Prepared for:

PAYSON
EXPERIENCE THE MANY LAYERS

# Storm Drain Master Plan

July 2020

Prepared by:

FREGONESE ASSOCIATES

BOWEN COLLINS & ASSOCIATES

# STORM DRAIN MASTER PLAN

## July 2020

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7/22/2020

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# Chapter 1 - Introduction and Background

## INTRODUCTION

This Storm Drain Master Plan was prepared as part of a citywide planning effort. Fregonese Associates from Portland, Oregon was retained by Payson City (City) to develop a new General Plan. As part of that planning effort, Bowen, Collins & Associates was retained to develop a Storm Drain Master Plan that identifies how to solve existing storm drain deficiencies as well as how storm water runoff should be managed from future development in the City.

## BACKGROUND INFORMATION

Payson City is located on an alluvial fan between the mouth of Payson Canyon and Interstate 15. This alluvial fan was formed by the natural forces of flooding, erosion, and sediment deposition associated with Peteetneet Creek. The City is experiencing significant development pressure. Its population has increased from about 4,500 in 1970 to an estimated current population of over 20,000. The population is projected to increase to 64,887 by 2050.

Payson was originally settled in 1850. Figure 1-1 is a copy of the original cadastral survey performed in the Payson area in 1856. It illustrates two important features. First, in 1856, the Peteetneet Creek channel traversed from the mouth of the canyon through the town, where the defined channel terminated. This is a common feature of an ephemeral stream on an alluvial fan. When the City was founded, there was no defined channel that could convey surface runoff generated from Payson Canyon and the area occupied by the City to Utah Lake. The 1856 survey shown in Figure 1-1 also indicates that shallow ground water and springs existed on the valley floor north and west of the City. The shallow ground water conditions can be seen in recent aerial photographs and in historic aerial photographs that date back to 1947 (see Appendix A).

As the City developed, roads were constructed and a gravity irrigation system was developed that used a network of ditches to distribute water that was diverted out of the High Line Canal to irrigate the lawns and gardens of City residents. Runoff from Peteetneet Creek was diverted around the center of the City by constructing a diversion structure near the mouth of the canyon and a diversion channel that conveys diverted runoff to the historic Dry Creek channel. Runoff in Dry Creek then discharges into Spring Creek which ultimately conveys it to Utah Lake. The system of historic irrigation ditches also collected runoff from the paved roads and conveyed the urban runoff to areas where it could infiltrate into the ground. As Payson has transitioned from a small rural community to a medium sized city over the last 20 years, the old system of ditches that distributed irrigation and storm water runoff from the City has been replaced with a pressurized irrigation system. Most of the ditch network has been abandoned and backfilled. In addition, paved roads with curb and gutter have been constructed. The construction of the system of curb and gutter has largely confined runoff from streets to the road rights-of-way, limiting the amount of runoff that can infiltrate into the ground as it had historically. In an effort to mitigate the shallow flooding caused by confining road runoff to the street rights-of-way, the City has constructed storm drain facilities that include storm drain inlets, infiltration sumps (Class V injection wells), and pipelines that convey runoff to either Dry Creek, Peteetneet Creek, or storm water retention basins.

A Storm Drain Master Plan was last prepared for Payson in 2001. That report identified areas of the City where storm drain system improvements should be constructed to mitigate shallow flooding problems that occur during runoff events. Many of the recommended improvements identified in that report have been constructed.


Figure 1-1. 1856 Cadastral Survey (from the U.S. Bureau of Land Management Records)

In addition to identifying how storm water should be managed from areas that are projected to develop in the future, the storm drain master planning process associated with this study also included identifying existing storm water management facilities that exist in the City, performing technical analyses to identify capacity deficiencies in major existing storm drain facilities, and making recommendations to mitigate those deficiencies.

This study seeks to address the following issues and challenges with regards to effective storm water management in Payson:

- **How to manage runoff from projected new development.** Larger amounts of storm water runoff are generated from paved surfaces and streets with curb and gutter as undeveloped areas are developed and urbanized.
- **The lack of major receiving streams that can accept runoff.** Runoff generated in most parts of Payson cannot be discharged into an existing natural stream or existing storm drain that can convey it away from the study area. In addition, there are existing storm drain facilities that currently discharge urban runoff into historic ditches or open channels that are on private property and have not outfall point, creating flood potential and possible liability for the City.
- **Needed improvements along existing streams.** FEMA recently completed work to update the Flood Insurance Rate Maps for Payson. The results from that study are currently in the review process and indicate that there are some undersized culverts and channels that result in significant flood potential associated with Dry Creek. No mapping of floodplain hazards has been completed along Spring Creek.
- **Prioritize recommended improvements and administrative actions.** The analyses performed as part of this study resulted in identifying capital improvements and administrative actions that should be implemented to address existing storm drain system deficiencies and to provide direction regarding how runoff should be managed from future urbanization and development in the City.

This document is a working document. Some of the recommended improvements identified in this report assume that development and/or potential annexation will occur in a certain manner. If future land use, growth, or development patterns change significantly from the patterns that were assumed and documented in this report, the recommendations may need to be revised. Some of the needed projects could be phased to match available funding sources. Proposed pipelines should be sized to convey the estimated design discharges based on slope available in the field. The need to update this document should be evaluated at least every five years with regards to the status of development and potential changes to land use. It may need to be updated more frequently if assumed development patterns or zoning/land use patterns change and those changes impact recommended projects and priorities. This report and the associated recommendations should also be updated about every five years.

## 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 Craig Bagley or Andrew McKinnon at (801) 495-2224.

| | |
|---|---|
| Craig Bagley | Project Manager |
| Andrew McKinnon | Project Engineer |
| Wyatt Andersen | Staff Engineer |

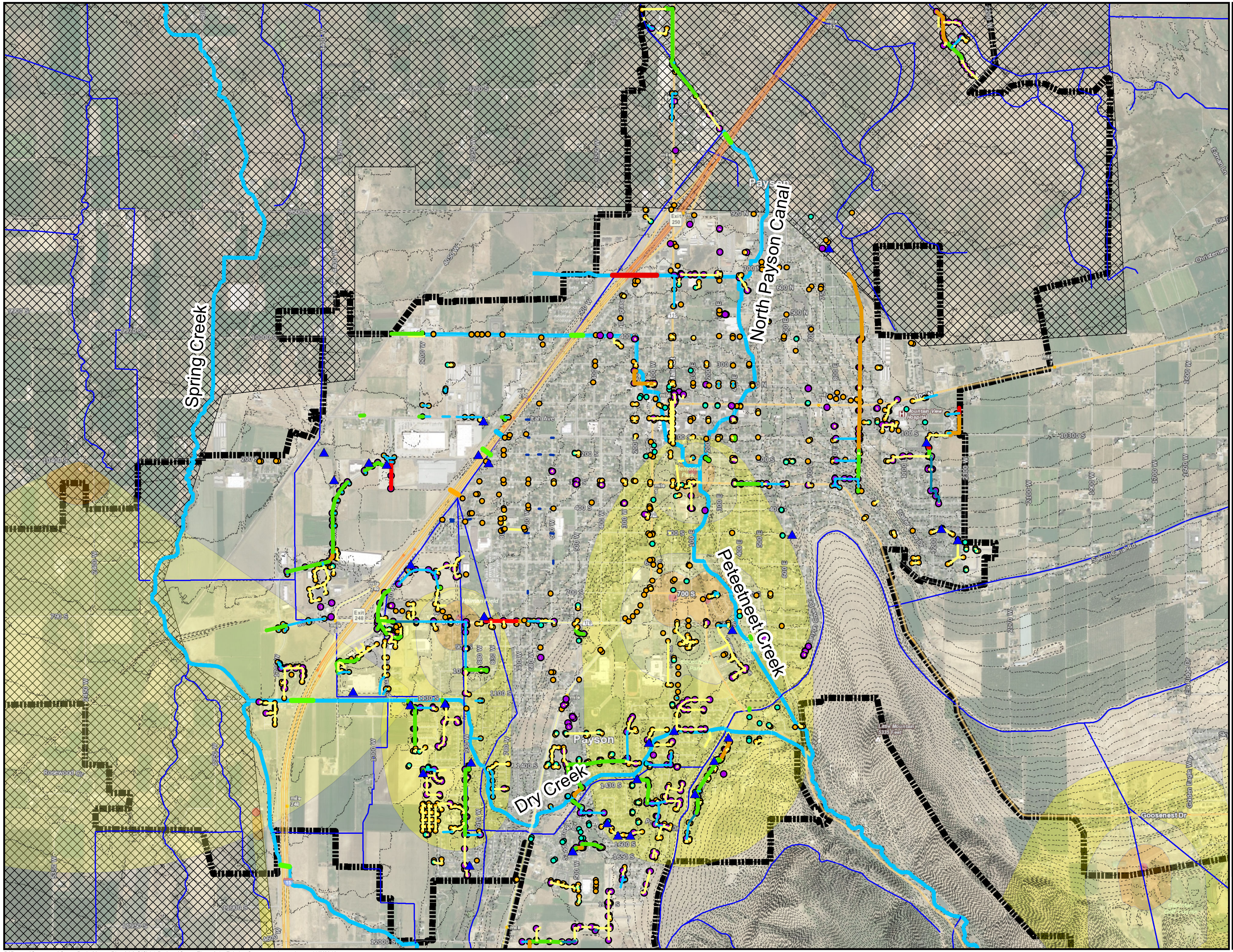
# Chapter 2 - Existing Drainage Features and Facilities

## INTRODUCTION

One of the biggest challenges in managing storm water runoff generated from the urbanized areas in Payson City is the fact that the City is located on an alluvial fan that does not have a nearby perennial stream or major storm drain facility that has capacity to accept a significant amount of urban runoff. The local topography is such that surface runoff generated from only a small portion of the City can be directly discharged to Dry Creek. The historic Peteetneet Creek channel is small and is currently used only to convey a small amount of irrigation water. Spring Creek has limited capacity and discharging significant amounts of urban runoff into this stream would likely require the replacement of bridges and culverts as well as significant downstream channel improvements to increase conveyance capacity. The extent of improvements that Spring Creek would require to accept significant amounts of storm water runoff from Payson are considered financially and environmentally infeasible. These conditions were all considered in the development of recommended storm water management facilities and practices identified by this study.

## STUDY AREA

Payson City, which was first incorporated as a town in 1853, is located about 20 miles southwest of Provo City, and is one of the fastest growing cities in Utah County. The topography of most of the City slopes from East to West and South to North. Figure 2-1 shows the current corporate boundaries of Payson, which is also the general study area associated with this project. Figure 2-1 also shows most of the City's existing storm water management facilities, the natural streams or creeks in the area, topographic contours, areas where shallow ground water exists, and the approximate boundaries of the City's municipal drinking water well source




**Legend**

- ▲ Existing Detention/Retention Basin

**Existing Storm Drain Pipe Diameter**

- 15" or less
- 18"
- 21"
- 24"
- 30"
- 36"
- Existing Cross Drains
- Storm Inlet Box
- Sump
- Storm Manhole

**Streams/Canals**

- Minor
- Major
- 10-foot Contours

**Groundwater Source Zones**

- Source Protection Zone 1
- Source Protection Zone 2
- Source Protection Zone 3
- Source Protection Zone 4
- Payson City Corporate Boundary
- Areas with Shallow Groundwater

NORTH:

SCALE: 0 2,000 Feet

EXISTING STORM DRAIN SYSTEM FACILITIES

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 2-1

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure2-1 - Existing System.mxd wandersen 11/6/2019 protection zones. As Figure 2-1 shows, most of the existing storm water management facilities are sumps (or Class V injection wells) and retention facilities that store runoff until it infiltrates into the ground. There is not an extensive network of existing storm drain pipes. There are some pipelines that discharge urban runoff generated in the south part of the City to Dry Creek and a couple of major pipelines that convey collected urban runoff to regional retention facilities in the northeast and southwest portions of the City. Other than those facilities, most of the existing pipelines are fairly small (pipe diameters smaller than 18 inches), have limited capacities, and were installed to convey urban runoff from one or two development projects to local storm water retention facilities.

## EXISTING DEVELOPMENT CONDITIONS

The 2010 Census population for Payson City was 18,294. The 2019 population is estimated to be 19,892. Population growth, accompanied by the progression of urban development in and around the City, has resulted in increased storm water runoff as undeveloped lands with relatively low runoff potential have been converted to residential, industrial, and commercial developments with a significant amout of impervious paved areas and roof tops. As recent development has occurred, the City has enforced the two general storm drain related development requirements listed below.

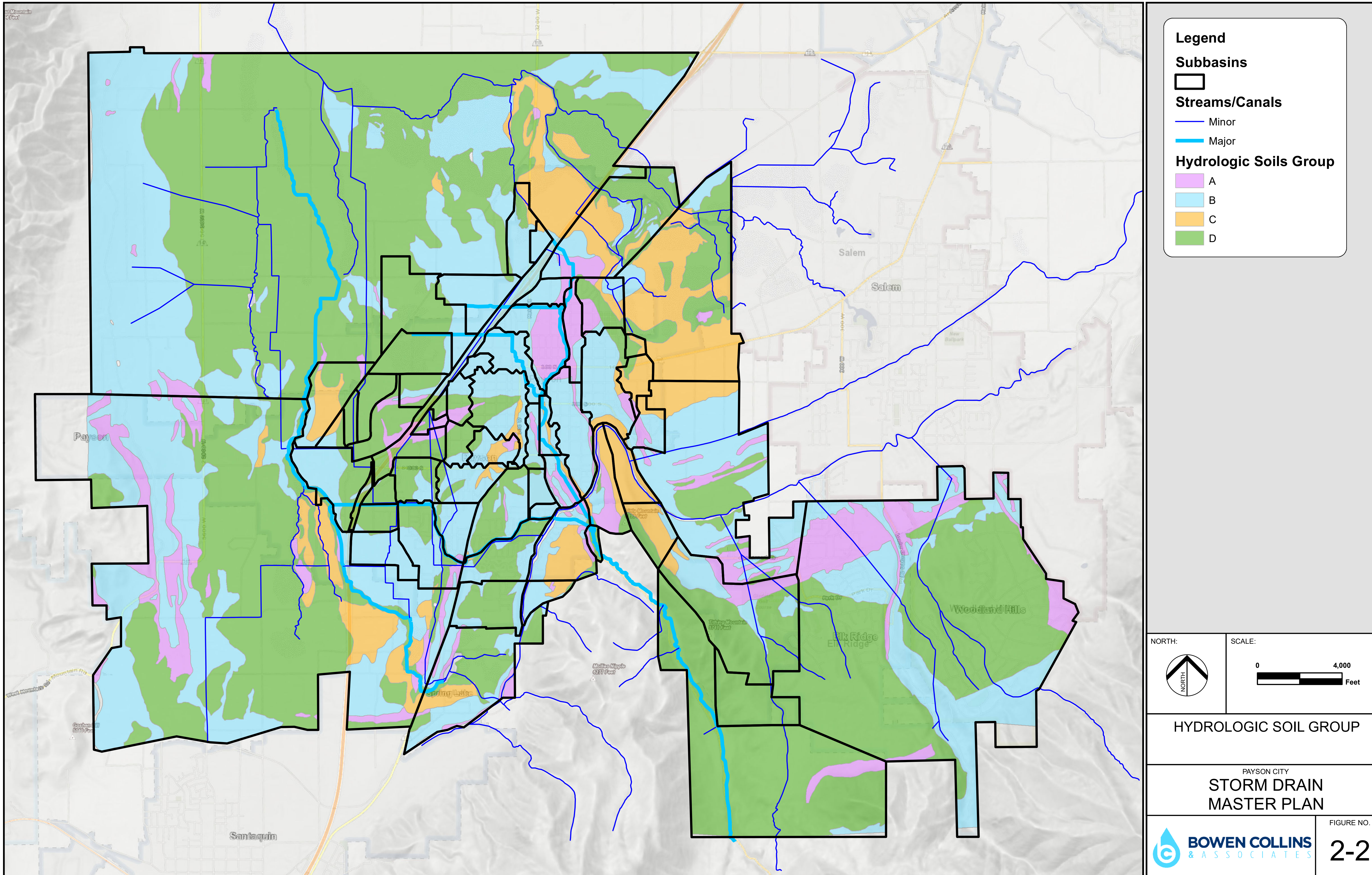
1. **The requirement that curb and gutter be installed on streets that front new construction.** The City currently has curb and gutter constructed along the shoulders of most of its streets. Installing curb and gutter and widening the paved street section as part of new developments increases the storm water runoff rates and volumes significantly above pre-development levels.

2. **The requirement that new development construct onsite storm water management facilities to limit post-development storm water discharges to pre-development levels.** Since most of the undeveloped area in the City does not have an urban storm drain system or a natural stream that can accept urban runoff, most developments have constructed storm water retention basins or storm water sumps to allow runoff generated on the impervious surfaces to infiltrate into the ground, as it did naturally before being developed. These practices reduce the negative impacts from development-related storm water runoff in the City.

Some cities in Utah, including Payson, allow storm water to be discharged into storm water sumps. A storm water sump is typically a manhole with perforated sides and no bottom. Runoff that is discharged into a sump percolates into the ground. Storm water sumps like this are classified as Class V injection wells by the State of Utah and should be inventoried and properly maintained to protect ground water resources. All storm water sumps should have a pretreatment manhole to remove sediment, hydrocarbons, and other pollutants before allowing the water to percolate into the ground. The suitability of a site for a storm water sump is dependent on the permeability of the soils that are site specific and the depth to the water table. Sumps should not be considered without appropriate field testing, design, and means to protect ground water quality.

## SOIL CHARACTERISTICS

Figure 2-2 identifies the hydrologic soil group classifications that exist in the study area. These hydrologic soil classifications, based on infiltration potential, were characterized and mapped by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). Group A soils are well-drained sands, gravels, and sandy-loams, with high infiltration rates that generally result in low storm water runoff potential. At the other end of the scale, Group D soils can have high clay content with low infiltration rates, generally resulting in relatively high storm water runoff during intense storm events. The general characteristics of the 4 Soil Groups are summarized in Table 2-1.




HYDROLOGIC SOIL GROUP

PAYSON CITY

STORM DRAIN MASTER PLAN

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FIGURE NO. 2-2

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure2-2 - Subbasins Soil Group.mxd wandersen 10/31/2019

**Table 2-1**

**Summary General Characteristics of Hydrologic Soil Groups**

| Hydrologic Soil Group | General Soil Characteristics | Infiltration Rate (inches/hour) |
|---|---|---|
| A | Soils that have high infiltration rates and low runoff potential when thoroughly wetted. Well drained sands and gravels are common. | >0.3 |
| B | Soils that have moderate infiltration rates when thoroughly wetted. These soils are moderately well to well drained and have a moderately fine to moderately coarse texture. | 0.15-0.30 |
| C | Soils that have low infiltration rates when thoroughly wetted. These soils typically have a layer that impeded the downward movement of water and have a moderately fine to fine texture. | 0.05-0.15 |
| D | Soils that have very low infiltration rates when thoroughly wetted. These soils include clayey soils, shallow soils over impervious material, or soils in areas with a permanent shallow water table. | 0-0.05 |

As shown in Figure 2-2, native soils in the study area are primarily composed of soil Types B and D, but some small pockets with soil Types A and C also exist. Undeveloped areas with Type C and D soils can naturally generate significant runoff during high intensity cloudburst events due to their relatively low infiltration rates. Undeveloped areas with Type A and B soils generally will not produce significant runoff during a rainfall event. However, when undeveloped ground is developed by adding impervious surfaces (roads, sidewalks, roofs, etc.), the magnitudes of both the peak runoff rate and runoff volume can significantly increase, particularly in areas with Type A and B soils. Site development usually creates the need to design and construct new or larger storm water management facilities to manage runoff generated from the new impervious areas.

Information shown on a geologic map of the area published by the Utah Geologic Survey (see Appendix B) generally corresponds to the soils map information presented in Figure 2-2. Soils in the east part of the City are comprised of alluvial fan deposits (poorly stratified sands, silts, and gravels). Soils on the valley floor, west and north of the City are fine-grained lacustrine deposits (silt and clay) and spring and marsh deposits (fine, organic-rich sediment associated with springs, ponds, seeps, and wetlands).

## GENERAL DRAINAGE CHARACTERISTICS

The Payson City study area can be divided into 5 separate subareas, each with different general drainage characteristics:

- The east hillside
- The north and west areas with shallow ground water
- The area that drains to Dry Creek
- Areas that drain to 2 regional retention facilities, and
- Other areas that drain either to local retention facilities or sumps/Class V injection wells.

The general characteristics of each of these subareas is described below.

### The East Hillside

In the southeast part of the City, the Strawberry Highline Canal traverses near the east City boundary and along the top of Rocky Ridge.  This canal is an open channel that conveys irrigation water to Payson and areas south of Payson.  The Rocky Ridge hillside, north of Peteetneet Creek, appears to be an area that has low potential to generate storm water runoff because there are no visible ephemeral washes on the hillside.  Currently, there is no existing development on the hillsides north of Peteetneet Creek that would discharge urban storm water into the canal.  Any runoff generated from this hillside area would discharge into the Strawberry Highline Canal.  However, no storm water discharge is allowed into this canal.

South of Peteetneet Creek there is some existing development east of the canal.  As Figure 2-1 indicates, there are some storm drain pipes that convey runoff from the impervious surfaces in the developed area to a local storm water retention facility at about 1320 South 250 East. But no urban runoff is currently discharged into the canal.  Discharging urban runoff into irrigation canals is generally discouraged because canals get smaller in the downstream direction.  Storm drains typically get larger in the downstream direction.

### Areas with Shallow Ground Water

The 1856 Cadastral Survey Map shown in Figure 1-1, USGS quadrangle maps, and historic aerial photographs of the area all indicate that the areas north and west of Payson have shallow ground water, marsh areas, springs and flowing wells, as shown in Figure 2-1. The area north of the City generally drains to Beer Creek, a very small tributary to Spring Creek. The soils in the areas with shallow ground water have much lower infiltration rates and have higher potential to generate runoff during a significant storm. There is no existing major natural stream or storm drain facility that can accept significant runoff from future development in these areas.

### The Area that Drains to Dry Creek

As shown in Figure 2-1, there are multiple small networks of storm drain pipes in the areas adjacent to Dry Creek in the southern portion of the City convey runoff collected from the streets in this area to Dry Creek.

### Areas that Drain to Regional Retention Basins

There are 2 storm water retention facilities in the City that are considered to be regional facilities. One is located at about 800 East 800 North; the other at about 600 South 1200 West. Several networks of storm drain pipes convey runoff collected from streets and parking lots to these facilities which have no outlets. Water is stored in these facilities until it infiltrates into the ground. It should be noted that there is not future capacity in these facilities.

### Areas that Drain to Local Retention Facilities or Sumps

Runoff from the remaining parts of the City is managed using either local storm water retention facilities or sumps/Class V injection wells.

## NATURAL CHANNELS/MAJOR CREEKS

There are three natural channels or major creeks that convey runoff through Payson City, as shown in Figure 2-1. Only two of these natural drainages have been preserved and are currently used for storm water conveyance purposes in Payson. The City has one minor canal that conveys only a small amount irrigation water: the North Payson Canal. This canal conveys irrigation water that is diverted out of Peteetneet Creek through the City Park to the northern City boundary, near 1000 North and 500 East. The North Payson Canal also receives a small amount of storm water runoff. The three natural streams are Dry Creek, Peteetneet Creek, and

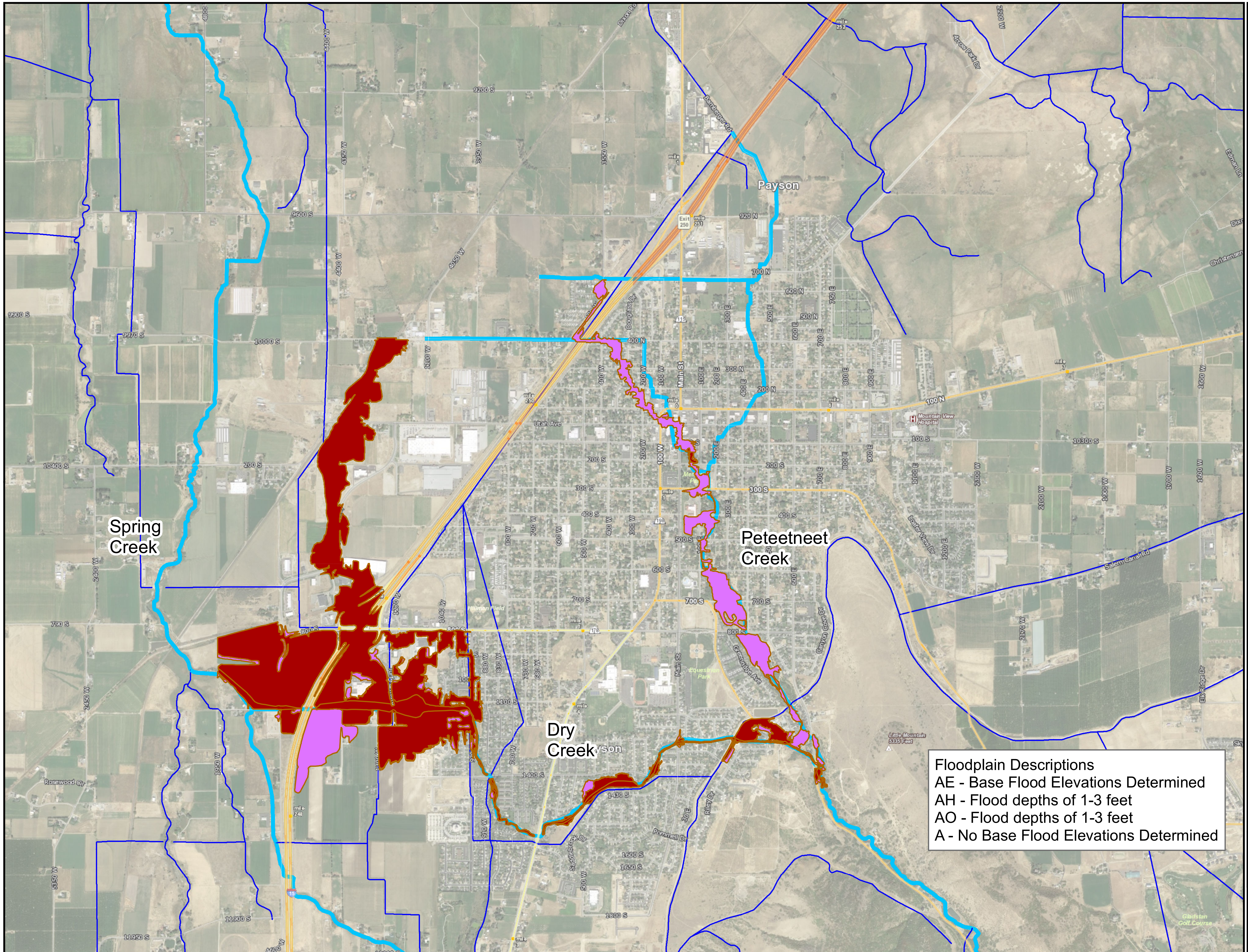
Spring Creek. Peteetneet Creek originates in the higher elevations of Payson Canyon and flows through the canyon towards the City. However, the reach of Peteetneet Creek through the City is used only for irrigation purposes. Only a small amount of storm water runoff is discharged into Peteetneet Creek below the canyon mouth. Nearly all flow in Peteetneet Creek is diverted to Dry Creek at the canyon mouth. Dry Creek is in the southern section of the City and conveys nearly all runoff in Peteetneet Creek that is not used for irrigation to Spring Creek. Dry Creek was built around 1950 to convey runoff from Payson Canyon around the City. Spring Creek flows north along the west edge of the City and ultimately discharges into Utah Lake.

Storm water runoff generated in some of the southern areas of the City is conveyed to Dry Creek, which discharges into Spring Creek, and ultimately flows to Utah Lake. Dry Creek will continue to function as an important part of the City's storm water management system. In areas of future development, the natural drainages will need to be preserved and protected. FEMA has developed a flood map of the Payson City study area, which is shown on Figure 2-3. This flood map only defines special flood hazards associated with Peteetneet Creek and Dry Creek. The flood hazards associated with Spring Creek have not yet been evaluated.

The segments of Peteetneet Creek and the North Payson Canal do not have capacity to convey significant amounts of urban storm water runoff, as they are usually nearly full of irrigation water between April and October each year. Therefore, these two irrigation facilities are not considered to be key storm water management facilities.

## URBAN STORM DRAIN PIPES AND CULVERTS

Table 2-2 lists the estimated length of existing pipes in the City's storm drain system as documented in the City's GIS as of February 2019. Although there is almost 24 miles of storm drain pipes in the City, 74 percent of the pipes have a diameter that is 18 inches or smaller. Most of these pipes were installed in the newer developed areas of the City to convey runoff to local storm water retention facilities that store the runoff until it percolates into the ground. The older areas of the City contain fewer storm drain pipes so runoff is managed using scattered sumps or shallow ponding of vegetated areas outside the street rights-of-way. The City has about 121,200 linear feet of existing curb and gutter.




**Legend**

**Flood Insurance Categories**

- AE
- AH
- AO
- A
- 500 Year Flood

**Streams/Canals**

- Minor
- Major

*No flood hazards have been identified for Spring Creek

NORTH:

SCALE: 0 2,000 Feet

RIVERINE FLOOD HAZARDS DEFINED BY FEMA

PAYSON CITY

STORM DRAIN MASTER PLAN

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FIGURE NO. 2-3

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure2-3 - Flood Plain.mxd wandersen 10/31/2019

**Table 2-2**
**Payson Storm Drain Pipe Lengths**

| Diameter (in) | Length (ft) | Length (mi) |
|---|---|---|
| Unknown | 7,372 | 1.40 |
| <6 | 118 | 0.02 |
| 6 | 644 | 0.12 |
| 8 | 3,857 | 0.73 |
| 10 | 926 | 0.18 |
| 12 | 30,140 | 5.71 |
| 15 | 29,921 | 5.67 |
| 18 | 20,940 | 3.97 |
| 21 | 2,306 | 0.44 |
| 24 | 20,763 | 3.93 |
| 30 | 8,137 | 1.54 |
| 36 | 1,470 | 0.28 |
| **Total** | **126,594** | **23.98** |

I-15 bisects the City. Most of the freeway is constructed on an elevated earthen embankment that technically forms a dam for surface water that would flow from east to west. As Figure 2-1 shows, there are only 8 existing culverts that currently convey runoff under I-15. Other than the Dry Creek culvert crossing, the other 7 culverts are fairly small (with diameters between 18 and 36 inches) and have limited conveyance capacities. West of I-15, the Dry Creek channel is the only defined drainage facility that currently conveys runoff conveyed through any of these culverts to Spring Creek. Six of the 7 other culvert crossings discharge into open channels that currently terminate on private property, some in areas where shallow ground water exists.

## STORM WATER DETENTION/RETENTION BASINS

There are over 20 detention/retention facilities in the existing storm drain system. Storm water detention facilities attenuate peak inflows to reduce impacts to downstream conveyance facilities. Storm water retention facilities generally do not connect to downstream conveyance facilities and impounded water infiltrates into the ground. Most of the existing facilities are retention basins. Figure 2-1 shows the locations of existing detention/retention facilities that are used to manage runoff in the City, some of which are privately owned.

## AREAS WITH SHALLOW GROUND WATER

As Figure 2-1 shows, areas on the north and west sides of the City have shallow ground water. Some seeps and springs discharge into small drainage channels that flow to Spring Creek. But those channels are privately owned and the City likely does not have the right to discharge additional urban storm water into those facilities.

## MUNICIPAL WELL PROTECTION ZONES

The City has designated some areas as Ground Water Source Protection Zones. These are areas where potential contamination sources could influence the water quality of existing ground water wells that are used as sources for municipal drinking water. These areas need to be protected from infiltrating potentially contaminated storm water runoff into the ground. The defined Ground Water Source Protection Zones are shown in Figure 2-1.

The protection zones are defined as follows:

- Zone One is the area within a 100-foot radius from the wellhead or margin of the collection area.
- Zone Two is the area within a 250-day ground water time of travel to the wellhead or margin of the collection area, the boundary of the aquifer(s) which supplies water to the ground water source, or the ground water divide, whichever is closer.
- Zone Three (waiver criteria zone) is the area within a 3-year ground water time of travel to the wellhead or margin of the collection area, the boundary of the aquifer(s) which supplies water to the ground water source, or the ground water divide, whichever is closer. Zone three is a three-year time of travel zone because use and susceptibility waivers must be renewed every three years.
- Zone Four is the area within a 15-year ground water time of travel to the wellhead or margin of the collection area, the boundary of the aquifer(s) which supplies water to the ground water source, or the ground water divide, whichever is closer.

Class V injection wells for storm water disposal and storm water impoundment sites (detention or retention facilities) are potential ground water contamination sources. These types of facilities should be prohibited within drinking water source protection zones. However, if needed, these types of facilities may be constructed in drinking water source protection zones if their potentially contaminated discharges are controlled with design standards, the implementation of storm water Best Management Practices (BMPs) and physical controls.

# Chapter 3 - Hydrologic Analysis

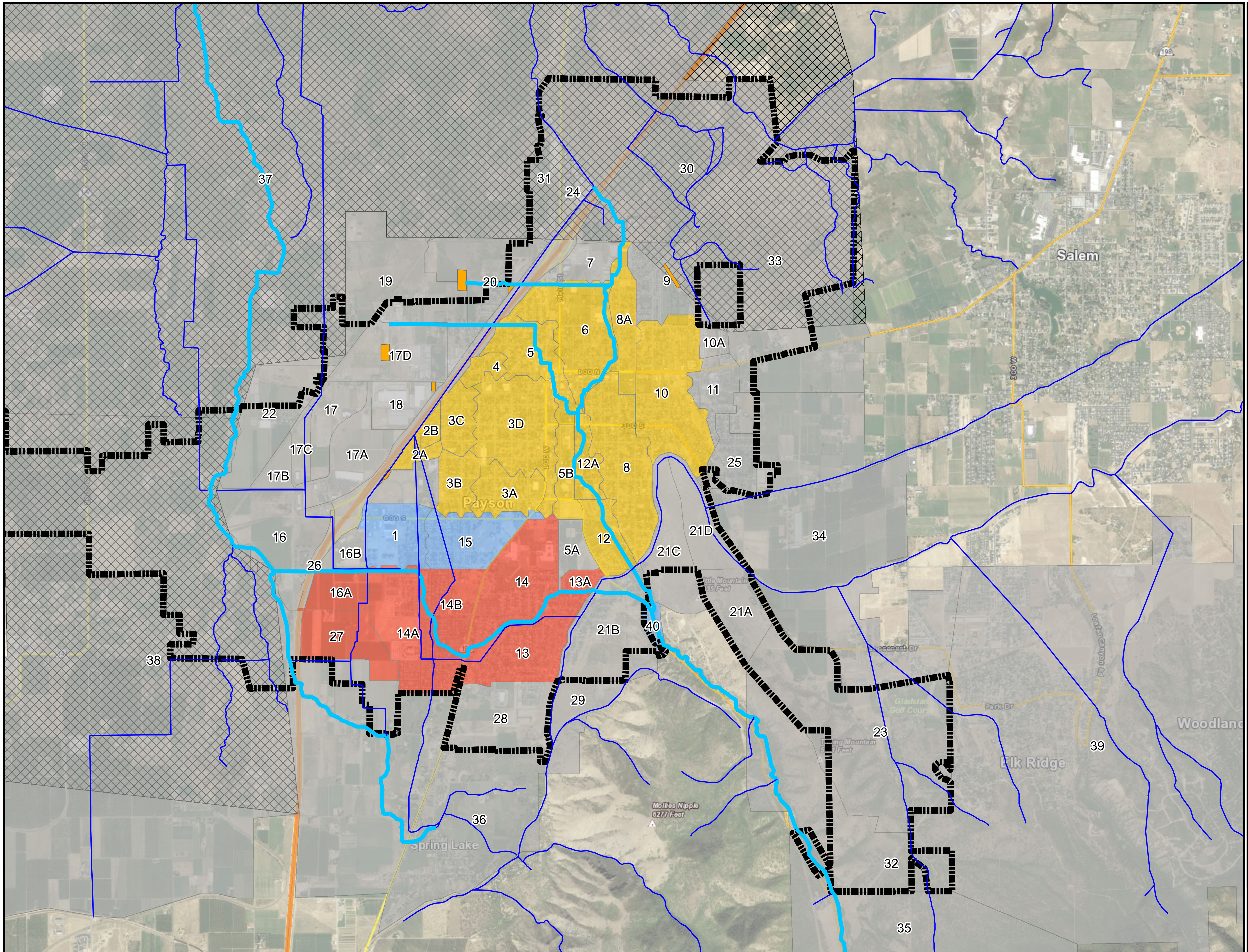
## INTRODUCTION

A hydrologic computer model for projected full build-out conditions of the study area was developed using the AutoDesk Storm and Sewer Analysis computer program (ASSA), version 13.0.94. This model was developed to estimate storm water runoff volumes and peak discharges generated by a design cloudburst event in areas throughout the City. ASSA uses the hydraulic engine from the Environmental Protection Agency Storm Water Management Model (EPA-SWMM) to perform computations that simulate the rainfall-runoff process. As with EPA-SWMM, ASSA can be used to dynamically model the hydrologic and hydraulic components of the study area. The hydraulic modeling process is described in Chapter 4.

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 hydrologic computer model is to delineate drainage basins and subbasins. Drainage basins and subbasins were delineated using detailed topographic data and a map of existing storm drain facilities that was provided by Payson City. The drainage basin and subbasin boundaries were then reviewed by Payson City Personnel and the general drainage characteristics of each of the areas was discussed. The drainage basin and subbasin boundaries associated with the hydrologic model are shown on Figure 3-1. This figure also shows the portion of the City's service area where the runoff is generally retained by regional retention basins, where runoff is generally retained by local retention basins or sumps, where runoff is generally discharged to Dry Creek, and where runoff is retained by a combination of local retention basins/sumps and regional retention basins.




## Legend

### Streams/Canals

- Minor
- Major
- Payson City Corporate Boundary
- Proposed Regional Detention

### Subbasins

- Runoff Retained Regionally
- Runoff Retained Locally
- Runoff to Dry Creek
- Runoff Retained Locally/Regionally
- Areas with Shallow Groundwater

NORTH:

SCALE: 0 – 3,000 Feet

DRAINAGE SUBBASINS

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 3-1

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure3-1 - Subbasins No Offsite Flow.mxd wandersen 10/31/2019

Table 3-1 summarizes the hydrologic parameters used in the model for each drainage subbasin. Those parameters are discussed in more detail below.

**Table 3-1**
**Summary of Drainage Subbasin Hydrologic Parameters**

| Subbasin ID | Area (acres) | Time of Concentration [tc] (hours) | Curve Number | Future Directly Connected Imperviousness (%) |
|---|---|---|---|---|
| 1 | 97.27 | 0.74 | 80 | 57 |
| 2A | 23.35 | 0.3 | 64 | 49 |
| 2B | 15.55 | 0.3 | 77 | 38 |
| 3A | 72.29 | 0.33 | 71 | 45 |
| 3B | 57.06 | 0.35 | 78 | 43 |
| 3C | 54.58 | 0.3 | 70 | 38 |
| 3D | 191.97 | 0.54 | 73 | 48 |
| 4 | 24.28 | 0.58 | 69 | 39 |
| 5 | 107.82 | 0.64 | 69 | 44 |
| 5A | 38.9 | 0.51 | 70 | 6 |
| 5B | 46.98 | 0.41 | 66 | 57 |
| 6 | 175.27 | 0.53 | 56 | 48 |
| 7 | 51.66 | 0.42 | 64 | 68 |
| 8 | 188.14 | 0.53 | 67 | 34 |
| 8A | 77.13 | 0.53 | 54 | 43 |
| 9 | 119.49 | 0.42 | 72 | 24 |
| 10 | 220.75 | 0.44 | 70 | 32 |
| 10A | 20.13 | 0.4 | 82 | 61 |
| 11 | 63.63 | 0.5 | 78 | 48 |
| 12 | 65.04 | 0.48 | 60 | 27 |
| 12A | 44.98 | 0.4 | 71 | 36 |
| 13 | 157.17 | 0.77 | 79 | 21 |
| 13A | 19.48 | 0.35 | 70 | 21 |
| 14 | 173.22 | 0.51 | 77 | 50 |
| 14A | 179.86 | 0.48 | 74 | 25 |
| 14B | 91.24 | 0.52 | 70 | 23 |
| 15 | 114.67 | 0.44 | 73 | 29 |
| 16 | 194.44 | 0.95 | 75 | 72 |
| 16A | 58.29 | 0.86 | 83 | 63 |
| 16B | 38.08 | 0.59 | 83 | 85 |
| 17 | 75.04 | 0.94 | 84 | 80 |
| 17A | 115.13 | 1.08 | 77 | 80 |

| Subbasin ID | Area (acres) | Time of Concentration [tc] (hours) | Curve Number | Future Directly Connected Imperviousness (%) |
|---|---|---|---|---|
| 17B | 30.67 | 0.6 | 77 | 76 |
| 17C | 32.88 | 0.86 | 84 | 79 |
| 17D | 144.83 | 0.72 | 82 | 67 |
| 18 | 61.93 | 0.2 | 76 | 80 |
| 19 | 271.89 | 0.82 | 80 | 37 |
| 20 | 147.9 | 0.83 | 70 | 65 |
| 21A | 105.71 | 0.15 | 79 | 13 |
| 21B | 196.74 | 0.32 | 68 | 22 |
| 21C | 135.56 | 0.29 | 63 | 22 |
| 21D | 93.71 | 0.23 | 71 | 22 |
| 22 | 166.54 | 0.68 | 79 | 53 |
| 23 | 561.67 | 0.48 | 76 | 10 |
| 24 | 28.48 | 0.57 | 70 | 78 |
| 25 | 74.44 | 0.41 | 67 | 22 |
| 26 | 18.28 | 0.82 | 81 | 81 |
| 27 | 106.86 | 0.67 | 69 | 28 |
| 28 | 162.83 | 0.85 | 79 | 27 |
| 29 | 59.14 | 0.3 | 65 | 22 |
| 30 | 449.94 | 1.12 | 75 | 50 |
| 31 | 102 | 0.75 | 74 | 68 |
| 32 | 186.92 | 0.22 | 84 | 26 |
| 33 | 901.49 | 1 | 80 | 36 |
| 34 | 1007.87 | 1 | 69 | 14 |
| 35 | 1311.28 | 0.9 | 82 | 45 |
| 36 | 451.8 | 0.75 | 72 | 44 |
| 37 | 7753.22 | 1 | 78 | 12 |
| 38 | 4847.16 | 1 | 74 | 32 |
| 39 | 3314.51 | 1 | 75 | 33 |
| 40 | 18.92 | 0.2 | 75 | 36 |

# HYDROLOGIC MODEL PARAMETERS

The following hydrologic model parameters were used to develop the ASSA computer model.

## Hydrology Method

In the ASSA software there are multiple options to simulate the hydrologic components of the study area, including the EPA-SWMM method and Hydrologic Engineering Center (HEC-1) method, among others. For this study, the HEC-1 method was chosen.

## Unit Hydrograph Method

The SCS Unit Hydrograph method was used in the hydrologic model to convert a rainfall hyetograph to a runoff hydrograph. This method requires “lag time” as an input parameter. In non-urban areas, including hillsides, drainage basin lag times were calculated based on approximate collection channel lengths and slopes using the Corps of Engineers version of Snyder’s equation for lag time (Flood Hydrology Manual, 1989). In urban areas, worksheet 3 in Technical Release 55 (TR-55) was used to estimate the time of concentration. Previous studies have shown that the lag time in urban areas can be approximated as the time of concentration. The Lag Time was adjusted during the calibration process for some subbasins. See “Model Calibration” below for a more detailed description.

## Loss Method

The SCS Curve Number method was used in ASSA to calculate infiltration losses (see Natural Resources Conservation Service (NRCS) TR-55 publication for additional information). This method requires the input of a composite runoff Curve Number for pervious areas and the percent impervious for each subbasin.

**Composite Curve Number.** The Curve Numbers (CN) was estimated for each subbasin based on soil type and vegetative ground cover. The hydrologic soil type was obtained from the NRCS Soil Survey Geographic (SSURGO) dataset. Table 3-2 shows the Curve Numbers used in this study based on soil type and as assumed vegetative ground cover for developed areas. See “Model Calibration” below for a more detailed description.

**Table 3-2**
**SCS Curve Number**

| Soil Type | Curve Number* |
|---|---|
| A | 49 |
| B | 69 |
| C | 79 |
| D | 84 |

* From Table 2-2 in TR-55 "Open Space – Grass Cover 50% to 75%"

**Directly Connected Impervious Area.** The amount of directly connected impervious area for existing conditions in each subbasin was estimated using the 2018 High Resolution Orthophotography (HRO) and Land Use. Directly connected impervious area is defined as an impervious surface, typically paved areas, where storm water runoff is conveyed via curb and gutter or paved drainage swales directly to a point of discharge. A disconnected impervious area is typically a roof or paved surface that discharges runoff onto a permeable area, such as a lawn or vegetated field. Each subbasin was analyzed and the estimated directly connected impervious area was recorded. The amount of directly connected impervious area was also estimated for full build-out conditions, which can be seen for each subbasin in Table 3-1. Most urban runoff is generated on directly connected impervious areas like roads and parking lots. For areas that are currently undeveloped, Table 3-3 was used to estimate the amount of directly connected impervious area.

**Table 3-3**
**Average Percent of Directly Connected Impervious Area Based on Land Use**

| General Plan Land Use Type | Directly Connected Imperviousness (Percent) |
|---|---|
| Agricultural Holding Zone | 0% |
| Commercial | 85% |
| High Density Over 16 Units | 50-70% |
| Industrial | 72% |
| Low Density Residential 0-6 Units | 15-28% |
| Medium Density Residential 6-16 Units | 38% |

| | |
|---|---|
| Mixed Use Center | 70% |
| Mixed Use Neighborhood | 70% |
| Office Flex | 80% |
| Parks Open Space | 5% |
| Public Facilities* | 80% |
| Public Facilities Zero | 80% |
| Rural Residential | 80% |
| Transit Oriented Development | 75% |

## DESIGN STORM PARAMETERS

The design storm for this storm drain master plan was based on the Modified Farmer-Fletcher study of cloudburst events in the Intermountain West. The parameters listed below were used to develop the depth, duration, and temporal distribution for a cloudburst design storm.

- Storm Distribution: Modified Farmer and Fletcher Distribution (see Appendix C)
- Storm Recurrence Interval and Duration:
  - Minor conveyance facilities (urban storm drain pipes and collection facilities): 10-year recurrence interval with a duration of 3 hours (10-year, 3-hour storm)
  - Major conveyance facilities: Curb and gutter, major streams and major culverts (100-year flood based on stream gage flow frequency)
  - Retention Volume: Runoff from a 100-year, 24-hour storm (including infiltration)
- Storm Depth (From NOAA Atlas 14):

  10-Year: 1.10 inches

  100-Year: 2.80 inches

After multiple discussions with Payson City personnel, a 3-hour design storm with a 10-year return period was selected for the basis of the hydrologic analyses for storm drain pipelines and a 24-hour design storm with a 100-year return period was selected as the basis for the hydrologic analyses of detention/retention basins for this study. Many other cities and counties in Utah utilize similar design storm parameters in planning and designing storm drain facilities. More detailed information on the 10-year and 100-year design storms is included in Appendix C.

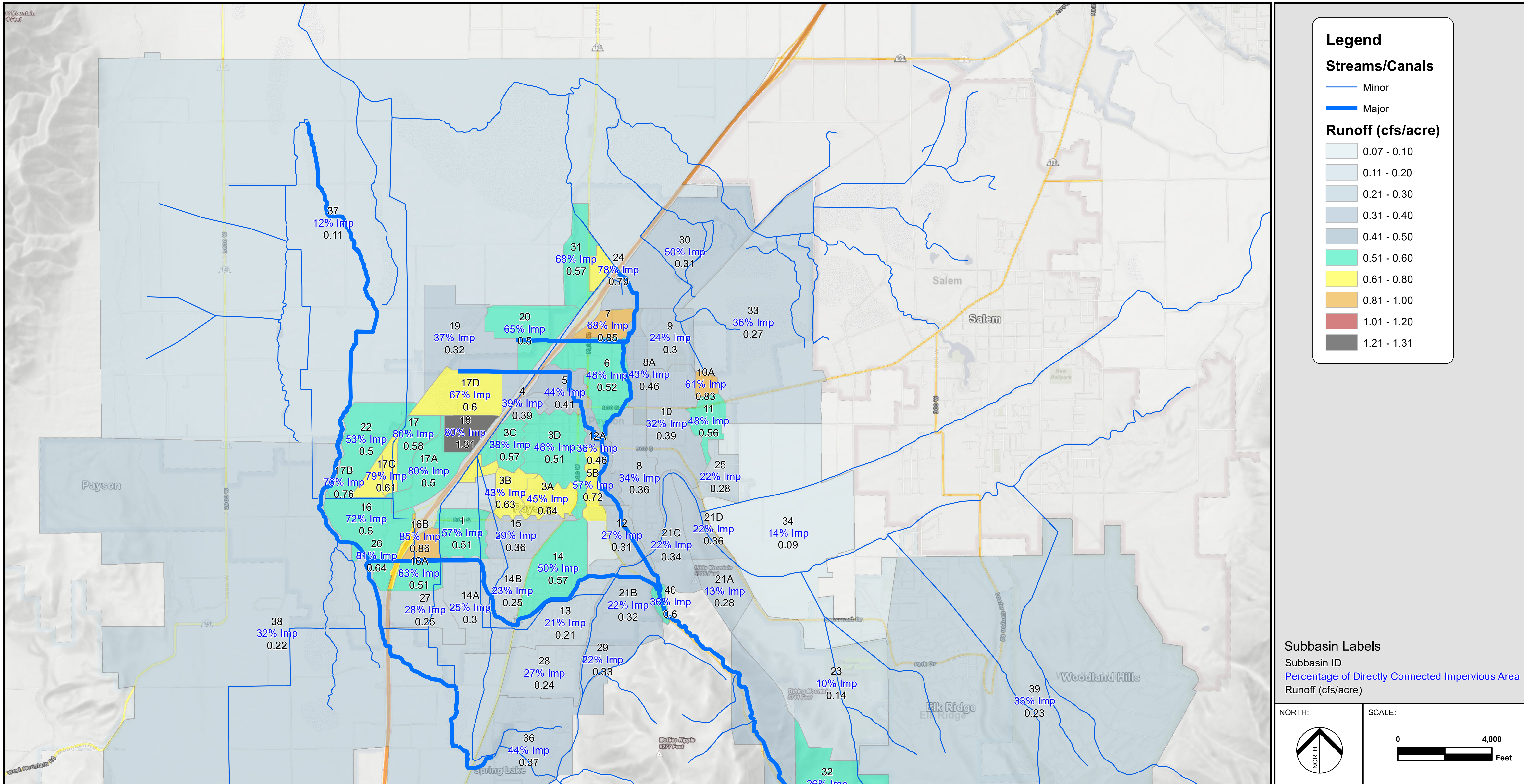
## Model Calibration

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.** The rainfall-runoff model for the study area generally produce peak runoff rates that range from 0.26 cfs/ac to 0.34 cfs/ac runoff for quarter-acre subdivision lots, on subbasins ranging in size from 50-100 acres. The calibration target range for runoff on a quarter acre subdivision lot is typically between 0.25 and 0.35 cfs/ac during a 10-year design storm, based on information in the Water-Resources Investigations Report 89-4095 entitled "Peak-Flow Characteristics of Small Urban Drainages along the Wasatch Front, Utah" from the U.S. Geological Survey published in 1989. Figure 3-2 shows the ratio of runoff to area for each of the drainage subbasins. In some cases, runoff rates are well above 0.35 cfs. This is more typical of highly impervious areas or areas with steep slopes.

**Curve Number (CN) Values.** In some instances, the simulated peak runoff initially exceeded the calibration range. In these instances, the CN Value for the subbasin, which is used to represent the runoff potential for an area based on soil type and impervious area, was examined and adjusted if necessary. These adjustments typically occurred in areas where the soil map indicated the underlying soil was Type C or D soil (CN value 79 or 84), indicating low infiltration and high runoff potential. However, once an area develops the pervious portion of the development area is usually landscaped with sod, mulch or other materials that have higher infiltration rates and lower runoff potential. Runoff is typically only generated from the impervious area of the developed area during a 10-year storm event. Therefore, in some of these areas the CN Value was adjusted to reflect little or no runoff from the pervious portions of developed areas.

**Lag Time.** As indicated above, Snyder's equation, or Worksheet 3 in TR-55, was initially used to estimate the Lag Time. The Lag Time was further adjusted for some subbasins during the calibration process to adjust the peak runoff to be within, or closer to, the calibration target range described above.




BUILDOUT CONDITION ESTIMATED UNIT RUNOFF (CFS/ACRE)

PAYSON CITY

STORM DRAIN MASTER PLAN

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FIGURE NO.

3-2

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure3-2 - Subbasins CFS-AC.mxd wandersen 10/31/2019

## 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 2) antecedent soil moisture conditions exist at the beginning of the design storm.
4. The hydrologic computer model accurately 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 100-year storm event can be collected and conveyed to existing City detention/retention facilities.
7. No runoff from the hillside drainage areas in the southeast part of the City would be allowed to cross Strawberry Highline Canal.
8. Existing storm drain sumps or Class V injection wells were not accounted for in the hydrologic analyses the estimated runoff. It was discovered that the City's GIS inventory of storm drain facilities is not complete enough to complete that analysis.

**Existing Inlet Capacity Issues.** In urbanized areas with larger storm drain pipes or trunk lines, the assumption was made that there are enough existing storm drain inlets in each subbasin to collect runoff from a 10-year design storm event. A cursory evaluation indicated that some subbasins may not have enough inlets to intercept the runoff generated from the 10-year storm. In areas where ponding or flooding occurs, the inlet capacity should be evaluated and additional inlets should be added if necessary.

## FUTURE DEVELOPMENT CONDITIONS

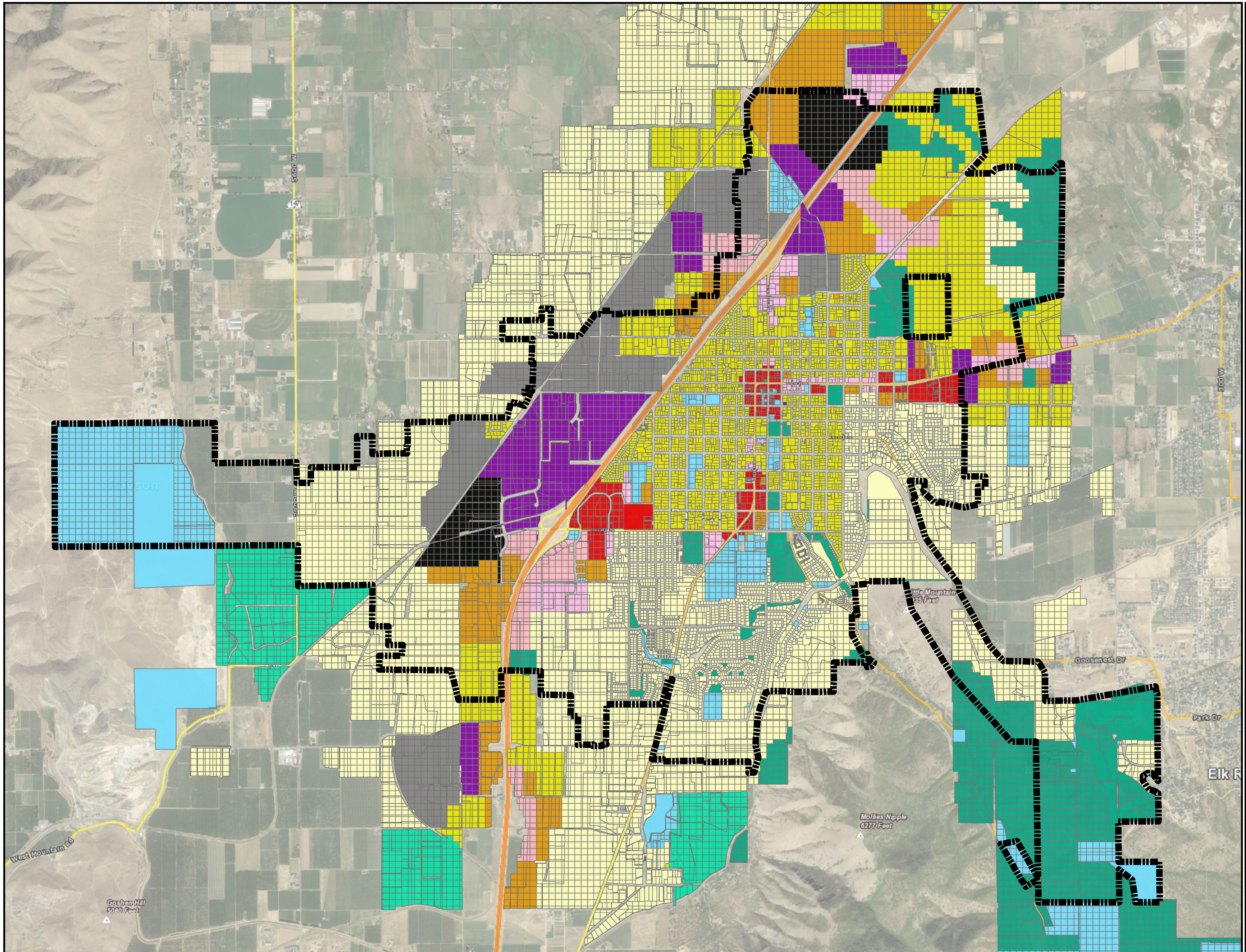
For the purposes of this study, it was assumed that the current trends of growth and development in the City would continue. BC&A worked with Fregonese Associates and engineers Hansen, Allen & Luce (who prepared master plans for the City water and pressurized irrigation systems) to predict future land uses based on zoning and projected land use maps provided by the City. The Projected Land Use Map is shown in Figure 3-3. Table 3-3 lists each of the future land uses for the City.

## FEMA FLOW FREQUENCY ANALYSIS

As part of the FEMA Flood Insurance Study, a flow frequency analysis was performed using stream gage records on Peteetneet Creek. The results of that analysis for Peteetneet Creek and Dry Creek are summarized in Table 3-4 and shown on Figure 3-4. The 100-year discharge values in Table 3-4 should be used as the basis of design for culverts and open channel sections to limit flood potential along those streams.

**Table 3-4**
**Summary of 10-Year, 50-Year, 100-Year, and 500-Year Discharges from FEMA Flood Insurance Study**

| Creek Name | Discharge Per Recurrence Interval (cfs) | | | |
|---|---|---|---|---|
| | 10-Year | 50-Year | 100-Year Discharge | 500-year |
| Dry Creek (At Divergence From Peteetneet Creek) | 450 | 800 | 1,000 | 1,240 |
| Dry Creek (Downstream of 1400 South) | 450 | 800 | 959 | 1,097 |
| Dry Creek (Downstream of 900 West) | 450 | 757 | 935 | 1,153 |
| Dry Creek (Downstream of I-15) | 300 | 315 | 320 | 410 |
| Dry Creek (1250 South Split) | -- | 3 | 41 | 143 |
| Dry Creek (900 West Split) | -- | 37 | 65 | 87 |
| Dry Creek (I-15 Split) | 150 | 485 | 680 | 830 |
| Peteetneet Creek at Canyon Mouth | 7 | 7 | 7 | 160 |




**Legend**

Payson City Corporate Boundary

**Future Development Type**

- Agricultural
- Commercial
- Industrial
- Office Flex
- Parks Open Space
- Public Facilities
- Public Facilities Zero
- Rural Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Mixed Use Center
- Mixed Use Neighborhood
- Transit Oriented Development

NORTH:

SCALE:

0 3,000 Feet

FUTURE LAND USE

PAYSON CITY

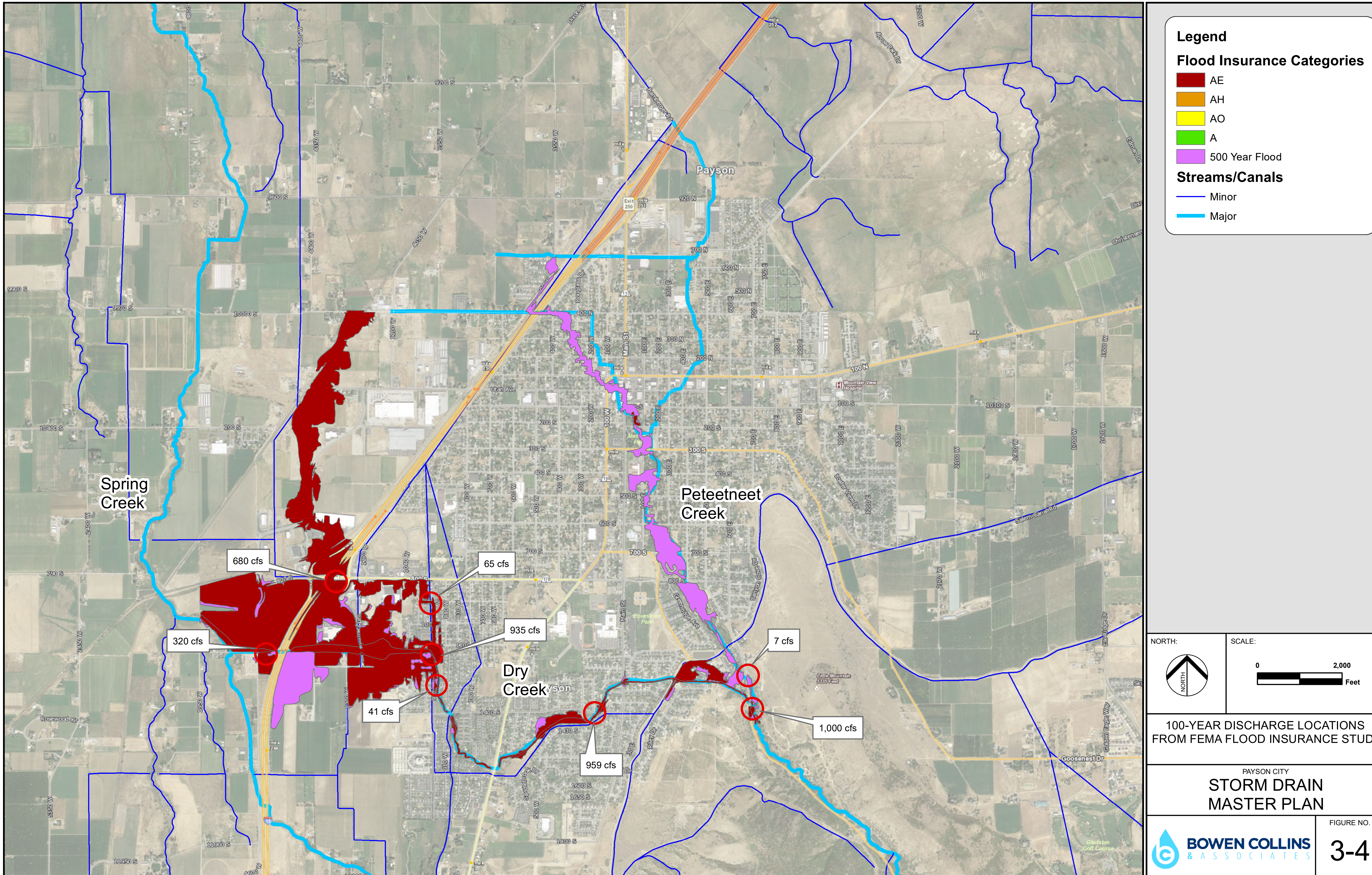
STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO.

3-3

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure3-3 - Future Land Use.mxd wandersen 10/31/2019




100-YEAR DISCHARGE LOCATIONS FROM FEMA FLOOD INSURANCE STUDY

PAYSON CITY

STORM DRAIN MASTER PLAN

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FIGURE NO.

3-4

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure3-4 - Flood Plain with Capacities.mxd wandersen 12/12/2019

# Chapter 4 - Hydraulic Analysis

## INTRODUCTION

Hydraulic analyses of 3 types of flood control facilities were performed as part of this study. These facilities include:

1. Existing storm drain trunklines
2. Storm water detention/retention facilities
3. Existing Dry Creek and Spring Creek culverts

Hydraulic computer models of the two storm drain trunklines and their related detention/retention basins of interest were developed in ASSA for the purpose of routing runoff and evaluating the capacity of the two trunk lines and their associated retention facilities. ASSA uses an EPA-SWMM based engine to perform hydraulic computations. As with EPA-SWMM, ASSA can be used to model the hydrologic and hydraulic components of the study. ASSA was used to model the following selected existing storm drain pipelines and existing retention basins.

The culverts were not modeled in ASSA. No detailed hydraulic analysis was performed as part of this study for the culverts on Dry Creek.

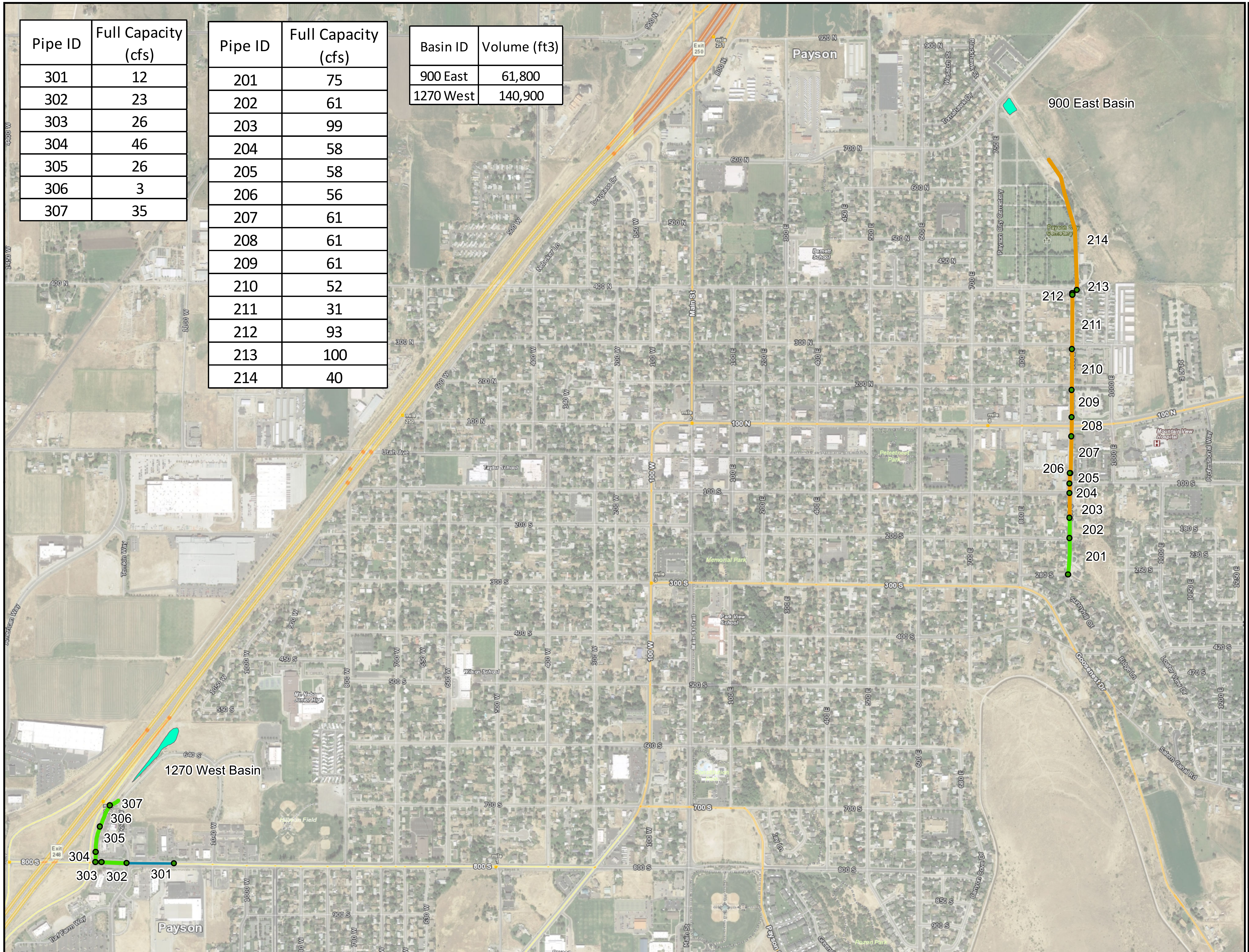
## STORM DRAIN PIPELINES

The scope of this storm drain master plan included a hydraulic analysis of only the major storm drain trunklines. The storm drain trunklines included in the hydraulic model are shown in Figure 4-1. The two storm drain trunk lines included in this model were selected by Payson City. The City has limited data on their storm drain infrastructure and only wanted to model a few selected local systems.

| Pipe ID | Full Capacity (cfs) |
|---|---|
| 301 | 12 |
| 302 | 23 |
| 303 | 26 |
| 304 | 46 |
| 305 | 26 |
| 306 | 3 |
| 307 | 35 |

| Pipe ID | Full Capacity (cfs) |
|---|---|
| 201 | 75 |
| 202 | 61 |
| 203 | 99 |
| 204 | 58 |
| 205 | 58 |
| 206 | 56 |
| 207 | 61 |
| 208 | 61 |
| 209 | 61 |
| 210 | 52 |
| 211 | 31 |
| 212 | 93 |
| 213 | 100 |
| 214 | 40 |

| Basin ID | Volume (ft3) |
|---|---|
| 900 East | 61,800 |
| 1270 West | 140,900 |




## Legend

- Modeled Existing Manholes
- Retention Basin Area

**Modeled Existing Pipes**

**Diameter**

- 15" or less
- 18"
- 21"
- 24"
- 30"
- 36"

NORTH:

SCALE: 0 1,000 Feet

MODELED STORM DRAIN TRUNKLINES AND REGIONAL RETENTION FACILITIES

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 4-1

Information on the physical characteristics of the pipes included in the model was collected and assembled by Payson personnel. A basic framework for the model was developed using Payson's GIS records. The City's GIS database included information on the diameter, length, material, and location of each pipe included in the model. Rim elevations were collected by a City survey crew. Inverts based on measure downs were included as well.

## DETENTION/RETENTION BASINS

As mentioned previously, only the two existing regional storm water retention facilities were modeled. Those facilities are the 1270 West Retention Basin and the 900 East Retention Basin, as shown in Figure 4-1. The stage storage curves provided by the City for both of these retention basins were entered into the model.

Initial modeling results indicated that the regional retention facilities do not have the capacity to store all the runoff generated in the upstream tributary area from a 100-year, 24-hour storm. Therefore, at the request of City personnel, the retention basins were modeled assuming that impounded water could infiltrate into the ground. A detailed description of this analysis in provided in Chapter 5.

## DRY CREEK AND SPRING CREEK CULVERTS

The engineering department at Utah County provided size information for the culverts along Spring Creek that were of interest. The size and estimated capacity of the Spring Creek culverts near Payson are listed in Table 4-1. FEMA has not completed a flood insurance study on Spring Creek, but FEMA has produced a flood map that defined special flood hazards associated with Peteetneet Creek and Dry Creek, as shown in Figure 2-3. The capacities of the Spring Creek culverts were estimated using FHWA culvert nomographs assuming inlet control and 1 foot of water above the crown of the pipe. The Dry Creek culverts were determined to be undersized based on hydraulic profile information and flood map information published with the FEMA Preliminary Flood Insurance Study, which is discussed further in Chapter 5 of this report.

**Table 4-1**
**Spring Creek Culvert Information**

| Culvert Location | Culvert Size | Estimated Culvert Capacity (cfs) |
|---|---|---|
| **9600 South** | 6-foot box culvert[1] | 270 |
| **10000 South** | 10-foot box culvert[1] | 450 |
| **Utah Avenue** | 66" CMP | 175 |

[1]Depth assumed to be 6 feet

# Chapter 5 - Drainage System Deficiencies

## INTRODUCTION

The purpose of this chapter is to document the results of the hydraulic evaluation of Payson City's storm water management facilities and identify capacity deficiencies, primarily for projected future development conditions. The problems and deficiencies listed in this chapter were identified by evaluating hydraulic model output, field reconnaissance during rainfall events, and information provided by the City's Storm Drain Superintendent.

## EVALUATION CRITERIA AND LEVEL OF SERVICE

To define deficiencies in the City's existing storm drain system, the desired level of service for each of the storm drain components needs to be defined. Below are the recommended major design and performance criteria for storm drain management facilities in Payson. Facilities that do not meet these desired performance criteria were considered deficient. Detailed design criteria for the items listed below are provided in the City's Design Standards.

### Storm Drain Pipelines

Storm drain pipelines should be designed so that they are not pressurized during the 10-year design storm. In cases where pressurized pipes are allowed by the City Engineer, the hydraulic grade line experienced during the 10-year, 3-hour design storm event is at least 2 feet below the rim or grate elevations of manholes or inlets. Storm drain pipes should not have an inside diameter smaller than 15 inches in diameter. It is important to note that roadways become the major storm water conveyance facility during storms that are larger than the 10-year design storm event.

## Open Channels

Major open channels should have at least two feet of free board during the 100-year flood event. Open channels should also have a protective lining that reduces the potential for erosion and lateral channel migration. If velocities are less than 4 feet per second (fps), an open channel may be grass lined. However, if the peak design flood velocity in a channel is over 4 fps, then grass will not be sufficient to protect the channel from erosion damage and some type of channel armoring should be provided.

Culverts and bridges on the major open channels should also have capacity to pass the 100-year flood event. Bridges should have at least 1 foot of freeboard between the estimated 100-year water surface elevation and the low chord of the bridge. Culverts should have the capacity to pass the 100-year flood discharges with less than 2 feet of surcharge above the crown of the pipe and should not create backwater issues that will flood upstream developed property.

## Retention and Detention Facilities

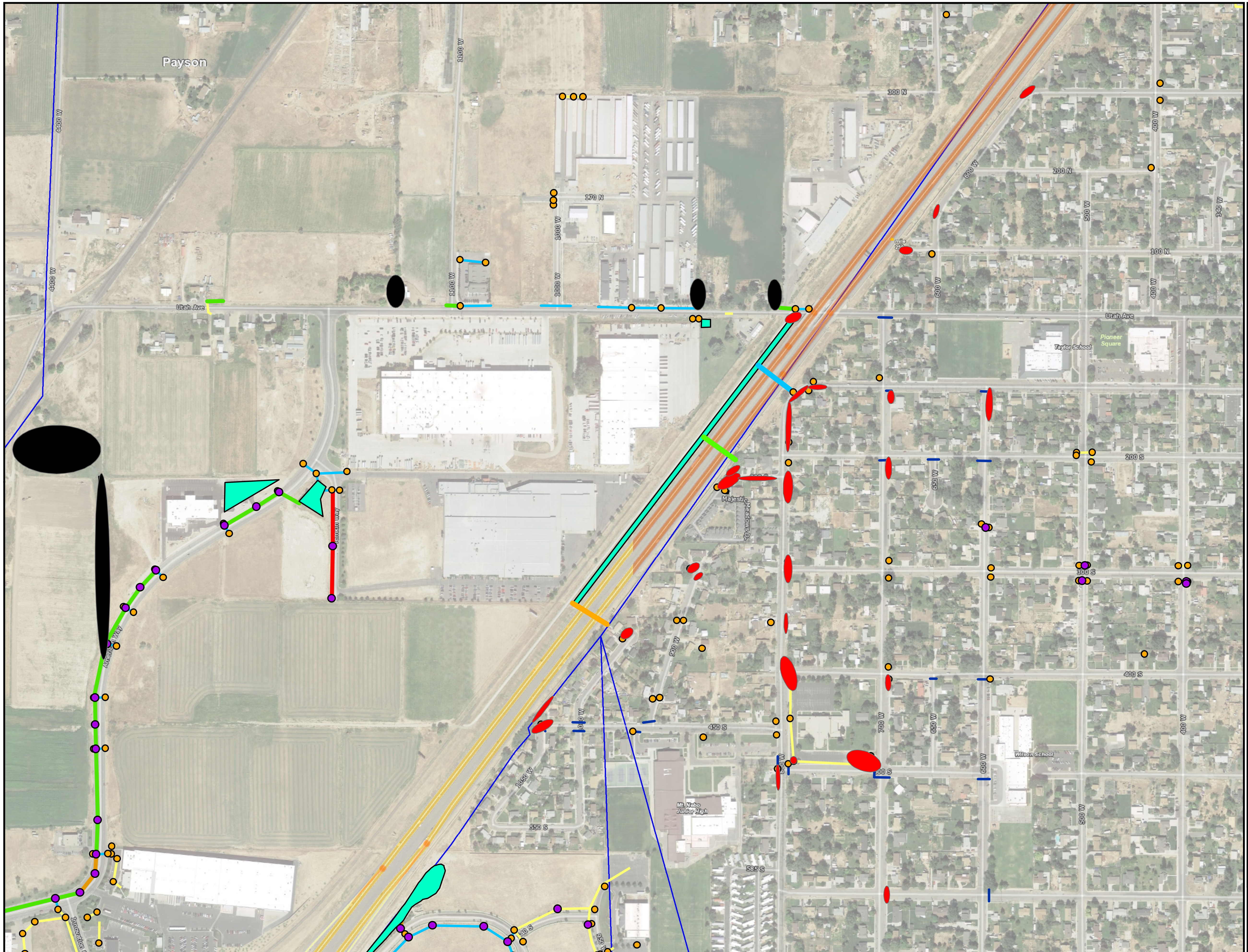
Storm water retention facilities should be designed to store runoff generated from the tributary area for the 100-year, 24-hour storm, with at least one foot of freeboard, and have an emergency overflow that directs water away from private property. Detention basins should also be designed for the 100-year, 3-hour storm defined in this master plan report. When calculating required volumes, it is recommended that infiltration losses not be considered when sizing retention basin volumes. Detailed design criteria are included in the City's Design Standards.

# DRAINAGE SYSTEM DEFICIENCIES

The major existing drainage system deficiencies identified as part of this study are presented below and are presented based on their location in the City or deficiency category. When identifying deficiencies, it was assumed that future development conditions would be imposed on the existing storm drain system infrastructure. Most of the existing problems or deficiencies will become more serious if additional development can occur without taking steps to mitigate the existing problems.

## 800 West / Utah Avenue Problem Areas

The City's highest priority problem is in the area generally bounded by 800 West, Utah Avenue, 600 West, and 800 South. Figure 5-1 shows the problems in this area that experience recurring shallow flooding problems. From field visits, information on topographic maps, and talking to the




**Legend**

**Drainage Problem Type**
- Flooding
- Discharge to Private Property

**Existing I-15 Culverts**

**Size**
- 18
- 24
- 30
- 36
- Existing Cross Drains
- Existing Detention/Retention Basin
- Storm Inlet Box
- Storm Manhole

**Existing Storm Drain Pipe**

**Diameter**
- 15" or less
- 18"
- 21"
- 24"
- 30"
- 36"

**Streams/Canals**
- Minor
- Major

NORTH:

SCALE: 0 400 Feet

EXISTING DRAINAGE PROBLEMS IN 800 WEST/UTAH AVENUE AREA

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

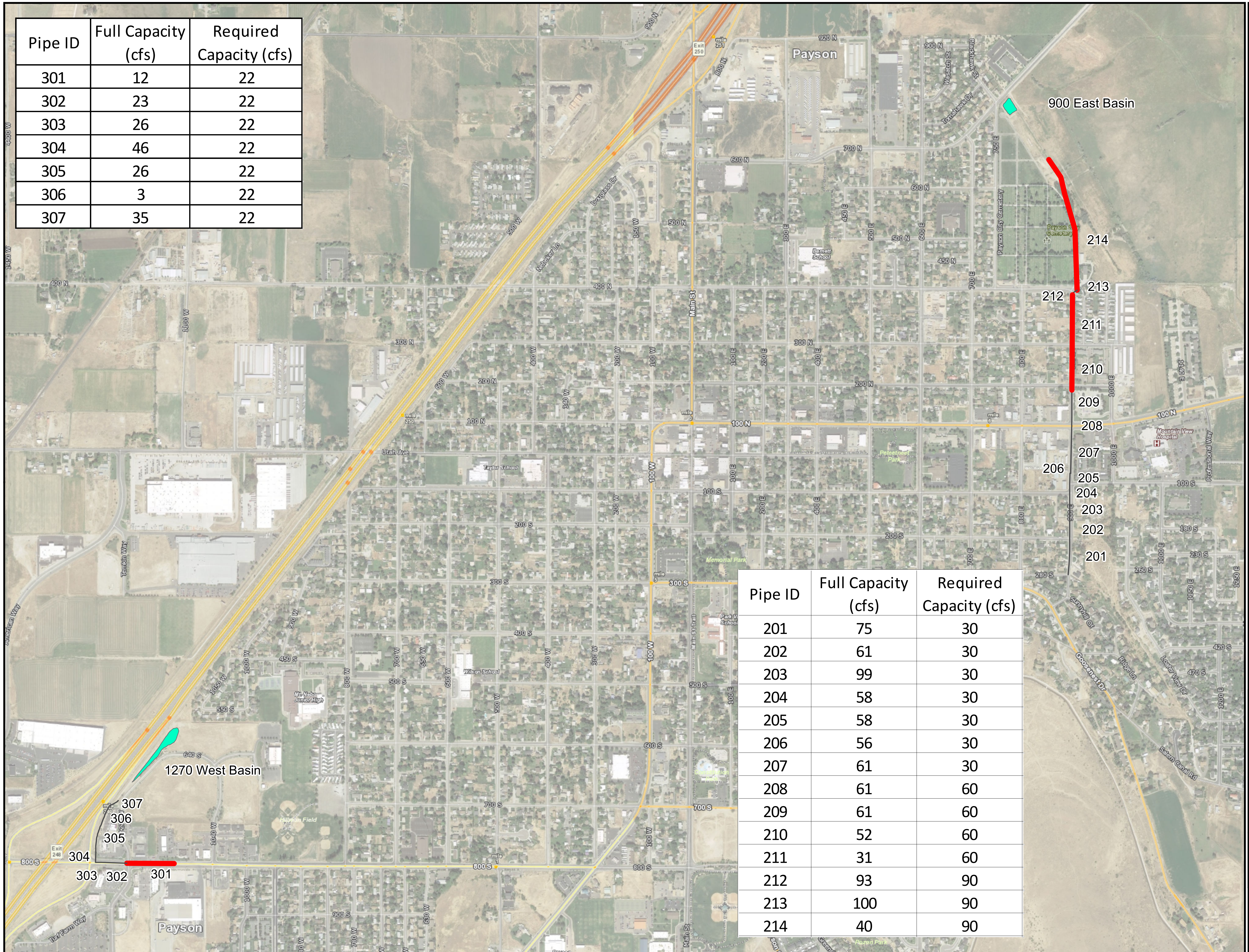
FIGURE NO. 5-1

City staff, stormwater surface flows to the northwest in streets between the area generally bounded by Utah Avenue, 100 West, 800 South and 800 West. The flooding problems in this area are caused by the following deficiencies:

- There are no storm drain collection and conveyance facilities in this area. Curb and gutters, which are intermittent in this area, are not able to confine runoff in the streets.
- There are only a limited number of storm drain sumps in this area that will allow runoff to be removed from the streets. Storm water runoff frequently causes shallow flooding along street shoulders and private property. In areas where there is no curb and gutter, storm water runs onto shoulders or yards where it infiltrates into the ground.
- Runoff from the west half of 800 West Street between 800 South and Majestic Meadows Drive (220 South) is conveyed to the intersection of 800 West and Majestic Meadows Drive, where it flows westward in the street into a private development that does not have storm drain facilities to manage the runoff from 800 West Street. Shallow flooding occurs in Majestic Meadows Drive and on private properties adjacent to I-15. The ponded water in this area either infiltrates into the ground or it is slowly conveyed through a 24-inch culvert that passes under I-15 just north of Majestic Drive.
- There is a significant crown on 800 West Street that tends to keep most runoff from areas east of that street confined to the east half of the road during smaller storm events. However, because there are no storm drain inlets on 800 West until about 100 South, significant street flooding and shallow flooding on private property occurs between 100 South and 250 South.

## 900 East / Cemetery System Deficiencies

The City has an existing storm drain trunkline that runs north on 900 East from 280 South to an existing retention basin located north of the cemetery, near Arrowhead Road and 750 East. The estimated existing capacities of the trunkline and retention basin are shown in Figure 4-1. This storm drain trunkline and associated retention basin were modeled in ASSA. The pipeline profile from the ASSA model is included in Appendix D. Assuming that all the runoff generated from the design storm in the associated subbasins (86 cfs) will flow to the trunk line, there are three sections of pipe in the existing 900 East trunkline that are capacity deficient, as shown in Figure 5-2. At projected full buildout conditions, approximately 46 cfs of the 10-year storm event will be conveyed within the street cross section instead of in the storm drain pipes because of




| Pipe ID | Full Capacity (cfs) | Required Capacity (cfs) |
|---|---|---|
| 301 | 12 | 22 |
| 302 | 23 | 22 |
| 303 | 26 | 22 |
| 304 | 46 | 22 |
| 305 | 26 | 22 |
| 306 | 3 | 22 |
| 307 | 35 | 22 |

| Pipe ID | Full Capacity (cfs) | Required Capacity (cfs) |
|---|---|---|
| 201 | 75 | 30 |
| 202 | 61 | 30 |
| 203 | 99 | 30 |
| 204 | 58 | 30 |
| 205 | 58 | 30 |
| 206 | 56 | 30 |
| 207 | 61 | 30 |
| 208 | 61 | 60 |
| 209 | 61 | 60 |
| 210 | 52 | 60 |
| 211 | 31 | 60 |
| 212 | 93 | 90 |
| 213 | 100 | 90 |
| 214 | 40 | 90 |

MODELED EXISTING SYSTEM DEFICIENCIES

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5-2

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure5-2 - Modeled Existing System Deficiencies.mxd wandersen 12/10/2019 inadequate capacity. This is a conservative estimate since the City has sumps that are not accounted for in this area, which will capture a portion of the runoff.

The existing percolation rate of the cemetery retention basin is unknown. Without measuring the percolation rate of the basin, it is not possible to accurately simulate how the retention basin operates. Based on observations from City personnel, the basin can infiltrate a full pond volume in 24 hours or less. City personnel claim that they have never had any flooding problems with the basin. Using an assumed infiltration rate of 2.4 in/hr (equivalent to the full basin infiltrating in 24 hours), the existing retention basin near the cemetery does not have the capacity to manage runoff from the 100-year storm event from the area that contributes flow to the retention basin, even when the trunkline is undersized and the full volume runoff from the design storm does not reach the basin. After discussing these results with City personnel, it was recommended by City staff to double the initial assumed infiltration rate so that the basin drains in 12 hours instead of 24 hours (the equivalent infiltration rate is 4.7 in/hr). Using the 12-hour infiltration rate and keeping the trunkline undersized, the computed volume of runoff that over tops the basin for the 10-year, 3-hour and 100-year, 24-hour design storms is 2.7 acre-feet and 17.4 acre-feet, respectively. If the trunkline is upsized, the computed volume of runoff that over tops the basin from the 10-year, 3-hour and 100-year, 24-hour design storms are 3.97 acre-feet and 17.22 acre-feet, respectively.

Based on existing topography, recent aerial photography, and a cursory review of existing inlet and pipe capacities, some runoff from a 100-year, 24-hour storm event will not enter the surcharge storm water pipes that convey runoff to the retention basin. This bypass runoff will be conveyed within the street right-of-way and into the fields to the north and east of the cemetery retention basin. These fields may experience shallow flooding during an extreme storm event. For existing development conditions, this type of flooding may be inconsequential, as most of the bypass runoff will likely infiltrate within 24 hours. When these fields are developed in the future, the flooding risk will have greater consequences during the 100-year storm event if sumps are not installed upstream of the collection trunkline. Additional percolation rate tests in and around the retention basin would also be needed to verify infiltration rates.

### 1270 West / 800 South System Deficiencies

The City has an existing storm drain trunkline that runs west along 800 South then turns north on 1270 West and discharges into an existing retention basin. The existing capacities of the trunkline and basin are shown in Figure 4-1. This storm drain trunkline and retention basin were modeled in ASSA and the results from the 10-year, 3-hour design storm event show that the most upstream pipe of the trunkline is undersized, as shown in Figure 5-2 and the pipeline profile in Appendix D. At buildout conditions, approximately 3 cfs of the 10-year, 3-hour design storm event will be conveyed within the street cross section instead of in the storm drain pipes because of inadequate capacity. During a 10-year, 3-hour design storm, shallow street flooding will occur at manholes and inlets along the trunkline. This is a conservative estimate since there are sumps upstream of the trunkline that have not been accounted for that will capture some runoff.

Based on anecdotal observations of City personnel, the existing retention basin near I-15 has a significant amount of capacity to infiltrate stormwater. City personnel have never observed stormwater in the basin for more than 24 hours for existing conditions. Soils in the vicinity of the basin are mostly Type A. Using an assumed initial infiltration rate of 2.0 in/hr (equivalent to the full basin infiltrating in 24 hours), the existing retention basin near I-15 does not have the capacity to meet the desired design storage criteria for the 100-year, 24-hour storm event from the area that contributes flow to the retention basin, even when the trunkline is undersized and the full volume of runoff from the contributing subbasin does not reach the basin. After discussing this result with City personnel, the City staff requested that the initial assumed infiltration rate be doubled so that the basin would drain in 12 hours instead of 24 hours (an equivalent infiltration rate is 4.0 in/hr).

Using the 12-hour infiltration rate and keeping the trunkline undersized, the volume of water that floods at the basin for the 100-year storm is 1.3 acre-feet. If the trunkline is upsized, the volume of water that is flooded for the contributing area for the 100-year storm is 1.5 acre-feet.

Even though 100-year stormwater runoff cannot be conveyed to the retention basin within City stormwater pipes, the local topography and roads would likely convey much of the bypass runoff to the retention basin because it is located in a topographical depression just east of the I-15 embankment. There is nowhere else for the runoff to go but into the basin. During a 100-year, 24-hour storm event, the basin will overtop its existing banks and flood the surrounding streets and properties. For existing conditions, the basin is primarily surrounded by undeveloped property. When these surrounding properties are developed, consideration will need to be given to the maximum water surface of flooding from a 100-year storm event. When these undeveloped properties are developed, the developments may at risk of flooding during extreme storm events if sumps are not added to the upstream collection area. Additional percolation rate tests in and around the retention basin are needed to verify the assumed infiltration rates used in this study.

## 600 North to Utah Avenue Problem Areas

The City has very few storm drain facilities east of I-15 between 600 North and Utah Avenue. Generally, the streets in the area bounded by I-15, 600 North 200 East, and Utah Avenue drain north and west, which causes problem areas near I-15 where the roadway embankment prevents sheet flow from crossing the freeway. Figure 5-1 shows existing deficiencies in this area that have shown signs of flooding. There are only two culverts that cross I-15 between Utah Avenue and 600 North. One is associated with the historic Peteetneet Creek, which conveys irrigation water under I-15 at 400 North. The other is a culvert at 600 North that conveys irrigation and storm water under I-15 and discharges it into an open channel that terminates in fields west of I-15. There are not enough inlets, sumps, and storm drain facilities in this area to properly manage runoff from this area. The system deficiencies in this area result in shallow flooding.

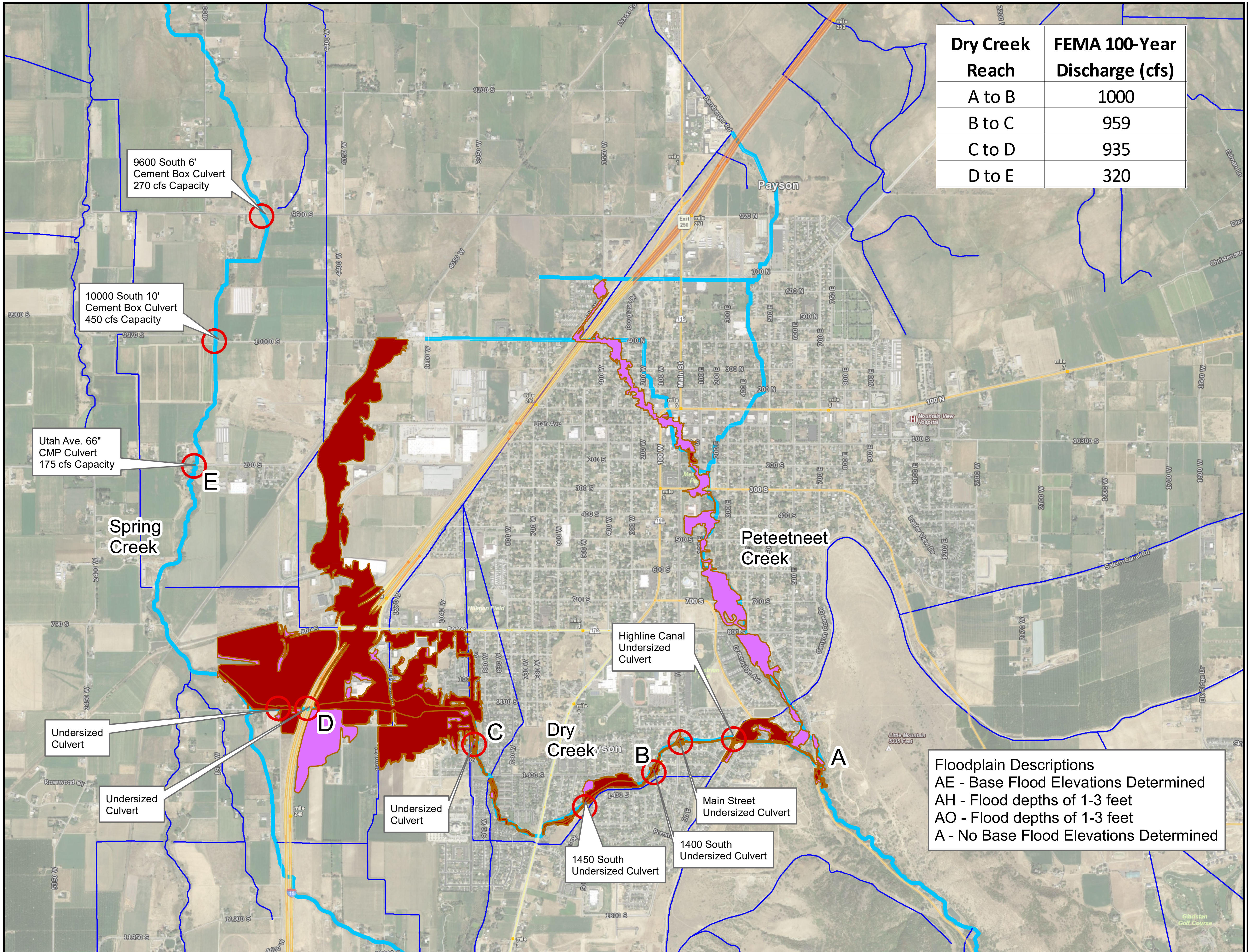
## Dry Creek and Spring Creek Culvert Deficiencies

Some storm drain systems adjacent to Dry Creek discharge directly to Dry Creek, which discharges into Spring Creek west of I-15. Both creeks have culverts at street crossings and there are at least 10 culverts that do not have capacity to convey the 100-year flood without flooding or resulting in significant backwater effects upstream of the bridges. Figure 5-3 shows where these undersized culverts are located on Dry Creek and Spring Creek.

Figure 5-3 also shows the FEMA-defined flood hazards for the major creeks in Payson and the FEMA 100-year discharge values at key locations along Dry Creek (accounting for culvert and channel capacity deficiencies). The FEMA hydraulic profile of Dry Creek, which illustrates the backwater effects upstream of the existing culverts, is included in Appendix E. The capacity of Dry Creek at its confluence with Spring Creek is approximately 320 cfs.

## Street Runoff Discharged onto Private Property

As development is expanding into the undeveloped areas west of I-15 and in other areas of the City, there are places where runoff from streets and developed areas are discharged into




| Dry Creek Reach | FEMA 100-Year Discharge (cfs) |
|---|---|
| A to B | 1000 |
| B to C | 959 |
| C to D | 935 |
| D to E | 320 |

**Legend**

**Flood Insurance Categories**
- AE
- AH
- AO
- A
- 500 Year Flood

**Streams/Canals**
- Minor
- Major

Note: For planning purposes, the Dry Creek channel and culverts in Payson should have capacity to convey at least 1,000 cfs.

NORTH:

SCALE: 0 2,000 Feet

RIVERINE FLOOD HAZARDS DEFINED BY FEMA AND CULVERT CAPACITY DEFICIENCIES

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5-3

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure5-3 - Flood Plain.mxd wandersen 12/10/2019 abandoned irrigation ditches or open channels that are located on private property. Most of those ditches facilities no longer function and have not outfall. Figure 5-1 shows 4 locations where runoff is currently diverted or discharged onto private property. As a general rule, runoff from City streets should be contained within the street rights-of-way and not discharged onto private property without having a storm drain easement or an easement associated with a historic open channel. The 4 locations shown cannot convey runoff to an existing receiving stream or facility. Development should not be allowed to generate runoff that will increase flood potential on downstream properties without the proper permission and easements.

### Lack of Storm Drain Facilities West of I-15

Developed areas on the west side of the I-15 corridor are generally susceptible to shallow flooding during large storm events due to the lack of existing storm water conveyance facilities, the lack of existing open channels that can convey runoff to Spring Creek, and shallow groundwater. The shallow groundwater in areas generally identified in Figure 3-1 will make it more difficult to utilize storm water retention facilities to manage runoff on a site-by-site basis.

### Historic Irrigation/Drainage Ditches are being Abandoned and Backfilled

Since the pressurized irrigation system was constructed in Payson, most of the historic irrigation/drainage ditches have been abandoned and backfilled, limiting the areas where storm water runoff can be discharged without causing undesired flooding. This has created shallow flooding and ponding problems in multiple areas of the City.

### Retention Facilities/Class V Injection Wells in Groundwater Source Protection Zones 1 and 2

Payson City owns multiple wells within the City limits that are used as sources for drinking water for City residents. The State of Utah Administrative Code (R309-600) requires public water suppliers to protect groundwater that is used for drinking water from being contaminated. The State regulations require that the City inventory potential groundwater contamination sources within certain well recharge zones and to develop and implement best management practices that will prevent groundwater from becoming contaminated. The City should not allow potential contamination sources to be constructed in areas that could impact drinking water wells.

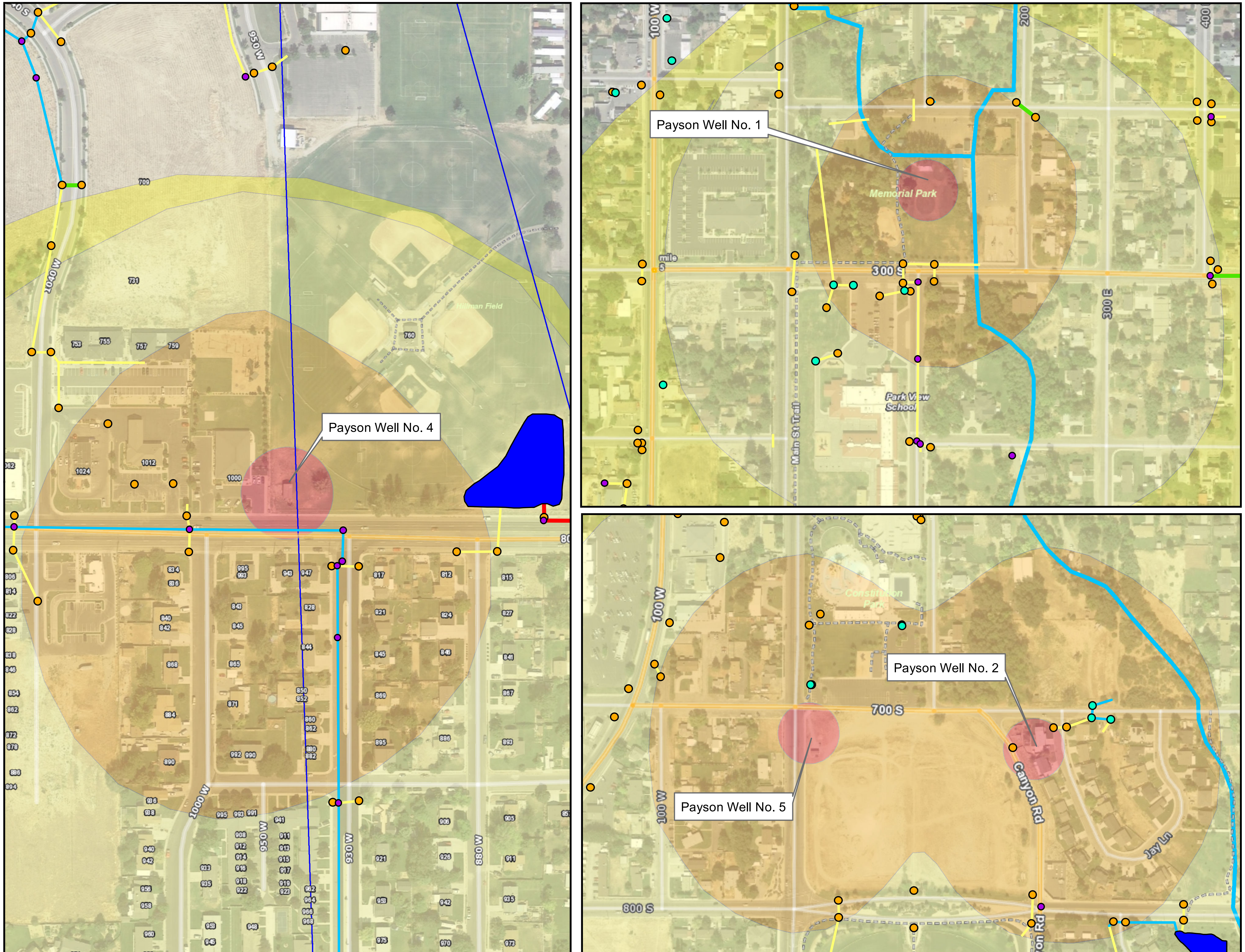
There are 4 drinking water wells that have been constructed in the central portion of the City, as shown in Figure 2-1 and Figure 5-4. Stormwater impoundment sites and Class V injection wells are both sources of potential groundwater contamination. Figure 5-4 shows existing storm drain infrastructure locations within the groundwater projection zones that have been delineated in accordance with State regulations. A summary of potential storm water facilities that could potentially contaminate groundwater that is used for public drinking water is summarized on Table 5-1.

**Table 5-1**
**Potential Storm Water-Related Groundwater Contamination Sources**

| Well Identifier | Potential Contamination Sources in Source Protection Zones 1 and 2 |
|---|---|
| Well 1 | • There may be a storm water retention basin located near 210 South 10 East, just outside of the Source Protection Zone 2 boundary.<br>• Multiple sumps or Class V injection wells appear to be located within Source Protection Zone 2. |
| Well 2 | • There appear to be several Class V injection wells located within Source Protection Zone 2, northeast of the well. |
| Well 4 | • A portion of a storm water retention basin extends into Source Protection Zone 2.<br>• There may be several Class V injection wells located in Source Protection Zone 2, west of the well. |
| Well 5 | • There appear to be several Class V injection wells located within Source Protection Zone 2, north and northeast of the well. |

Notes: Zone 1 = 100-foot radius from wellhead
Zone 2 = 250-day groundwater travel time
Zone 3 = 3-year travel time (waiver criteria zone)
Zone 4 = 15-year groundwater travel time

After reviewing the City's Drinking Water Source Protection Plans, it appears that the potential contamination sources related to the storm water facilities were not addressed.




**Legend**

- Existing Detention/Retention Basin
- Storm Inlet Box
- Sump
- Storm Manhole

**Existing Storm Drain Pipe Diameter**

- 15" or less
- 18"
- 21"
- 24"
- 30"
- 36"

**Streams/Canals**

- Minor
- Major

**Groundwater Source Zones**

- Source Protection Zone 1
- Source Protection Zone 2
- Source Protection Zone 3
- Source Protection Zone 4

NORTH: SCALE:

# EXISTING DEFICIENCIES IN GROUNDWATER SOURCE PROTECTION ZONES

PAYSON CITY

STORM DRAIN MASTER PLAN

BOWEN COLLINS & ASSOCIATES

FIGURE NO. 5-4

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure5-4 - GWSPZ Deficiencies.mxd wandersen 12/10/2019

# Chapter 6
# Recommended Storm Drain System Improvements

## INTRODUCTION

There are multiple challenges associated with solving the existing drainage deficiencies in the City that we identified in previous chapters of this report. The recommended improvements identified in this section have been made to address those drainage challenges and deficiencies. In accordance with instructions from City officials, the recommended improvements identified herein have been sized to accommodate runoff generated from projected full build-out conditions that include curb and gutter installed on every street throughout the City. The identified improvements focus primarily on larger conveyance facilities and regional retention facilities. More storm water collection facilities and local retention facilities must be designed and constructed as development occurs and as curb and gutter is installed on existing roads to properly manage runoff and prevent undesirable flooding problems.

## STORM WATER MANAGEMENT APPROACH

Three general approaches of managing storm water runoff in the City were explored as part of this project:

1. **Collect and pipe runoff to regional detention facilities that would ultimately discharge to Spring Creek –** This is a more conventional approach to storm water management. This approach would collect all storm water runoff from impervious areas in stormwater inlets, then pipe the stormwater to regional detention basins. The regional detention basins would then discharge to pipes or open channels that would ultimately convey it to Spring Creek. This approach would require extensive improvements to Spring Creek, which is not near where the development is occurring, and the

construction of large conveyance facilities to convey runoff to and from storm water detention facilities. The cost of constructing these facilities generally rendered this storm water management approach financially infeasible.

2. **Construct scattered sumps and retention basins throughout the City** – This approach is centered on constructing facilities that would locally collect and infiltrate storm water runoff into the ground similar to the natural, pre-development conditions on the alluvial fan.

3. **Utilize a combination of regional retention and sumps** – This approach combines the first two approaches. It focuses on constructing local sumps and retention facilities that would infiltrate storm water into the ground while also providing perforated overflow pipes that are connected to the sumps. The perforated overflow pipes would convey excess runoff that the sumps cannot manage and provide additional infiltration capacity and convey runoff that cannot infiltrate it to a regional retention facility.

After discussions with City personnel, the preferred general approach is a combination of regional retention and sumps (Approach #3).

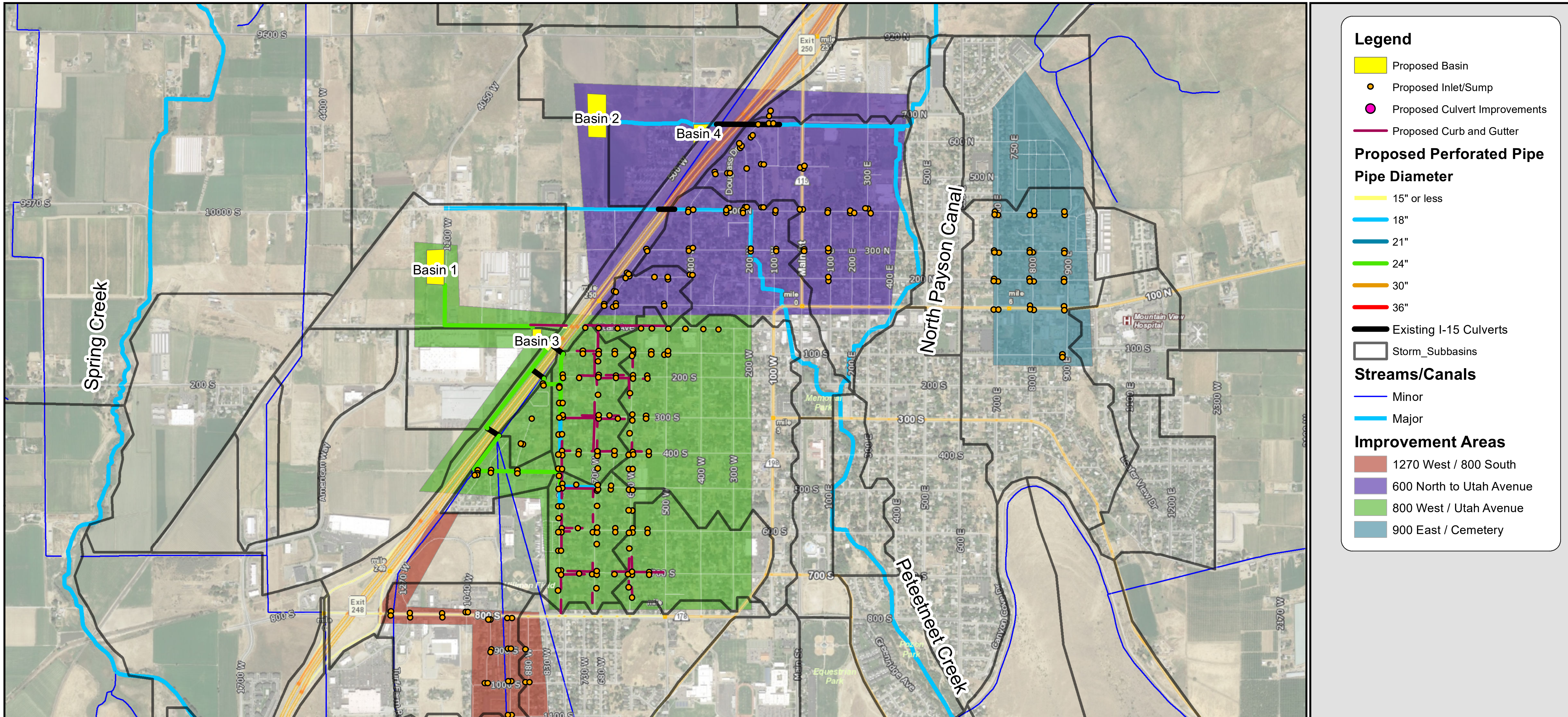
## GENERAL RECOMMENDATIONS

The following general recommendations should be implemented for storm water management in Payson City.

### 800 West / Utah Avenue

The recommendation for this area is to install new pretreatment manholes and sumps at the intersections and at mid-block in the City streets in the area generally bounded by Utah Avenue, 600 West, 800 South, and I-15, which will allow for runoff to infiltrate locally. To manage runoff from larger storms, perforated overflow pipes should be installed along 800 West, 450 South, and parallel to I-15 to convey runoff to regional retention facilities, as shown on Figure 6-1. This will require that the City purchase land or easements for the needed retention facilities. This project should be the highest priority of the recommended improvements.

The sump locations shown in Figure 6-1 are approximate. The number and locations of these Class V injection wells should be determined after some geotechnical data and some percolation test data is obtained. The City currently owns the property where Regional Retention




PROPOSED SYSTEM IMPROVEMENTS

PAYSON CITY

STORM DRAIN MASTER PLAN

FIGURE NO.

6-1

BOWEN COLLINS & ASSOCIATES

P:\Payson\Sewer and Storm Drain Master Plans\4.0 GIS\4.1 Projects\Storm-Figure6-1 - Proposed System Improvements.mxd wandersen 12/11/2019

Basin 1 will be located. It can be constructed first. If needed in the future, a second retention basin (Basin 3) can be constructed on a site on private property located just west of I-15 and south of Utah Avenue. That would require that the City either purchase the property or an easement for the retention basin. Basin 3 should only be constructed after the recommended sumps and Basin 1 have been constructed and there is a demonstrated need for additional retention storage.

It is also recommended that curb and gutter be constructed where it does not exist in this area of the City to reduce the recurring shallow flooding problems that exist. When the curb and gutter is constructed, additional inlets and sumps should also be constructed. Constructing the new curb, gutter, and additional sumps will also extend the life of street pavement in these areas by reducing areas where soils below the pavement become soft when saturated by runoff.

### 900 East / Cemetery

The existing trunkline along 900 East has some capacity deficiencies for the 10-year, 3-hour design storm at buildout conditions. To resolve this problem, it is recommended that new sumps be installed in the area generally bounded by 100 North, 700 East, 400 North, and 900 East, as shown on Figure 6-1. This will reduce volume and peak of stormwater that will be discharged to the existing trunkline so that pipeline improvements will not be required.

The regional retention basin into which the 900 East trunkline discharges also appears to be deficient in storage capacity to manage runoff from the 100-year, 24-hour storm event. However, constructing the recommended additional sumps to solve the pipe capacity problems should also solve the retention basin capacity deficiency by discharging stormwater into the Class V injection wells instead of the retention facility.

### 1270 West / 800 South

The existing 800 South trunkline has some capacity deficiencies for the 10-year, 3-hour design storm at buildout conditions. To resolve this problem, it is recommended that new sumps be installed along 800 South and from 1000 South to 800 South between 1000 West and 800 West, as shown on Figure 6-1. These additional sumps will reduce the amount of runoff that will be conveyed to the trunkline, thus solving the capacity deficiencies and mitigating the associated shallow flooding problems in the area.

The retention basin into which the 800 South trunkline discharges does not have enough capacity to meet the desire design criteria for the 100-year, 24-hour design storm event. However, constructing the recommended additional sumps to solve the pipe capacity problems should also solve the retention basin capacity deficiency by discharging stormwater into the Class V injection wells instead of the retention facility.

800 South Street is also a State Road (SR 178). The UDOT Drainage Manual of Instruction allows for Class V injection wells to be installed within State Road rights-of-way if they are properly permitted.  Most of the sumps that need to be constructed to resolve the capacity problems in this area should be constructed in the upstream tributary area, south of 800 South.

## 600 North to Utah Avenue

Since this area has very few existing storm drain facilities and there is a high risk of shallow flooding near the I-15 roadway embankment, it is recommended to install storm drain sumps throughout the area. For larger storms, a perforated overflow pipe should be installed in 400 North to convey runoff to a new regional retention facility (Basin 2) west of I-15, as shown on Figure 6-1.  Basin 2 should be constructed on property that is currently owned by the City. Before constructing this new regional retention facility, it is recommended that the performance of the new sumps and retention facilities in the 800 West/Utah Avenue area be monitored to determine the recommended timing for Basin 2 construction.

## Dry Creek and Spring Creek Culverts

According to the analyses performed by FEMA, the magnitude of the 100-year flood where Peteetneet Creek is diverted into Dry Creek is 1,000 cfs.  It is recommended that the Dry Creek culverts identified on Figure 6-1 each be constructed to convey 1,000 cfs.  The existing culverts to not have capacity to convey runoff from the 100-year flood. Some channel improvements may also be needed to ensure that the 100-year flood can be confined to the Dry Creek channel.  Locating those sections is outside the scope of this project.

Some of the culvert and channel deficiencies on Dry Creek (shown in Figure 6-1) may be mitigated by an NRCS-sponsored Emergency Watershed Protection Project that is currently underway in Utah County.

## Spring Creek Flood Study

It is recommended that a floodplain study be performed on Spring Creek to define associated flood hazards before development pressure begins in the area near that creek. The most cost-effective way to do this is by coordinating with Utah County and requesting that FEMA complete a flood insurance study for that channel.

## Street and Channel Runoff Discharged onto Private Property

It is recommended that the City not allow any storm water runoff from public or private areas to be discharged onto private property from existing or future development unless a historic conveyance facility exists with easements and an active outfall into which it can discharge. It is recommended that all future development be required to retain runoff onsite, which will help solve the problem of discharging onto private property.

## Lack of Storm Drain Facilities West of I-15

It is recommended that new development that occurs in the areas west of I-15, including public roads, be required to construct sumps and retention facilities to store and infiltrate runoff into the ground. The design of these infiltration facilities needs to be done carefully and should consider local infiltration rates and the ground water levels when being designed.

## Historic Irrigation/Drainage Ditches being Abandoned and Backfilled

As development continues and the historic irrigation/drainage ditches are being abandoned or backfilled and replaced with curb and gutter, the City needs to ensure that this is not causing flooding problems on private or public property.

## Low Impact Development

Low impact development (LID) techniques include methods that utilize more natural methods of managing storm water runoff. Some common LID techniques are bio-swales, rain gardens, permeable asphalt or pavers, storm water sumps (Class V injection wells), and cisterns. It is recommended that the City encourage developers to use LID techniques throughout the City to increase the amount of runoff that is infiltrated locally so that post-development runoff conditions mimic pre-development runoff conditions. The City should recommend that developers use the Guide to Low Impact Development within Utah, which is in Appendix F of this report, for LID techniques and guidance in designing. This is a requirement in the City's existing MS4 Permit.

Utilizing LID practices will also help meet the MS4 Permit requirement to retain onsite all runoff from the 90th percentile storm.

## Ground Water Source Protection

Chapter 5 contained a discussion of some potential storm water facilities that could be potential contamination sources near 4 of the City's municipal wells. It is the responsibility of City staff to implement policies and practices that will protect ground water quality in Payson. Figure 5-4 identified multiple stormwater management facilities that allow urban runoff to be discharged into the ground. It is recommended that City officials complete the items listed below to protect ground water used for drinking water from being contaminated by allowing stormwater from urban roads and parking lots to be discharged into the ground.

1. Update the City's Drinking Water Source Protection Plan inventories to include storm water retention and Class V injection facilities within the source protection zones.
2. Require that storm water treatment devices be installed upstream of any new facility that disposes of stormwater runoff unto the ground.
3. Remove or relocate Class V injection wells or storm water retention basins that are located within any Zone 2 ground water source protection area in accordance with the City's ground water source protection ordinance. Wells 1, 2, 4 and 5 are categorized as being in an unprotected aquifer and protecting the recharge zones for these wells is critical to preserve water quality.
4. Install storm water treatment devices upstream of any existing Class V injection wells or stormwater retention facilities located in ground water source protection Zones 3 and 4. This work should be completed to minimize the risk of contaminating the ground water used as to supply water for the City's drinking water system.
5. Identify areas in the City that may be in the primary ground water recharge areas for drinking water wells. Using that information, make decisions about whether or not to allow stormwater facilities that allow runoff from roads and other paved surfaces to be allowed to be disposed in the ground in those areas. Most stormwater treatment devices remove sediments, floatable debris, and hydrocarbons (oil and grease). However, if the City or State use road salt in the winter, those treatment devices will not remove salt and other dissolved solids. Significant road salt could pose a threat to ground water quality.

6. Begin annual testing and tracking the historic trends of the water quality in Wells 1, 2, 4 and 5 to watch for potential degradation of the water quality produced in these wells. One of the items to track is TDS so that potential impacts of the use of road salt can be monitored.

## Perform Field Percolation Tests in Existing Regional Retention Basins

Perform percolation or infiltration tests in the existing regional storm water retention basins to determine if they are different from those assumed when performing this study. The infiltration data should be used to update the analyses for these facilities to determine if they are undersized or if addition Class V injection wells are needed to help reduce the amount of runoff that reaches these facilities.

## Completing Storm Drain System Inventory

While performing field work and reviewing aerial mapping and other data during the course of this project, it was discovered that the City's existing GIS inventory is not yet complete. Items that include culverts, pipes, storm drain inlets, and sumps were observed that are included in the existing GIS inventory. It is recommended that the storm drain facilities inventory be completed. As part of this process, all Class V injection wells should be identified and inventoried. The updated Class V injection well inventory should be submitted to the State Division of Water Quality in accordance with Utah Underground Injection Control (UIC) Program requirements.

## Update Storm Drain System Design Standards

The City's Development Services Department has prepared development guidelines to assist developers and engineers in planning and designing public facilities and utilities in Payson. The current guidelines were adopted on March 20, 2019. Section 6 of the Development Guidelines outlines requirements for Storm Drain improvements and practices. The Storm Drain Development Guidelines were reviewed as part of this project. It is recommended that the current guidelines be updated to include the recommended standards and level of service that were developed as part of this master planning process. Some changes also need to be made to include requirements in the City's MS4 Permit. A marked-up copy that includes major recommended changes to the Storm Drain Development Guidelines in included in Appendix G.

### Purchase a New Vactor Truck for Storm Drain Facility Management

Constructing the number of recommended pretreatment manholes and sumps will significantly increase the amount of maintenance work required by City personnel. The City's existing GIS database indicates that there are at least 400 storm drain manholes, 100 storm drain inlets, and 120 sumps that need regular maintenance and inspection. The recommended pretreatment sumps and manholes will require cleaning and maintenance at least twice per year to ensure that they function properly. It is recommended that the City purchase a new vactor truck that can be used to maintain and clean these facilities. With the added maintenance workload, the City may also need to hire more staff to perform the required regular maintenance of storm drain facilities.

## RECOMMENDED STORM DRAIN IMPROVEMENT PROJECTS

Information obtained through consulting with City personnel, field reconnaissance, and by performing hydrologic and hydraulic analyses of existing and projected full buildout conditions were used to identify drainage system improvements that are needed to safely manage storm water runoff from designated design storms in the vicinity of Payson City. A list of prioritized recommended drainage system improvements has been developed for use in budgeting and planning for the needed improvements. These recommended drainage system improvements are grouped based on the areas discussed in chapters 5 and 6. The prioritized recommended improvements are shown in Figure 6-1 and summarized with conceptual costs estimates in Table 6-1. Higher priority projects should be constructed before lower priority projects. The recommended project timing for the three priority levels are zero to five years for high priority projects, six to ten years for medium priority projects, and greater than ten years for low priority projects. The unit costs for construction were developed in 2019 dollars using information from a variety of sources including recent bids for similar projects, local contractors, and construction estimating guides.

**Table 6-1**
**Storm Drain Collection System Improvement Cost Estimate**

| **Administrative, Operations and Maintenance** | | | | | | |
|---|---|---|---|---|---|---|
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Purchase Newe Vactor Truck | High | 1 | LS | $500,000 | $500,000 |
| 2 | Update Design Standards | High | 1 | LS | $10,000 | $10,000 |
| 3 | Update Rate Study | High | 1 | LS | $15,000 | $15,000 |
| 4 | Update System Inventory | High | 1 | LS | $30,000 | $30,000 |
| | Project Total | | | | | $555,000 |
| **800 West/Utah Avenue** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | 18-inch pipe | High | 1810 | LF | $110 | $199,000 |
| 2 | 24-inch pipe | High | 6860 | LF | $155 | $1,063,000 |
| 3 | 5-foot Manholes | High | 23 | EA | $5,000 | $115,000 |
| 4 | Sumps | High | 148 | EA | $20,000 | $2,960,000 |
| 5 | Curb/Gutter/Sidewalk | High | 12640 | LF | $71 | $897,000 |
| 6 | Retention Basin #1 (Excavation, hauling, landscaping, inlet, outlet) | High | 1 | LS | $627,000 | $627,000 |
| 7 | Detention Basin #3 (Excavation, hauling, landscaping, inlet, outlet) | Medium | 1 | LS | $203,000 | $203,000 |
| 8 | Basin #3 Property Acquisition | Medium | 1 | Acre | $200,000 | $200,000 |
| 9 | Engineering/Administration | | 15% | LS | $940,000 | $940,000 |
| | Project Total | | | | | $7,204,000 |
| **900 East/Cemetery** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Sumps | Low | 33 | EA | $20,000 | $660,000 |
| 2 | Engineering/Administration | | 15% | LS | $99,000 | $99,000 |
| | Project Total | | | | | $759,000 |
| **1270 West/800 South** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Sumps | Low | 25 | EA | $20,000 | $500,000 |
| 2 | Engineering/Administration | | 15% | LS | $75,000 | $75,000 |
| | Project Total | | | | | $575,000 |

| 600 North to Utah Avenue | | | | | | |
|---|---|---|---|---|---|---|
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | 24-inch pipe | Medium | 4250 | LF | $155 | $659,000 |
| 2 | 5-foot Manholes | Medium | 12 | EA | $5,000 | $60,000 |
| 3 | Sumps | Medium | 79 | EA | $20,000 | $1,580,000 |
| 4 | Retention Basin #2 (Excavation, hauling, landscaping, inlet, outlet) | Low | 1 | LS | $810,000 | $810,000 |
| 5 | Detention Basin #4 (Excavation, hauling, landscaping, inlet, outlet) | Medium | 1 | LS | $187,000 | $187,000 |
| 6 | Basin #4 Property Acquisition | Medium | 1 | Acre | $200,000 | $200,000 |
| 7 | Engineering/Administration | | 15% | LS | $524,000 | $524,000 |
| | Project Total | | | | | $4,020,000 |
| **Dry Creek and Spring Creek Culverts** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Culvert Improvements | Medium | 7 | EA | $500,000 | $3,500,000 |
| 2 | Engineering/Administration | | 15% | LS | $525,000 | $525,000 |
| | Project Total | | | | | $4,025,000 |
| **Rehabilitation of Existing System** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Sump Rehabilitation | Low | 150 | EA | $25,000 | $3,750,000 |
| 2 | Engineering/Administration | | 15% | LS | $563,000 | $563,000 |
| | Project Total | | | | | $4,313,000 |
| **Ground Water Source Protection** | | | | | | |
| No. | Item | Priority* | Quantity | Units | Unit Cost | Cost |
| 1 | Water Quality Structure for 800 South Basin | High | 1 | EA | $60,000 | $60,000 |
| 2 | Water Quality for Sumps/Inlets/MHs | High | 13 | EA | $20,000 | $260,000 |
| 3 | Engineering/Administration | | 15% | LS | $153,000 | $48,000 |
| | Project Total | | | | | $368,000 |

| | |
|---|---|
| **Total** | **$21,819,000** |

*Recommended project timing is as follows: High priority: 0-5 years; Medium priority: 6-10 years; Low priority: 10+ years

## FUNDING RECOMMENDED STORM DRAIN IMPROVEMENTS

Payson City currently charges property owners a monthly fee to fund storm drain maintenance activities and needed storm drain capital improvement projects. There are no “System Improvements” recommended in this master plan that are primarily associated with future development. It is recommended that all future development construct “Project Improvements” to manage storm water runoff onsite. In addition, there really is not any existing capacity in existing storm drain management facilities that can be utilized by future development.

Therefore, it is not recommended that storm drain impact fees be developed for the City. This means that the primary source of funding for storm drain improvements and maintenance activities is the storm drain user fund that has a user fee that is based on equivalent service unit. It is recommended that the storm drain fee be reviewed and updated to ensure that there is adequate revenue to fund the storm drain improvements, maintenance activities, needed maintenance personnel and equipment, and regulatory compliance work required by the MS4 Permit. Bonding may be utilized if some of the larger capital improvement projects significantly exceed the annual revenue stream generated by the user fees.

# APPENDIX A

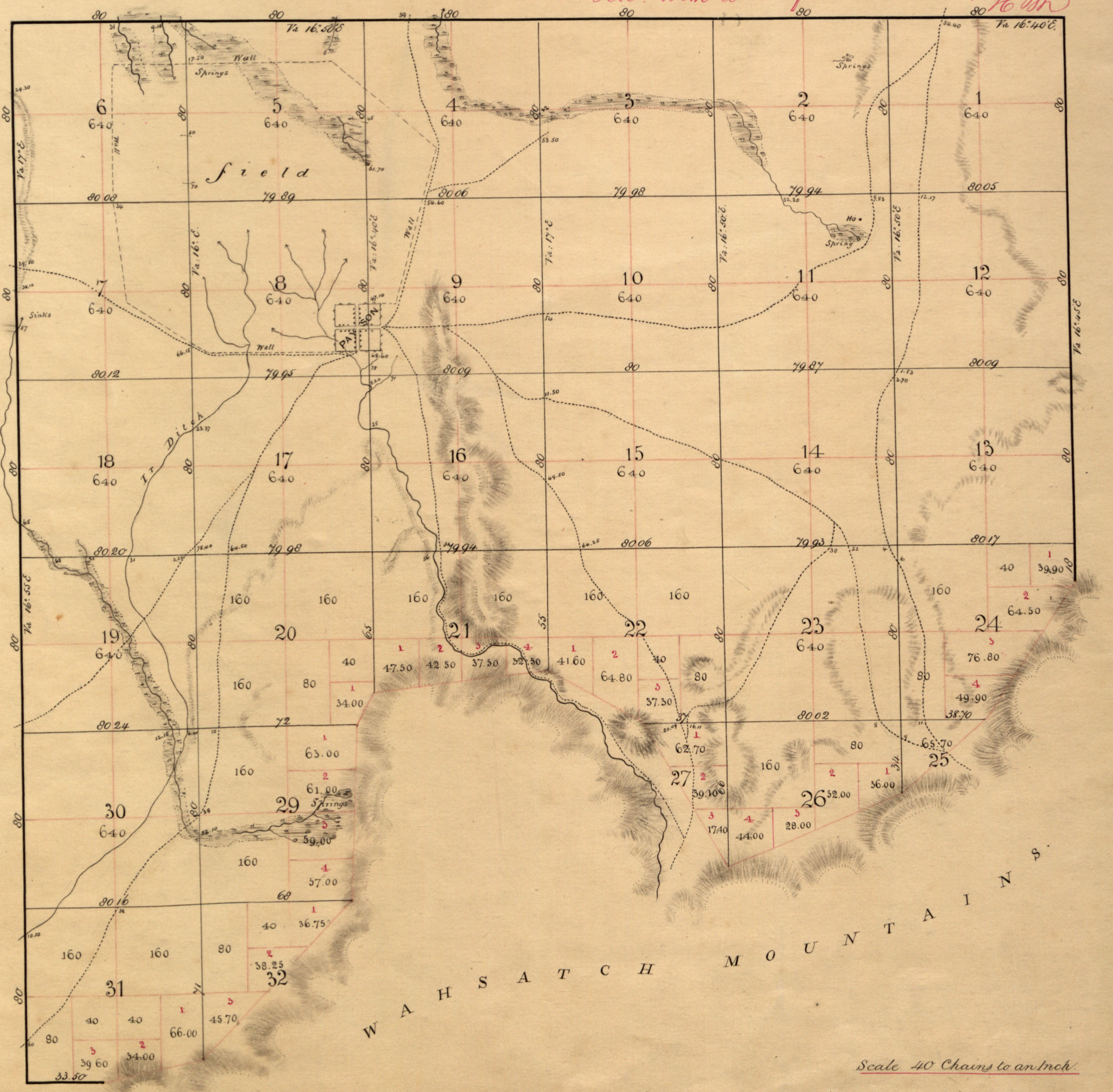
## HISTORIC
## PAYSON DATA

UTAH

Index HM

# T 9 S — R 2 E. *Salt Lake Meridian.*

Recd. with letter of Decr. 8th. 1856 HM




Scale 40 Chains to an Inch

Total number of Acres 17.654.00.

| Surveys designated | By whom surveyed | Date of Contract | Amount of Surveys | When surveyed |
|---|---|---|---|---|
| South Boundary | C. L. Craig, | June 8th 1856. | 0. 32. 50. | 3d qr 1856. |
| Section lines | do | do | 46. 27. 52. | do |

Surveyor Generals Office
Great Salt Lake City Nov 20 1856.

The above Map of Township 9 South of Range 2 East of Salt Lake Meridian is strictly conformable to the Field-notes of the Survey thereof on file in this Office, which have been examined & approved.

David H Burr

Surveyor General of Utah.

Rec^d with Sur. Gen's letter of Aug^t 13. 1869.

UTAH

# T. 9 S. — R. 2 E.

Salt Lake Meridian


Plat filed with Register Jany 25^th 1869
as per record in Surveying Division

Surveyor General's Office
Great Salt Lake City Nov. 20. 1856.
The above Map of Township 9 South of Range 2
East of Salt Lake Meridian is strictly conformable
to the field notes of the survey thereof on file in
this office which have been examined & approved.
David H. Burr
Surv^r Genl. of Utah

I hereby certify that the above is a true copy of
the original Plat on file in this Office.
Surveyor General's Office
Salt Lake City Utah
August 10^th 1869
C. C. Clements
Surv Genl.

Entered in Tract Book
April 8. 1870.
J. P. Driver

Total number of acres 17.086.47

| Surveys designated | By whom surveyed | Date of Contract | Amount of Surveys | When surveyed |
|---|---|---|---|---|
| South Boundary | C. L. Craig | June 8th 1856 | 0 . 32 . 50 | 3d qr 1856 |
| Section lines | " do " | " do " | 46 . 27 . 52 | " do " |

Scale 40 Chains to an Inch

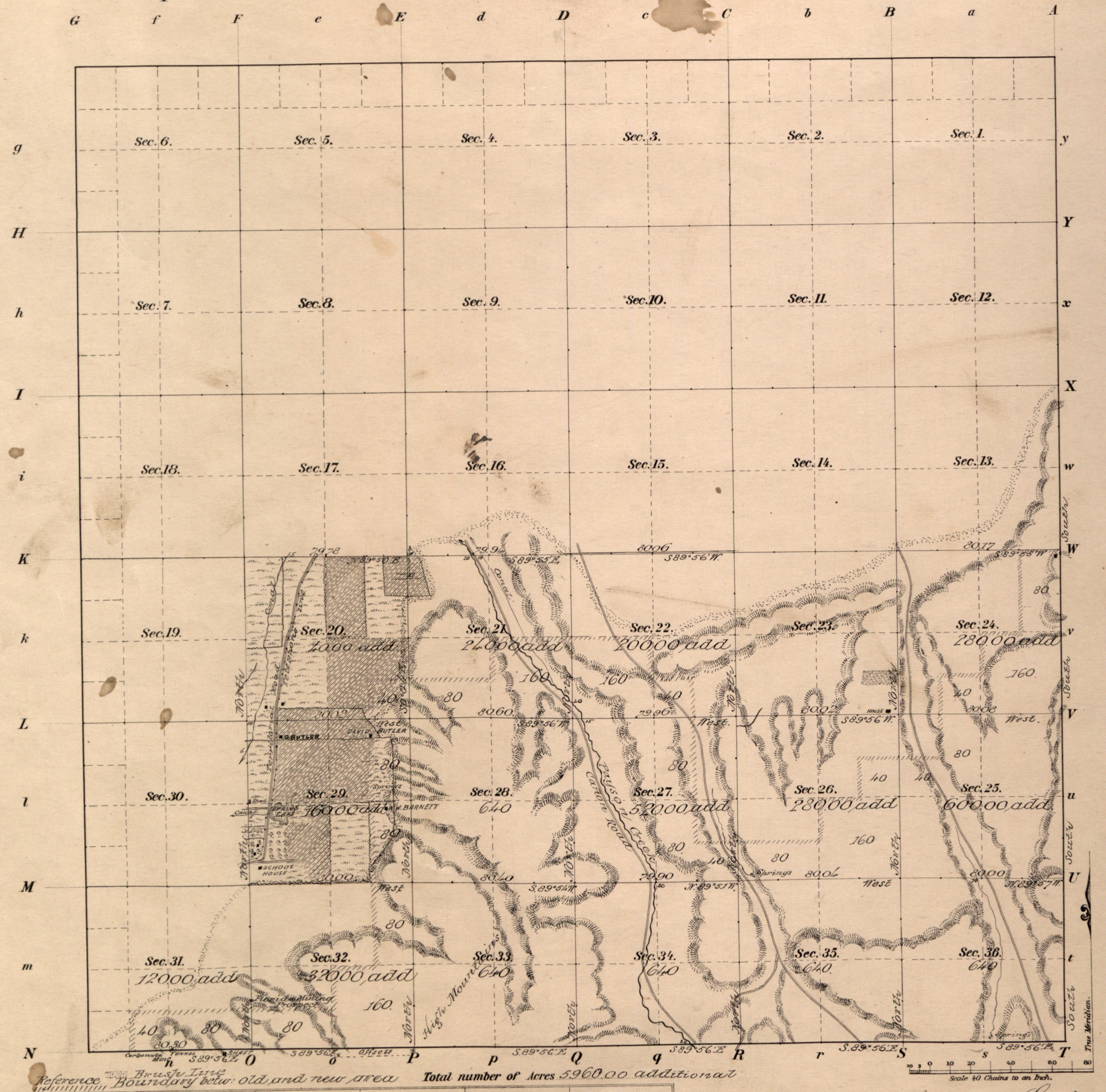
TRa "az"
7/18/50

UTAH

55907

J.H.

# Township No. 9 South  Range No. 2 East of the Salt Lake Meridian




*Reference* Brush Line; Boundary betw: old and new area

**Total number of Acres** 5960.00 additional

| Surveys Designated | By Whom Surveyed | No. Date of Contract | Amount of Surveys M. | Ch.s | Lk.s | When Surveyed | Mean Declination |
|---|---|---|---|---|---|---|---|
| S & E Township lines H. | John T. Breckon | 175 June 23rd 1891 | 9 | 46 | 30 | Aug. 23rd - 27th 1891 | 16°54' East. |
| " " " I. | " " " | " " " " | | 34 | 00 | " " " " | |
| Subdivisions H. | " " " | " " " " | 24 | 32 | 14 | " 27th Sept. 2nd " | |
| " I. | " " " | " " " " | 4 | 49 | 03 | " " " " " | |

| Meanders of | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Posts | Courses | Ch.s Lk.s | Posts | Courses | Ch.s Lk.s | Posts | Courses | Ch.s Lk.s |

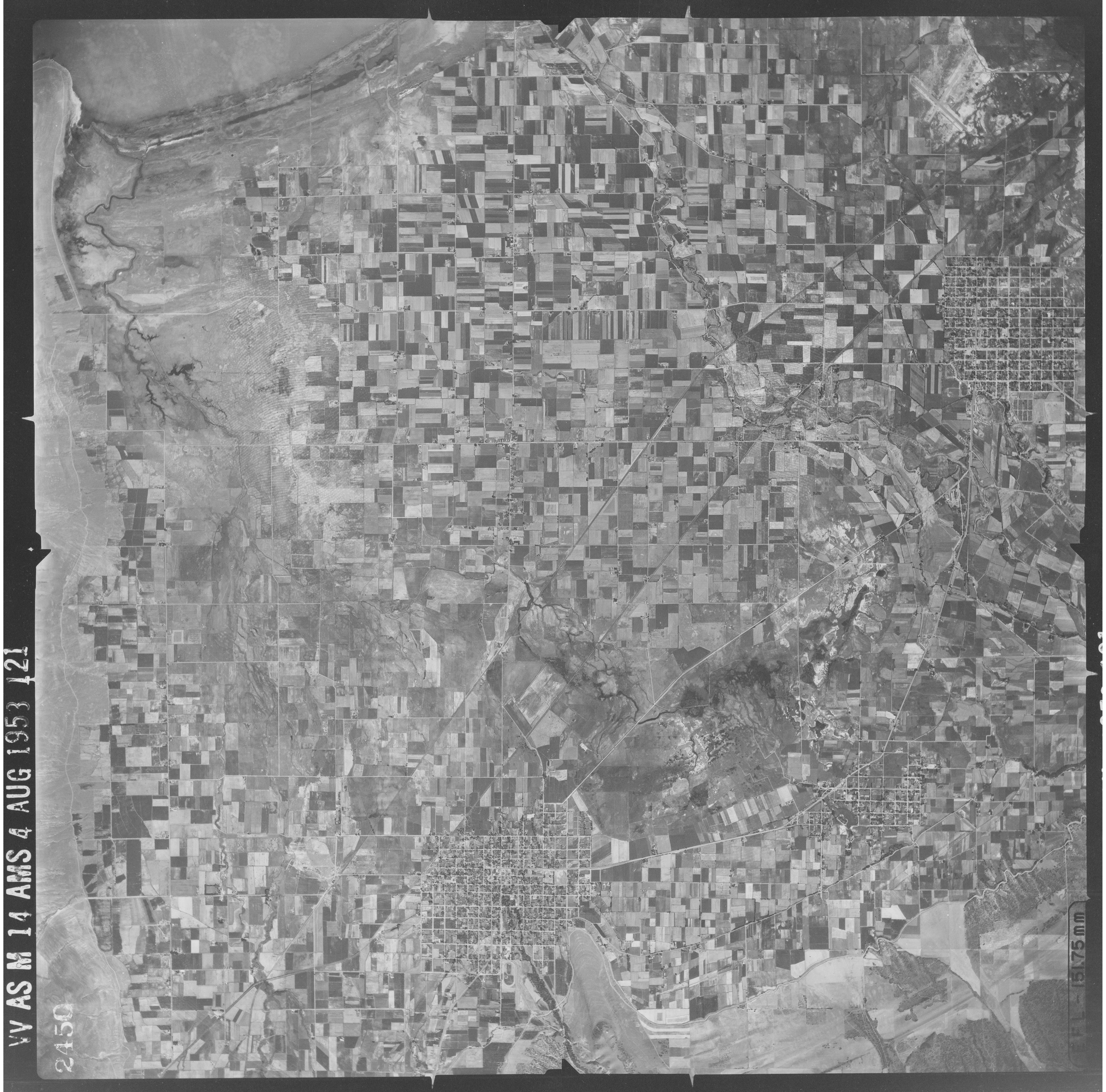
The above Map, of Township No. 9 South, of Range No. 2 East of the Salt Lake Meridian, Utah, is strictly conformable to the field notes of the survey thereof on file in this Office, which have been examined and approved.

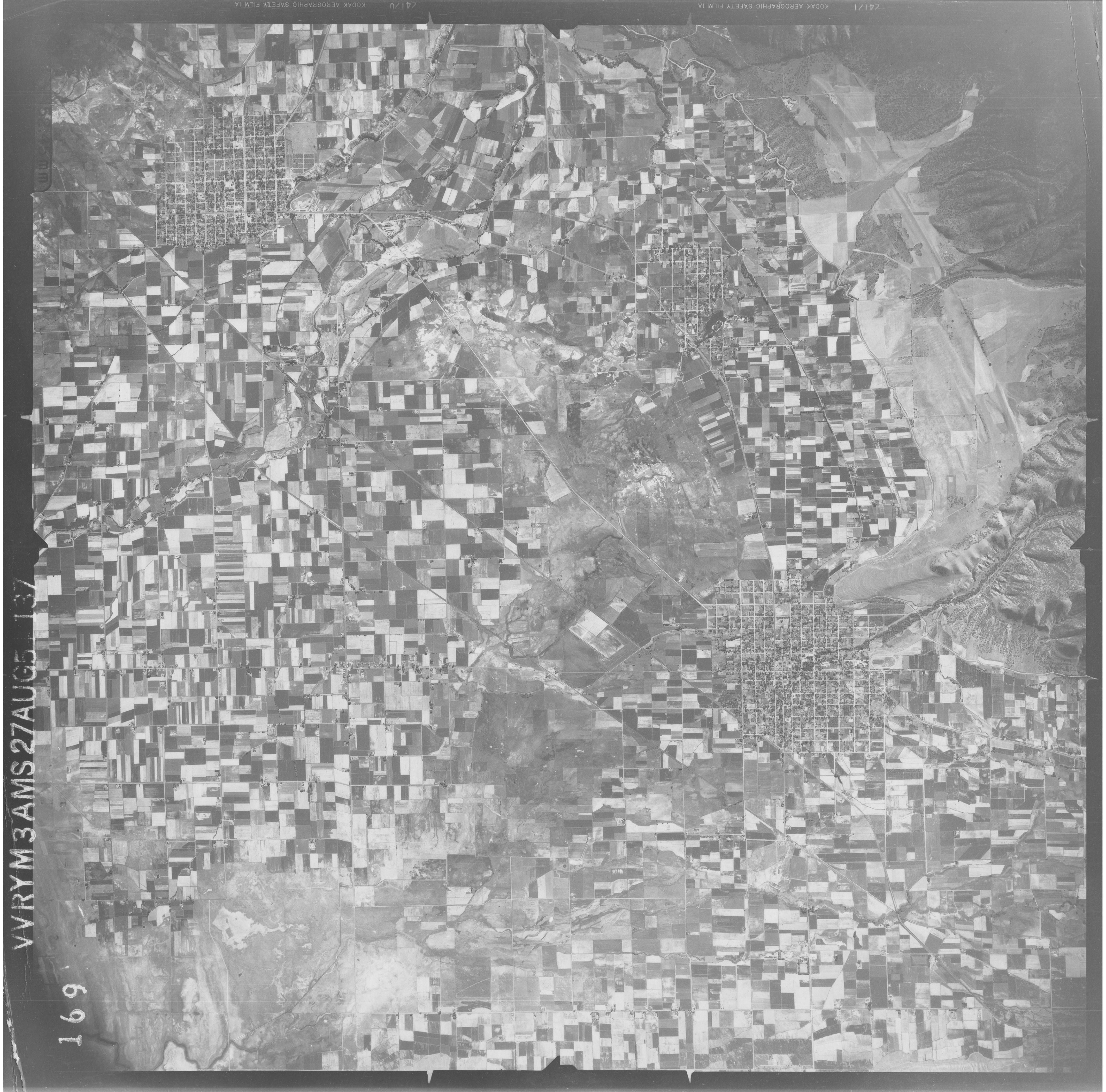
Surveyor General's Office.
Salt Lake City, Utah
June 21st 1892.

Ellsworth Daggett
Sur. Gen.

Posted in T.B. Feb 14/93
A.W.C.


SAFETY
4201
KODAK AEROGRAPHIC SAFETY
4202
KODAK AEROGRAPHIC SAFETY
9-11-47 11:12 8-81 1:27230 GS-EW
8-82


VV AS M 14 AMS 4 AUG 1953 121
2450
FL - 151.75mm



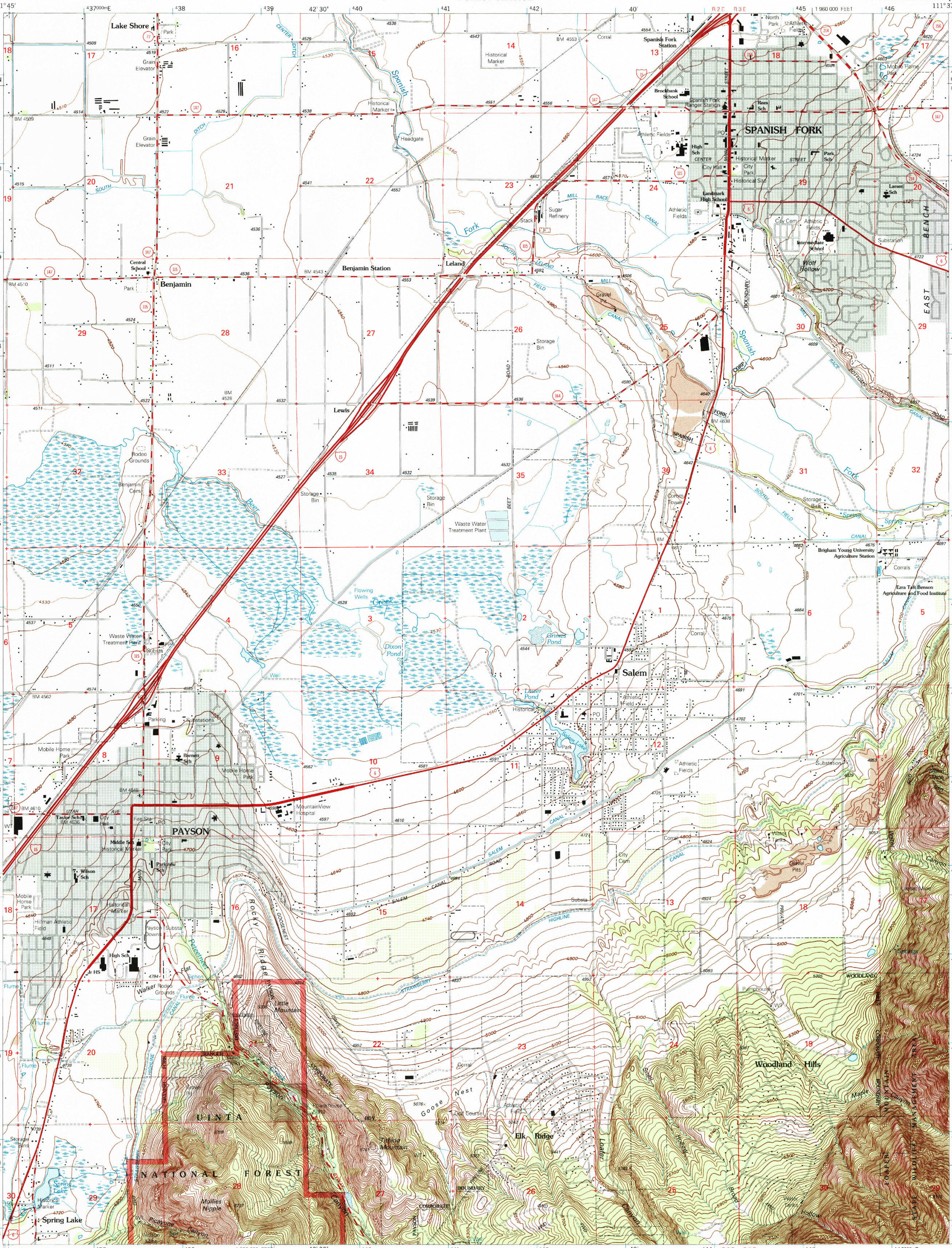
VVRY M3 AMS 27AUG5 137
169


0056
02797

USGS
science for a changing world
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

# SPANISH FORK QUADRANGLE
UTAH-UTAH CO.
7.5-MINUTE SERIES (TOPOGRAPHIC)




Produced by the United States Geological Survey 1994
Revision by USDA Forest Service 1998

Topography compiled 1946. Planimetry derived from imagery taken 1993 and other sources. Public Land Survey System and survey control current as of 2000

North American Datum of 1927 (NAD 27). Projection and 10 000-foot ticks: Utah coordinate system, central zone (Lambert conformal conic)
Blue 1000-meter Universal Transverse Mercator ticks, zone 12

North American Datum of 1983 (NAD 83) is shown by dashed corner ticks
The values of the shift between NAD 27 and NAD 83 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

Non-National Forest System lands within the National Forest
Inholdings may exist in other National or State reservations

This map is not a legal land line or ownership document. Public lands are subject to change and leasing, and may have access restrictions; check with local offices. Obtain permission before entering private lands

GN MN
0°27′ 8 MILS
13½° 240 MILS

UTM GRID AND 2001 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

20% TOTAL RECOVERED FIBER

SCALE 1:24 000

MILES · FEET · KILOMETERS · METERS

CONTOUR INTERVAL 20 FEET
SUPPLEMENTARY CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

UTAH
QUADRANGLE LOCATION

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | | 5 |
| 6 | 7 | 8 |

1 Lincoln Point
2 Provo
3 Springville
4 West Mountain
5 Spanish Fork Peak
6 Santaquin
7 Payson Lakes
8 Birdseye

ADJOINING 7.5' QUADRANGLES

INTERIOR-GEOLOGICAL SURVEY, RESTON VIRGINIA-2002

## HIGHWAYS AND ROADS

Interstate ........ 5
U. S. ........ 101
State ........ 79
County ........ 6
National Forest, suitable for passenger cars ........ 105 61
National Forest, suitable for high clearance vehicles ........ 105
National Fores Trail ........ 384

Primary highway ........
Secondary highway........
Light-duty road
Composition: Unspecified...
Paved........
Gravel........
Dirt........
Unimproved; 4 wheel drive ........ 4WD
Trail ........
Gate; Barrier........

# SPANISH FORK, UT
1998
40111-A6-TF-024
NIMA 3664 II SW-SERIES V897

ISBN 0-607-98889-4

# APPENDIX B

## GEOLOGIC
## MAP