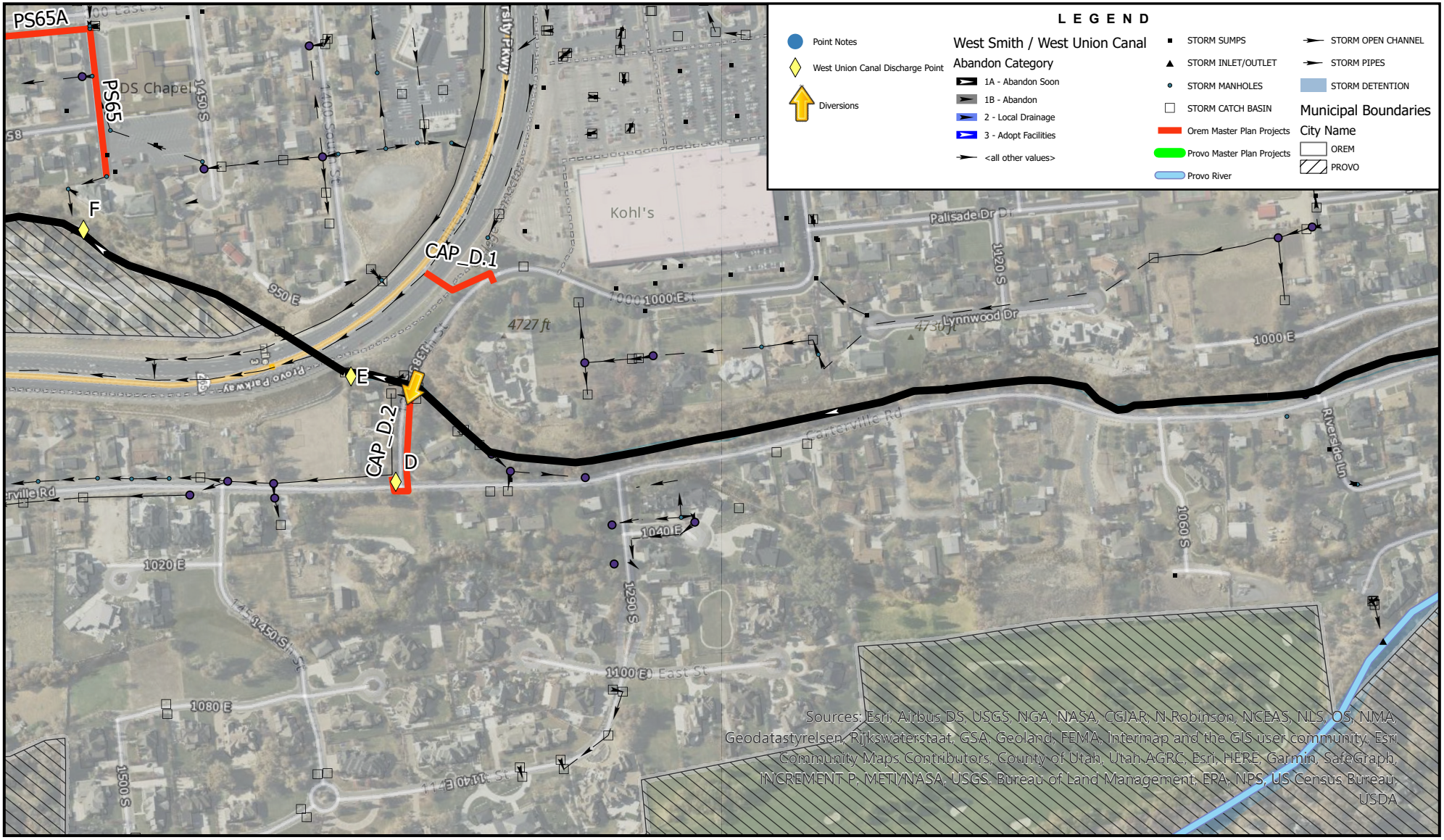
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P4

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

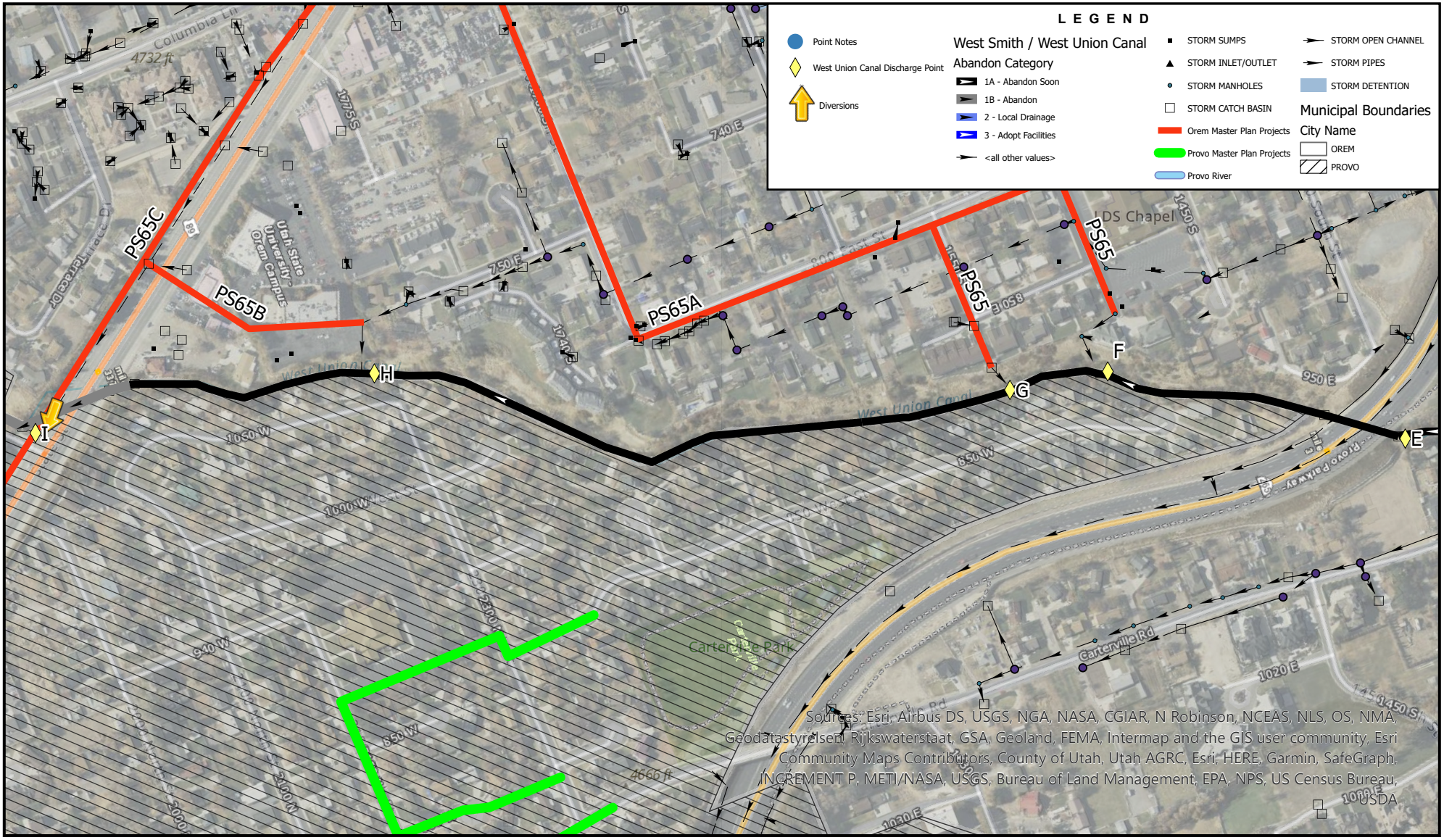
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P5

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

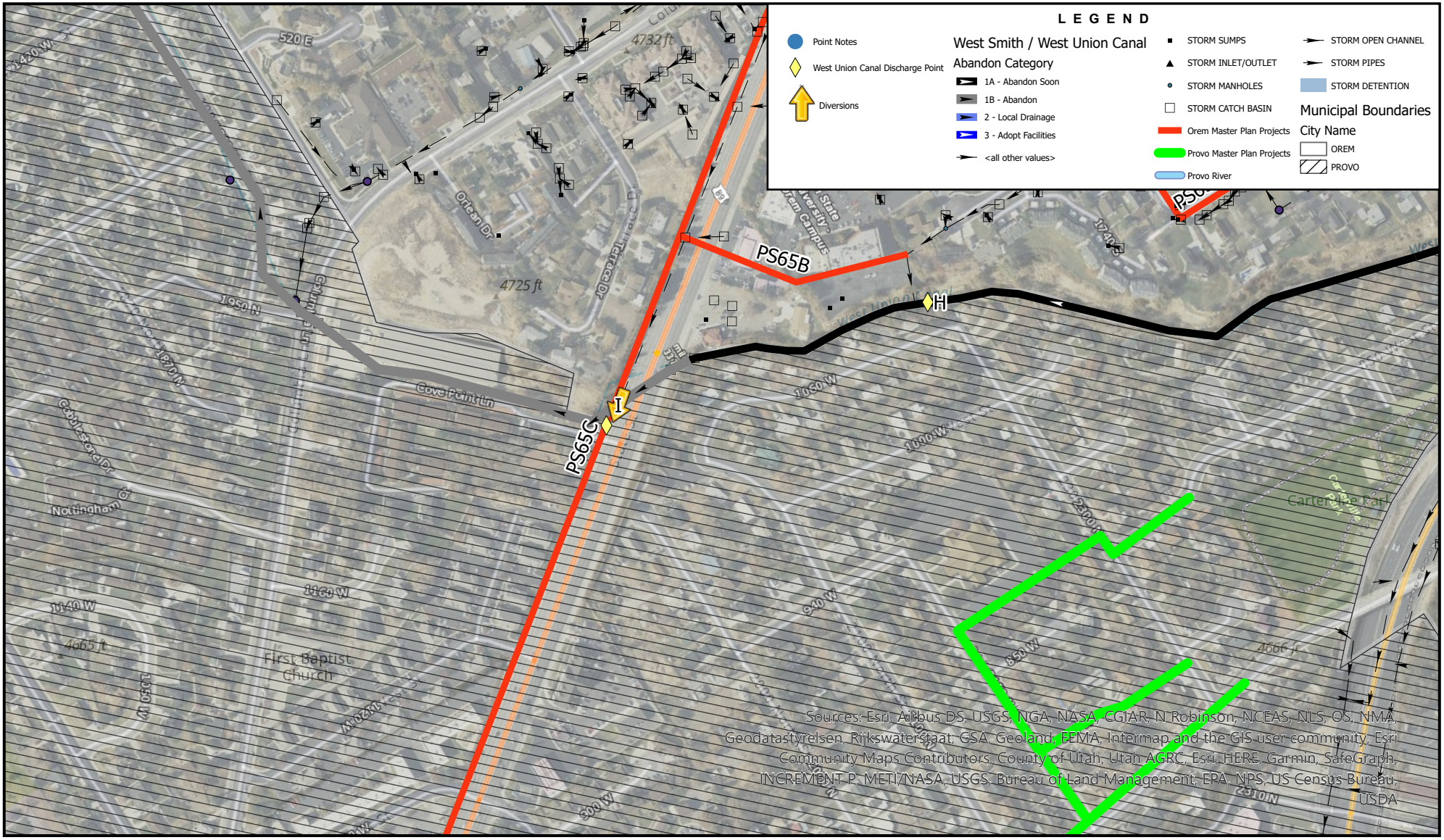
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P6

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

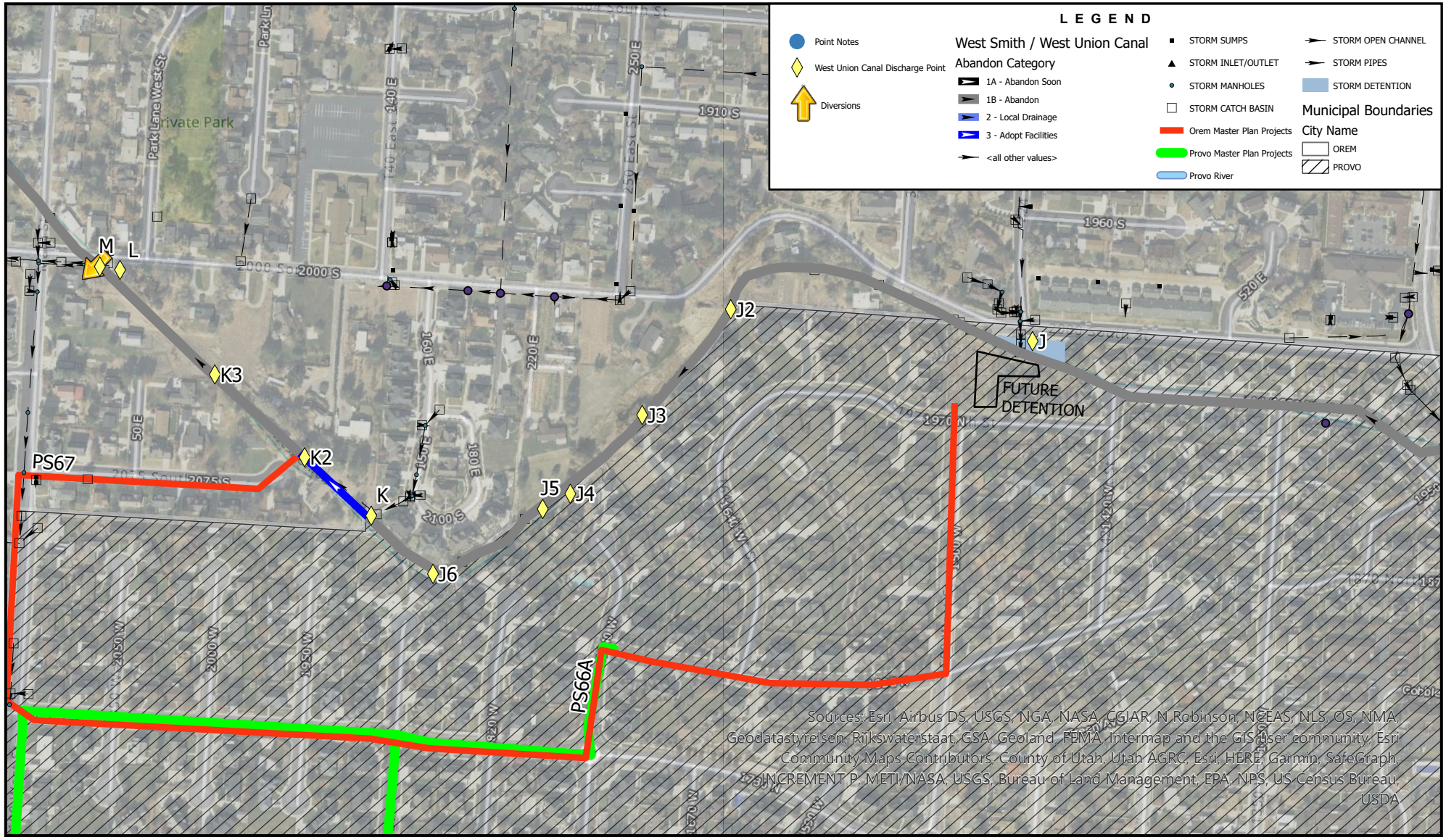
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P7

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

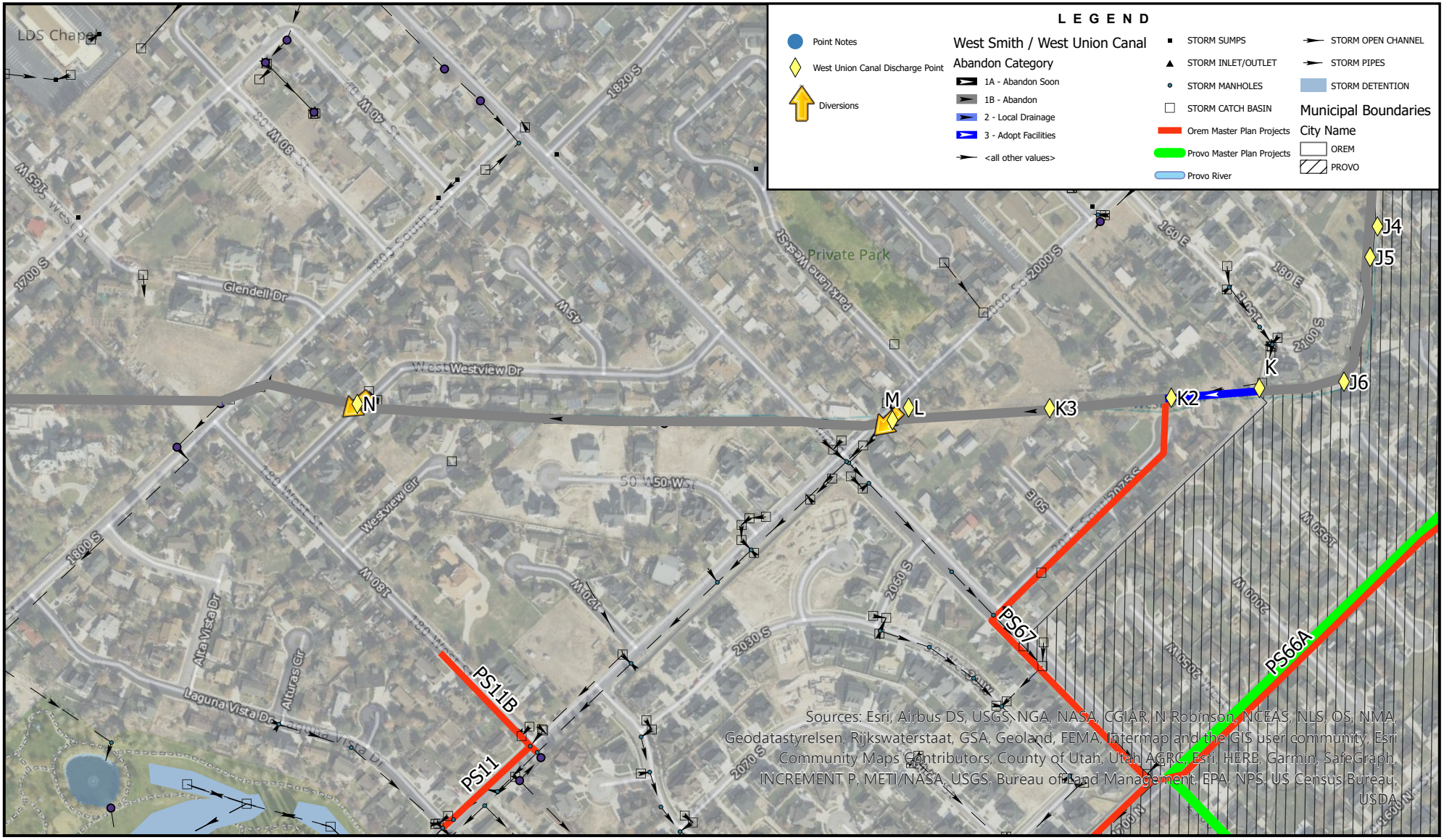
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P8

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

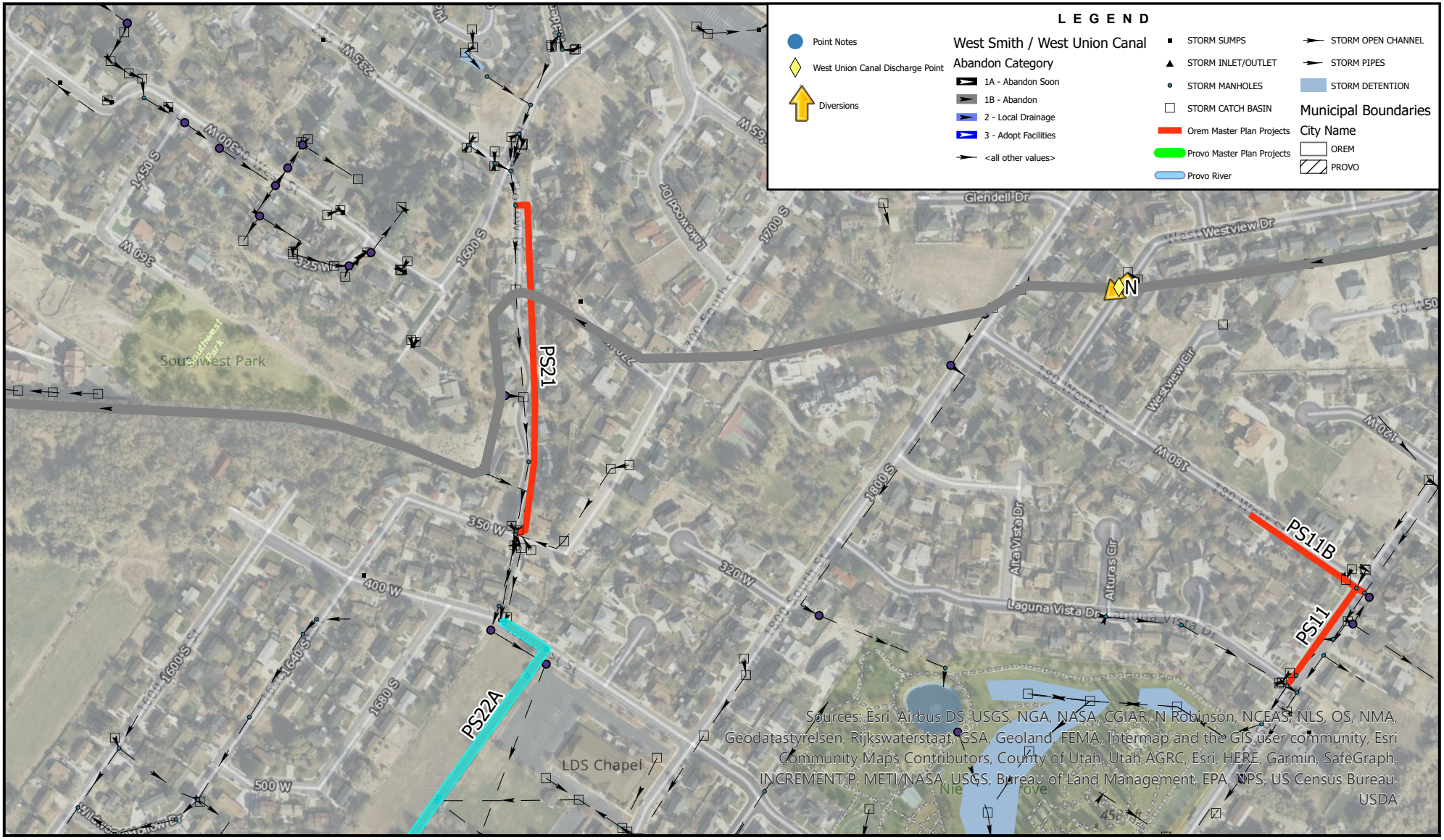
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P9

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

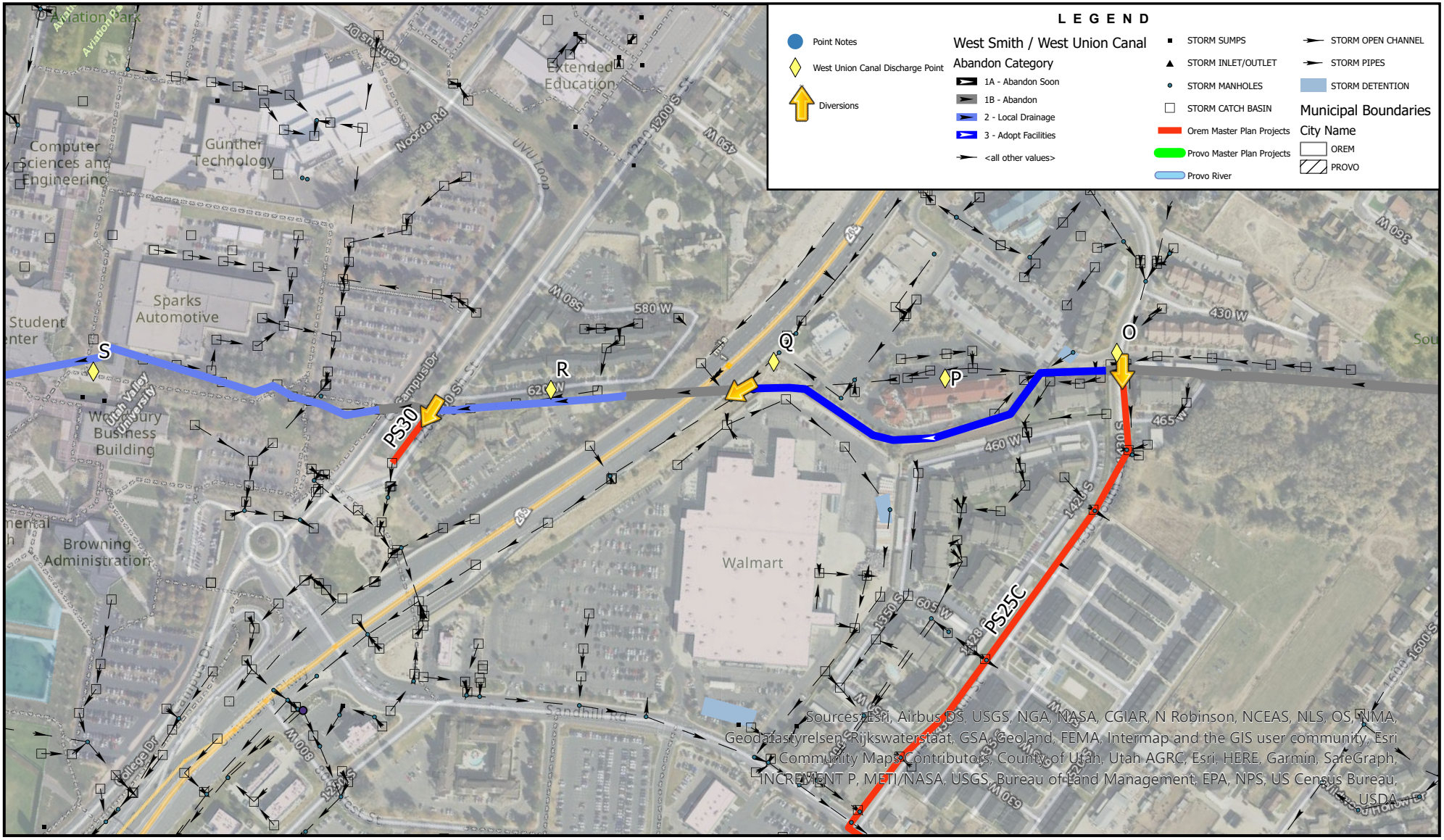
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P10

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



Points	Project
O	Project No. PS25C
P	City to adopt facilities, eventually rehabilitate

Points	Project
Q	Existing diversion may need modification
R	Local Drainage to 1200S, then divert at PS30

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

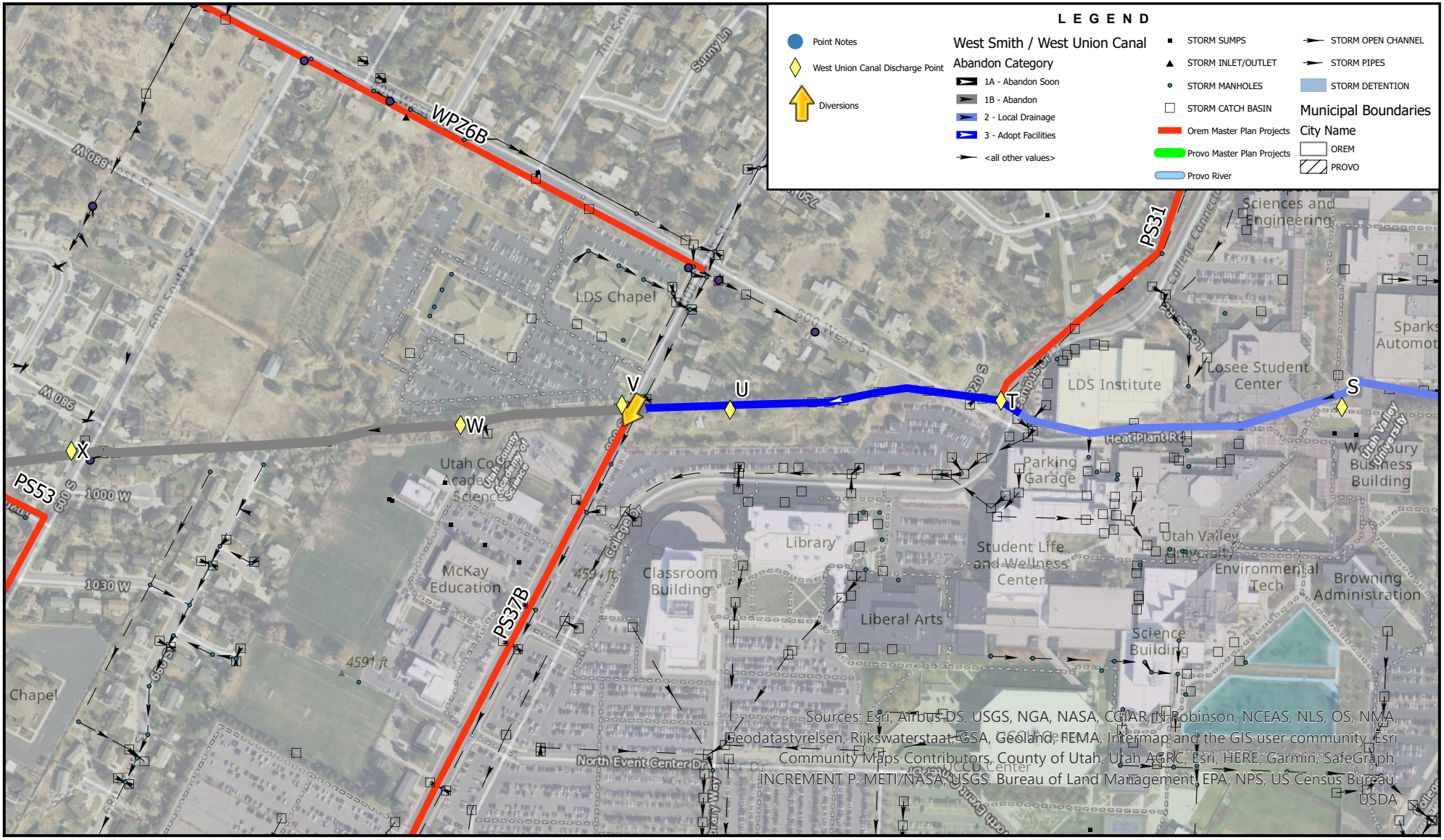
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P11

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

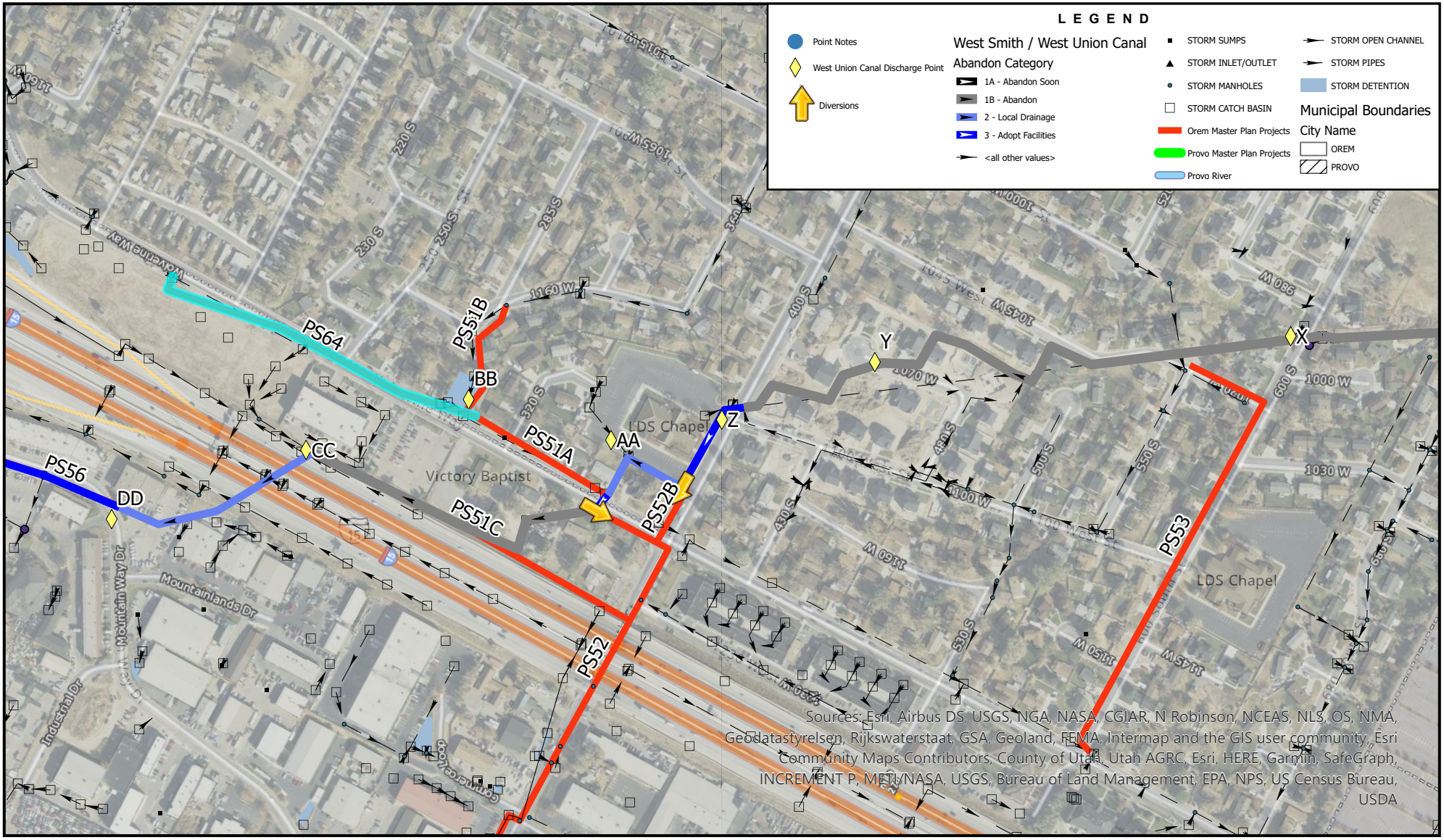
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P12

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

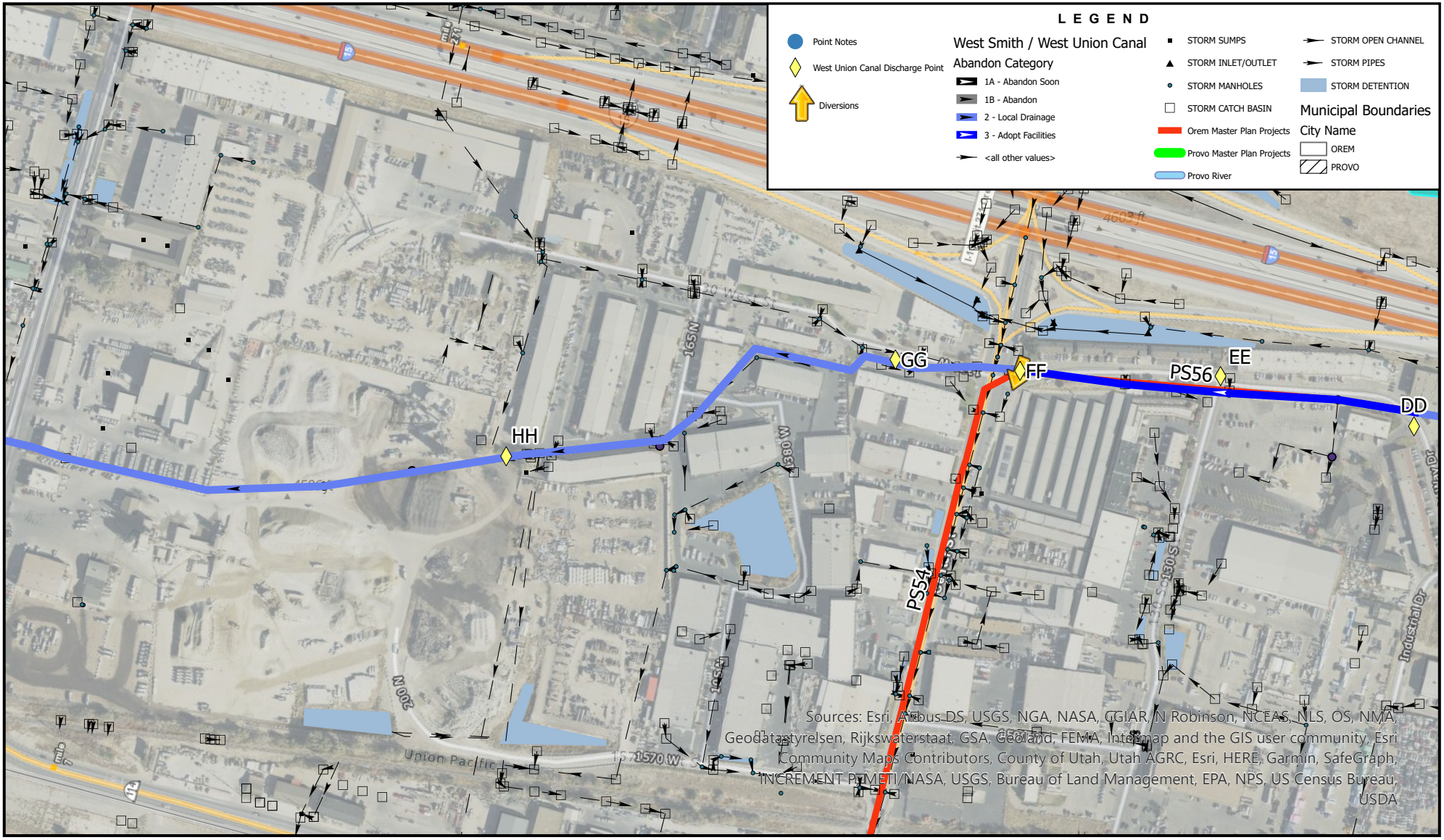
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P13

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

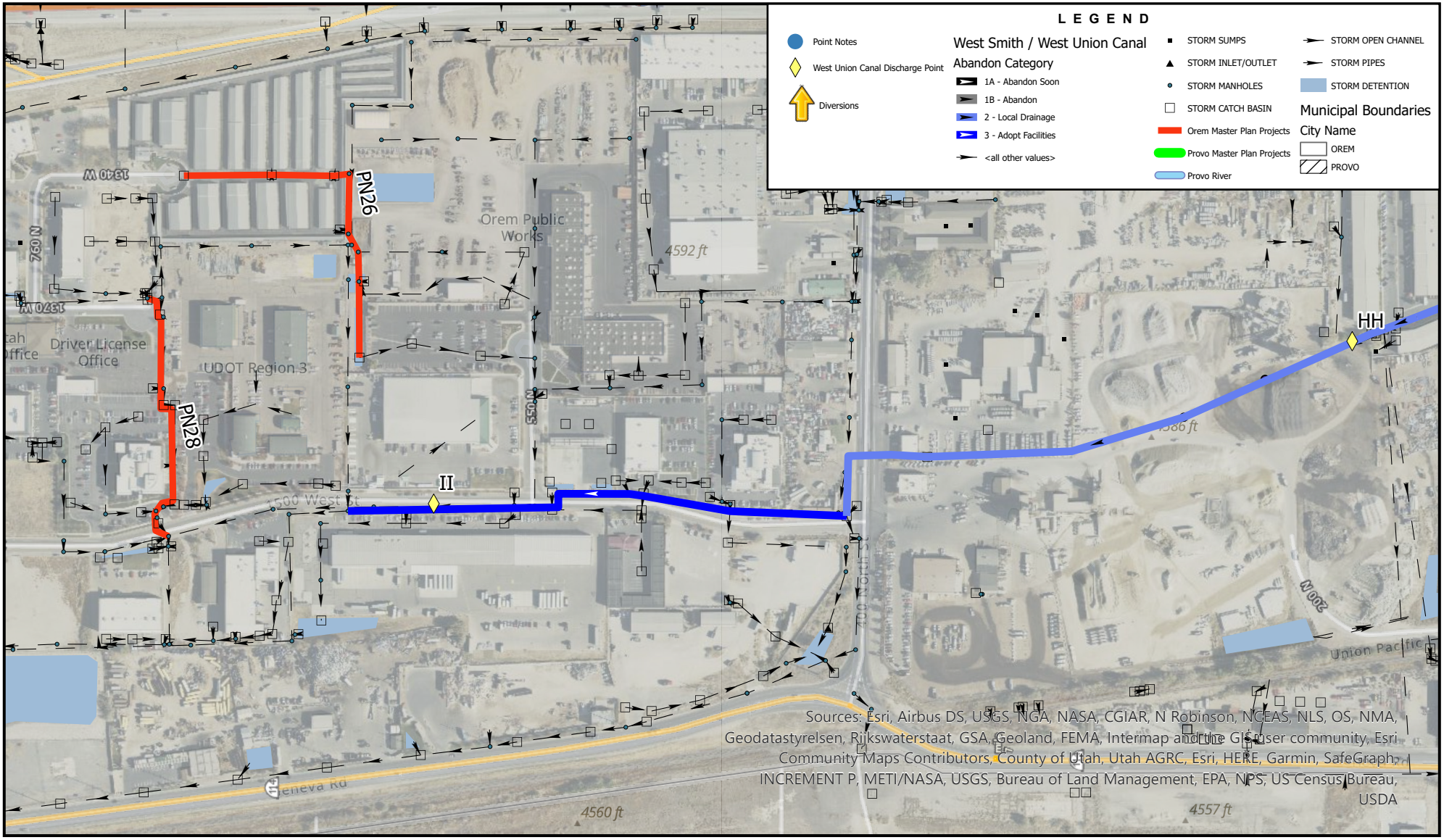
WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P14

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021



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

BOWEN COLLINS & ASSOCIATES

OREM CITY
STORM WATER MASTER PLAN

WEST UNION CANAL IMPROVEMENTS

NORTH:

SCALE: 0 200 400 Feet

FIGURE NO. P15

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Storm\StormMaps\StormMaps.aprx amckinnon 5/5/2021

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 runs 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.

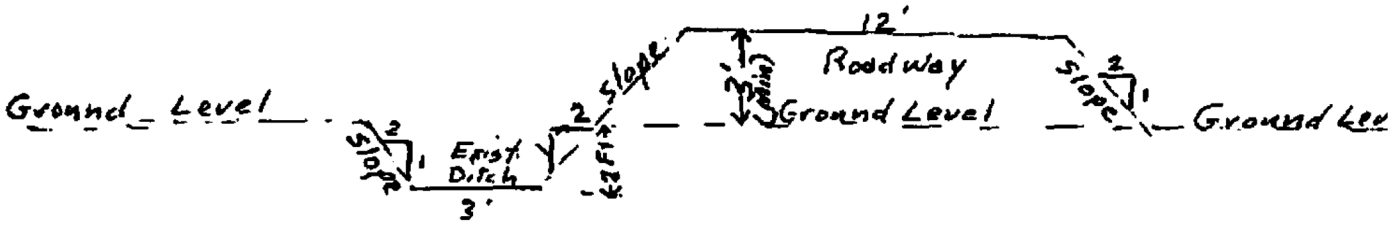
Resolution: The City intends to adopt and maintain the canal facilities from this point northward. No improvements identified here.

APPENDIX E

Southwest Annex Taylor Drain Project Background Information

EXHIBIT "A"

DRAIN MAINTENANCE ROAD



Roadway Profile Plan

1. A maintenance road will be constructed along the north side of the existing storm drain ditch. It will begin at the west end of the existing 24 inch concrete storm drain and will be constructed along the entire length of the existing open drain ditch, to Utah Lake.

2. The road will be constructed by the City using excess excavated materials whenever the materials become available to the City. There is no requirement on the material type or specifications.

3. The City will install the 3 existing 12 inch C.S.P. side drains through the proposed roadway in approximately the same location, and at the present elevation.

4. The City will complete the work no later than January 1, 1987.

Roland Rocha

From: Taggart Bowen <trbowen@orem.org>
Sent: Tuesday, January 5, 2021 8:13 AM
To: Reed Price
Cc: Roland Rocha
Subject: Re: Southwest Taylor Drain Project $2.7M
Attachments: Taylor Drainage Ditch Wetland Delineation Report.pdf; Taylor Drain Roadway Option1.pdf; Roadway cross section.pdf

Roland,

Here is some info about the Taylor Drain project. The wetland delineation report is attached and a concept map of the future dirt roadway alignment, as well as an older typical cross section.

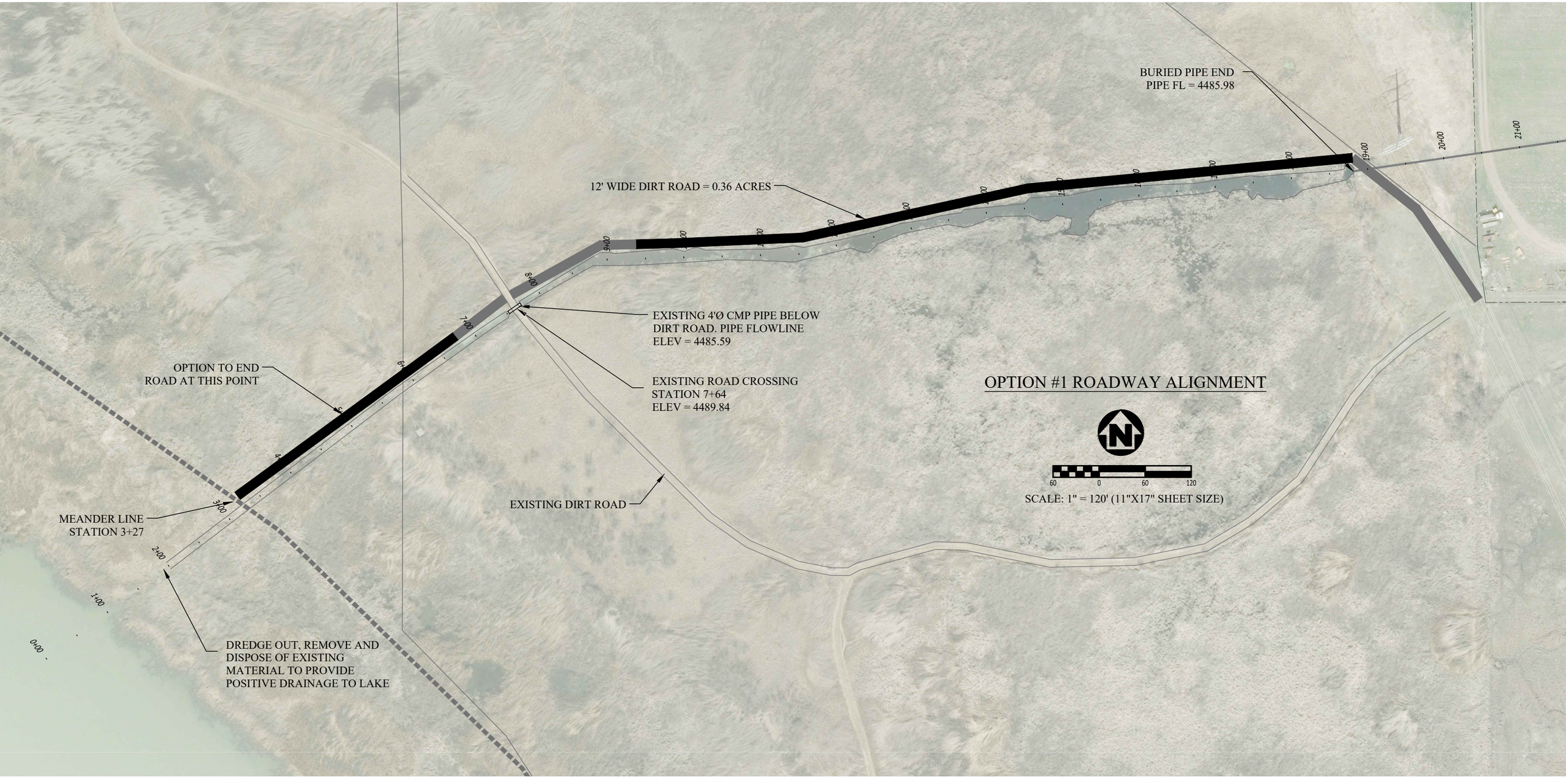
- The work for this project will require an individual permit from the army corp of engineers, this process will take at least 6 months to a year to meet the permit requirements.
- The wetland mitigation for the area impacted will be a 2 to 1 ratio.
- The City is in the process of reviewing potential wetland mitigation areas.
- The maintenance road will be built on the north side of the existing ditch line.
- The future roadway cross section will include a 12’ roadway width and 2 to 1 side slopes to tie into existing as shown in the attachment.
- In upland areas the material required for the maintenance road will be imported and placed on top of the existing surface, using less material than shown in the cross section.
- The exact location of the end of the maintenance road to the west is yet to be determined.
- The contractor will clear out any material needed to maintain positive drainage to the lake.
- The construction of the 12’ wide road will require impacts to a minimum 30’ width of area along the entire length (approx. 1600 feet) of the north side of the ditch. (This 30’ width of area impacted does not include the ditch)
- The work required to build the road and dredge out the ditch will include placing the dredged out sludge material in the 30’ wide area next to the road so the material can dry out and be removed at a later date.
- The City will work with the Taylors to finalize a temporary construction easement for the duration of the construction work to build the maintenance road.
- The City will review final roadway design details with the property owners.
- The City will coordinate with the State to obtain a permit for any area impacted within State Lands located west of the Taylor's property.

If you have any other questions or need any other information let me know.

Taggart

On Tue, Dec 29, 2020 at 4:50 PM Reed Price <rsprice@orem.org> wrote:

> Tag-
>
> Can you send the information you’ve compiled about the Taylor Drain to Roland?
>
> Reed
>
> ---------- Forwarded message ---------
> From: **Roland Rocha** <rrocha@bowencollins.com>
> Date: Tue, Dec 29, 2020 at 3:35 PM



OPTION #1 ROADWAY ALIGNMENT

SCALE: 1" = 120' (11"X17" SHEET SIZE)

TAYLOR DRAINAGE DITCH
WETLAND DELINEATION
UTAH COUNTY, UTAH

TAYLOR DRAINAGE DITCH
WETLAND DELINEATION
UTAH COUNTY, UTAH

Prepared for:

OREM CITY
56 NORTH STATE STREET
OREM, UT. 84057

And

U.S. ARMY CORPS OF ENGINEERS
UTAH REGULATORY OFFICE
533 WEST 2600 SOUTH, SUITE 150
BOUNTIFUL, UTAH 84010
801-295-8380

Prepared by:

INTERMOUNTAIN ECOSYSTEMS, LLC.
270 EAST 1230 NORTH
SPRINGVILLE, UT. 84663
801-489-4590

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TAYLOR DRAINAGE DITCH
WETLAND DELINEATION
UTAH CO., UTAH

EXECUTIVE SUMMARY

Intermountain Ecosystems, LLC was contracted by Orem City to conduct a wetland delineation on the Taylor drainage ditch and has an obligation to maintain the ditch. The Taylor ditch is approximately 0.76 acres in size and 1624 ft. in length. It is in the SW ¼ Section 28, Township 6 South, Range 2 East (N 40. 2611697^0 W 111. 7287454^0). The Taylor ditch has been delineated as Jurisdictional Wetlands.

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1.0 INTRODUCTION

1.1 Project Description

Orem City has contracted with Intermountain Ecosystems to conduct a Waters of the United States (WOUS) inventory which includes jurisdictional wetlands administered under Section 404 of the Clean Water Act (CWA). The project area is in Orem City, Utah at 1100 West and Pioneer Crossing (Fig 1). The wetland in question is a drainage ditch which empties into Utah Lake and Orem City is responsible for ditch maintenance. The property is owned by Byron Taylor and characterized as wetland pasture.

Average annual precipitation for Orem is estimated at 15 inches and elevation in the project area is about 4,489 feet (Ashcroft 1992). The following report includes a description of the field methods, vegetation, soils, hydrology, inventory results, and discussion of the wetland delineation and connectivity to Waters of the United States. Climatic conditions during the inventory were warm sunny days in the 70's. There is no interstate commerce associated with this project.

2.0 METHODS

2.1 Field Inventory

Field inventory was conducted on October 5th by Ronald J. Kass, Professional Wetland Scientist (PWS) in accordance with the 1987 "Corps of Engineers Wetlands Delineation Manual." Information reviewed included *Hydric Soils of the U.S.* (USDA-SCS 1991), *State of Utah- National Wetland Plant List*: 2012 Final Draft, Intermountain Region 8 (USFWS 1988), *National Wetland Inventory Maps (NWI), Field Guide to the Identification of the Ordinary High-Water Mark in the Arid West Region of the United States (Lichvar and McColley 2008) and Soil Survey Web* (USDA 2020).

Upland/wetland boundaries were identified and delineated by sampling vegetation, soils, and determining wetland hydrology at subjective sample points along ecological gradients. Nine (9) data points were established in areas most relevant to determine the upland/wetland boundary.

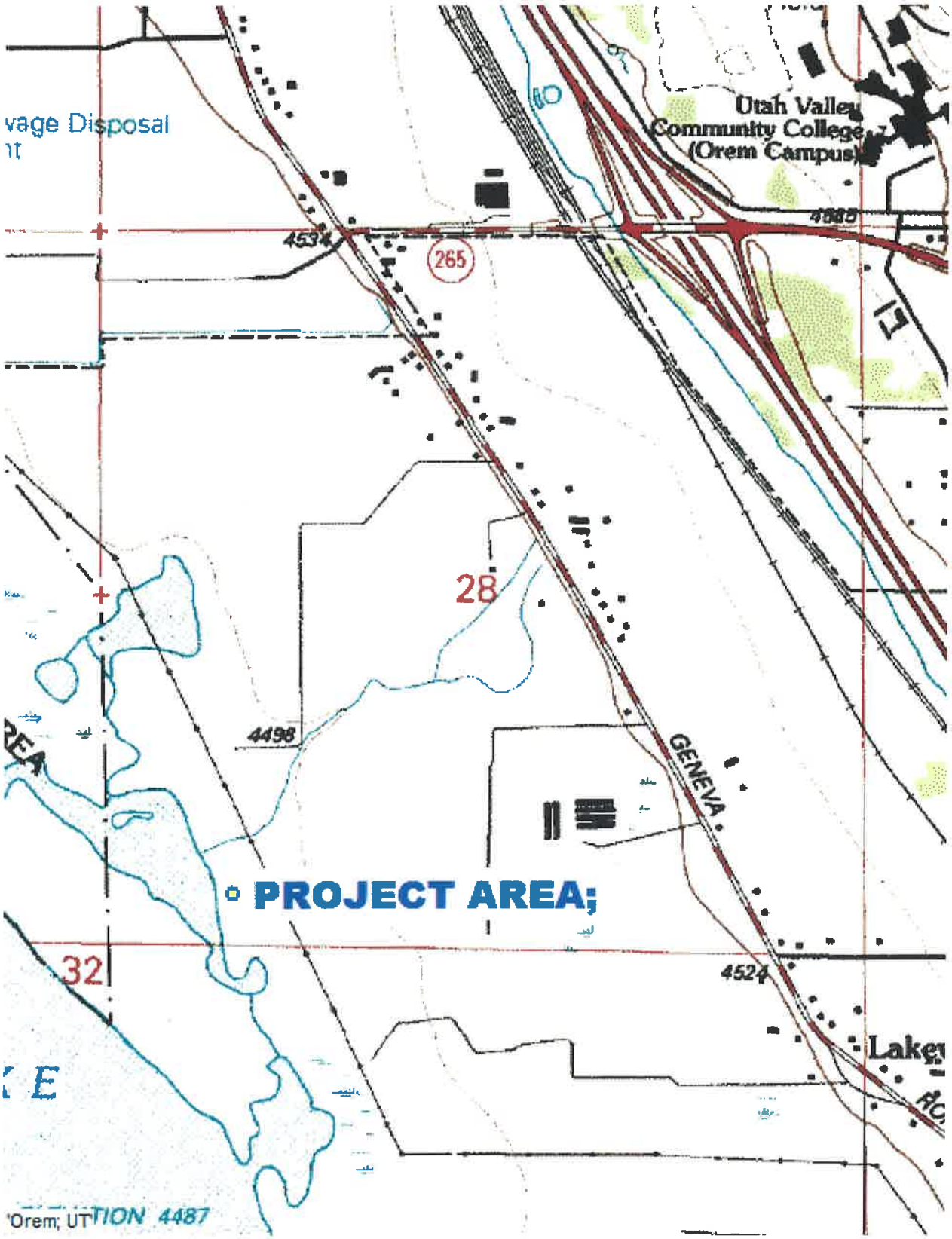


Fig. 1. Project Area Map (USGS 7.5).

Data points were designated with pink pin flags and wetland boundaries were mapped with Trimble Geo XT GPS. Vegetation was determined by ocular estimation of percent cover within a 6-foot radius for herbaceous strata and shrubs, and within 30-foot radius for trees. Vegetation dominance was determined by the 50/20 rule. A routine onsite determination data sheet was completed for each sample point (Appendix A).

Soil texture, chroma (Munsell color charts-Kollmorgen 1988), and moisture were determined at each sample point by examination of soil characteristics within an excavated pit 18 inches deep. Observing local conditions and assessing primary and secondary indicators determined hydrology.

Jurisdictional/non-jurisdictional wetland determination was concluded for each sample point based on the presence of at least one field indicator for each of the three USACOE parameters, and a surface connection to adjacent WOUS. Surface connections to WOUS were established by examining USGS maps and aerial photos and field checking these connections.

Table 1. Species List and Indicator Status

Common Name	Scientific Name	Indicator Status
Forbs		
Showy milkweed	*Asclepias speciosa*	FACW
Three-square bulrush	Schoenoplectus pungens	OBL
Broadleaf Cattail	*Typha latifolia*	OBL
Broadleaf peppergrass	*Lepidium latifolium*	
Woody		
Russian olive	*Elaeagnus angustifolia*	FAC
Graminoids		
Quackgrass	*Elymus repens*	FAC
Commo reedgrass	*Phragmites communis*	FACW
Rabbitfoot grass	*Polypogon monspeilensis*	FACW

Indicator Status (Reed 1988).
OBL Obligate wetland plants; almost always occur in wetlands under natural conditions (>99 percent probability).
FACW Facultative wetlands plants; usually occur in wetlands but occasionally found in one-wetlands (67-99 percent probability).
FAC Facultative plant; equally likely to occur in wetlands or non-wetlands (34-66 percent probability).
FACU Facultative upland plants; usually occur in non-wetlands but occasionally found in wetlands (1-33 percent probability).
UPL Upland plants; occur almost never in wetlands under natural conditions (<1 percent probability).
NI No indicator; insufficient information available to determine indicator status.

3.0 RESULTS

3.1 Vegetation

The project area is mapped as palustrine emergent wetland that is seasonally flooded (PEMC1) (NWI 2020). The ditch supports common reedgrass (*Phragmites australis*), broadleaf cattail (*Typha latifolia)* three-square bulrush (*Schoenoplectus pungens*) and quackgrass (*Elymus repens*). Upland species are mainly represented by creeping thistle (*Cirsium arvense*) and red clover (*Trifolium pratense*). Common species within the project area and their indicator status are listed in Table 1.

3.2 Soils

United States Department of Agriculture Soil Survey Web documented project soils as Peteetneet peat which are poorly drained soil derived from organic matter. Onsite observation of soils were dark brown to black soils with low chroma (10YR 2/1). Depth to water table varies from 0-12 inches and available water capacity is very high (Appendix C). The Peteetneet is classified as a hydric soil (USDA 2020).

3.3 Hydrology

All wetland data points (1,3,5,7) had surface and near surface water in the pit. The water discharging from this drainage ditch flows into Utah Lake and most of the flow is springs and some irrigation return (pers. comm. Byron Taylor).

3.4 Analysis of Data Points

Data Pt. #1--This point was in concave topography (see photo 1) vegetated to cattail (OBL) and three-square bulrush (OBL). Soils were histic (10YR 2/1) and there was surface hydrology. All 3 USACOE parameters were met rendering this point as wetland (Appendix A).

Data Pt. # 2-- This point was in level topography vegetated to creeping thistle (FACU) and red clover (FACU). Soils were a silt loam (10YR 3/2) and there was no hydrology. Only the USACOE vegetation parameter was met rendering this point as upland (Appendix A).

Data Pt. #3--This point was in concave topography vegetated to cattail (OBL) and common reedgrass (FACW). Soils were histic (10YR 2/1) and there was surface hydrology. All 3 USACOE parameters were met rendering this point as wetland (Appendix A).

Photo 1. Data Point 1 looking West (10/5/20).

Data Pt. # 4-- This point was in level topography vegetated to creeping thistle (FACU) and broadleaf peppergrass (FACU). Soils were a silt loam (10YR 3/2) and there was no hydrology. Only the USACOE vegetation parameter was met rendering this point as upland (Appendix A).

Data Pt. #5--This point was in concave topography vegetated to cattail (OBL) and three-square bulrush (OBL). Soils were histic (10YR 2/1) and there was surface hydrology. All 3 USACOE parameters were met rendering this point as wetland (Appendix A).

Data Pt. # 6-- This point was in level topography vegetated to creeping thistle (FACU) and broadleaf peppergrass (FAC). Soils were a silt loam (10YR 3/2) and there was no hydrology. Only the USACOE vegetation parameter was met rendering this point as upland (Appendix A).

Data Pt. #7--This point was in concave topography vegetated to common reedgrass (FACW). Soils were histic (10YR 2/1) and there was surface hydrology. All 3 USACOE parameters were met rendering this point as wetland (Appendix A).

Data Pt. # 8-- This point was in level topography vegetated to creeping thistle (FACU) quackgrass (FAC) and rabbitfoot grass (FACW). Soils were a silt loam (10YR 3/2) and there was no hydrology. Only the USACOE vegetation parameter was met rendering this point as upland (Appendix A).

Data Pt. # 9-- This point was in level topography vegetated to creeping thistle (FACU) common reedgrass (FACW) and rabbitfoot grass (FACW). Soils were a silt loam (10YR 3/2) and there was no hydrology. Only the USACOE vegetation parameter was met rendering this point as upland (Appendix A).

4.0 DISCUSSION

The Taylor drainage ditch is 1624 feet in length and 0.76 acres in area and is entirely within jurisdictional wetlands. The ditch drains into Utah Lake and for the most part is surrounded by jurisdictional wetlands (photo 2).

A USACOE permit will not be required if there are no impacts to wetlands. If dredge or fill is deposited into wetlands, then a USACOE nationwide permit will be required. It is recommended that a plan be implemented to avoid impacts to wetlands.

Photo 2. Taylor Ditch looking West into Utah Lake. (10/5/20).

5.0 REFERENCES

ACOE. 2012. State of Utah-National Wetland Plant List. 2012 Final Draft.

Ashcroft, G. L., J. T. Jensen and J. L. Brown. 1992. Utah Climate.

Kollmorgen Corp. 1988. Munsell Soil Color Chart. Kollmorgen Instruments Corp., Baltimore, Md.

Lichvar, R. W. and S. M. McColley. 2008. A Field Guide to the Identification of the Ordinary High-Water Mark in the Arid West Region of the United States. A Delineation Manual. Cord Regions Research and Engineering Laboratory.

National Wetland Inventory Website. 2020. U.S. Fish and Wildlife Service.

U. S. Department of Agriculture-Soil Conservation Service (USDA-SCS). 2020. Soil Web Site

U. S. Department of Agriculture-Soil Conservation Service (USDA-SCS). 1991. Hydric Soils of the United States. Misc. Pub. 1491. Soil Conservation Service, U. S. Government Printing Office, Washington, D. C. 149 p.

U. S. Department of Agriculture-Natural Resources Conservation Service and U.S. Army Corps of Engineers. 2006. Field Indicators of the Hydric Soils of the United States. A Guide for Identifying and Delineating Hydric Soils, Version 6.0.

APPENDIX A
ROUTINE WETLAND DETERMINATION DATA FORMS

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 1W

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shore Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26116977 N Long: 111.72874547 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔ No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔ No _____	
Wetland Hydrology Present?	Yes ✔ No _____	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Schoenplectus pungens	80	Y	OBL
2. Thypa latifolia	20	Y	OBL
3.			
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

Sampling Point: 1W

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 2/1							

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ✔ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ✔ No ___

Remarks:

Abrupt boundary with obligate plants

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ✔ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ✔ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✔ No ___ Depth (inches): 5

Water Table Present? Yes ✔ No ___ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ✔ No ___ Depth (inches): _____

Wetland Hydrology Present? Yes ✔ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 2U

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shore Local relief (concave, convex, none): none Slope (%): 0

Subregion (LRR): Arid Lat: 40.26104934 N Long: 111.72868431 Datum: WGS 1984

Soil Map Unit Name: Peetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No ✔	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Trifolium pratense	50	Y	FACU
2. Grindelia squarrosa	40	Y	UPL
3.			
4.			
5.			
6.			
7.			
8.			
	90 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No ✔

Remarks:

Sampling Point: 2U

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2						sandy loan	dry

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ✓ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✓

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✓ Depth (inches): _____

Water Table Present? Yes _____ No ✓ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✓ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 3W

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26032288 N Long: 111.73329657 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✔ No _____

Hydric Soil Present? Yes ✔ No _____

Wetland Hydrology Present? Yes ✔ No _____

Is the Sampled Area within a Wetland? Yes ✔ No _____

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Typha latifolia	50	Y	OBL
2. Phragmites australis	50	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

Sampling Point: 3W

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 2/1						loam	moist

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ✔ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ✔ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✔ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✔ Depth (inches): _____

Water Table Present? Yes ✔ No ___ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes ✔ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 4U

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): none Slope (%): 0

Subregion (LRR): Arid Lat: 40.26059775 N Long: 111.73301115 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No ✔	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Cirsium arvense	60	Y	FACU
2. Lepidium latifolium	20	Y	FAC
3. Elymus repens	20	Y	FAC
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

Sampling Point: 4U

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2						silt loam	dry

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✔ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 5W

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26054120 N Long: 111.73293055 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✔ No _____

Hydric Soil Present? Yes ✔ No _____

Wetland Hydrology Present? Yes ✔ No _____

Is the Sampled Area within a Wetland? Yes ✔ No _____

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Typha latifolia	80	Y	OBL
2. Schoenoplectus pungens	20	Y	OBL
3.			
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

Sampling Point: 5W

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 2/1						silt loam	moist

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ✔ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ✔ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✔ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✔ Depth (inches): _____

Water Table Present? Yes ✔ No ___ Depth (inches): 20

Saturation Present? (includes capillary fringe) Yes ___ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes ✔ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 6U

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): none Slope (%): 0

Subregion (LRR): Arid Lat: 40.26042252 N Long: 111.7328819 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Cirsium arvense	60	Y	FACU
2. Lepidium latifolium	20	Y	FAC
3. Elymus repens	20	Y	FAC
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

Sampling Point: 6U

SOIL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2						silt loam	dry

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✔ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 7W

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26079273 N Long: 111.73195013 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Phragmites australis	100	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

SOIL

Sampling Point: 7W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 2/1						silt loam	moist

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ✔ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ✔ No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ✔ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ✔ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✔ No ___ Depth (inches): 5

Water Table Present? Yes ✔ No ___ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ✔ No ___ Depth (inches): ___

Wetland Hydrology Present? Yes ✔ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 8U

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26042252 N Long: 111.7328819 Datum: WGS 1984

Soil Map Unit Name: Petetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Cirsium arvense	20	Y	FACU
2. Polypogon monospeilensis	20	Y	FAC
3. Elymus repens	40	Y	FAC
4.			
5.			
6.			
7.			
8.			
	80 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

SOIL

Sampling Point: 8U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2						silt loam	dry

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Orem City Drainage City/County: Orem/Utah Sampling Date: 10/5/20

Applicant/Owner: Byron Taylor State: UT Sampling Point: 9U

Investigator(s): Ron Kass Section, Township, Range: T6S, R2E, SW1/4, S28

Landform (hillslope, terrace, etc.): lake shoreline Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): Arid Lat: 40.26091885 N Long: 111.73206159 Datum: WGS 1984

Soil Map Unit Name: Peteetneet peat NWI classification: PEMC1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔ No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____ No ✔	
Wetland Hydrology Present?	Yes _____ No ✔	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	_____ = Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
	_____ = Total Cover		
Herb Stratum (Plot size: _____)			
1. Cirsium arvense	20	Y	FACU
2. Polypogon monospeilensis	20	Y	FAC
3. Phragmites australis	30	Y	FAC
4.			
5.			
6.			
7.			
8.			
	70 = Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
	_____ = Total Cover		

% Bare Ground in Herb Stratum _____ % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✔ No _____

Remarks:

SOIL

Sampling Point: 9U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/2						silt loam	dry

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

APPENDIX B.

WETLAND DELINEATION MAP

Taylor Drainage Ditch Wetland Delineation 2020

T 5S R 1W S 25
Utah County, Utah

Legend

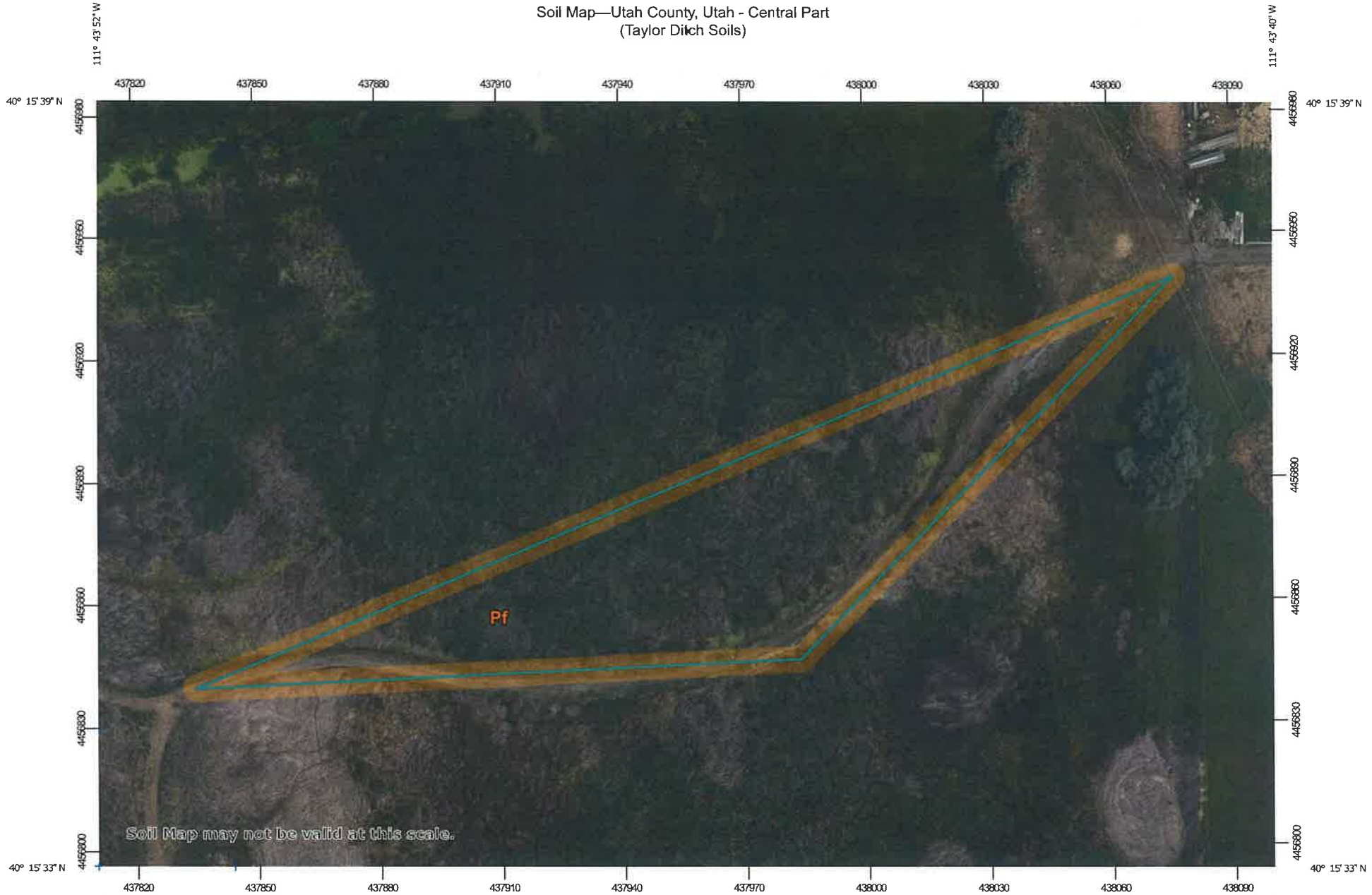
Data Point

- Upland
- Wetland
- Ditch (Total Area = 0.76 Acres)
- Ditch (Total Length = 1624.04 Feet)

Intermountain Ecosystems
270 East 1230 North
Springville, UT 84663
(801) 489-4590

APPENDIX C
USDA SOIL MAPS

Soil Map—Utah County, Utah - Central Part
(Taylor Ditch Soils)



Map Scale: 1:1,320 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Pf	Peteetneet peat	1.7	100.0%
Totals for Area of Interest		**1.7**	**100.0%**

Utah County, Utah - Central Part

Pf—Peteetneet peat

Map Unit Setting

National map unit symbol: j6z1
Elevation: 4,450 to 4,500 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 130 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Peteetneet and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peteetneet

Setting

Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Organic material

Typical profile

Oa1 - 0 to 15 inches: peat
Oa2 - 15 to 60 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 7.09 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: FrequentNone
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: Very high (about 13.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A/D
Ecological site: R028AY020UT - Wet Fresh Meadow
Hydric soil rating: Yes

Minor Components

Ironton

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R028AY012UT - Semiwet Fresh Meadow
Hydric soil rating: Yes

Logan

Percent of map unit: 5 percent
Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R028AY020UT - Wet Fresh Meadow
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Utah County, Utah - Central Part
Survey Area Data: Version 13, Jun 8, 2020

DRAPER, UTAH OFFICE
154 E 14075 S
DRAPER, UTAH 84020
PHONE: 801.495.2224

BOISE, IDAHO OFFICE
776 E RIVERSIDE DRIVE
SUITE 250
EAGLE, IDAHO 83616
PHONE: 208.939.9561

ST. GEORGE, UTAH OFFICE
20 NORTH MAIN
SUITE 107
ST.GEORGE, UTAH 84770
PHONE: 435.656.3299

OGDEN, UTAH OFFICE
2036 LINCOLN AVENUE
SUITE 104
OGDEN, UTAH 84401
PHONE: 801.495.2224

BOWEN COLLINS & ASSOCIATES

WWW.BOWENCOLLINS.COM