Spanish Fork City

Storm Drain Master Plan

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

November 2016

STORM DRAIN MASTER PLAN

Project No. 204-16-03

November 2016

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STATE OF UTAH

Prepared for:

SURROUND
Spanish Fork
UTAH
YOURSELF

Prepared by:

Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS

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CHAPTER 1
INTRODUCTION

INTRODUCTION

Bowen Collins & Associates (BC&A) was retained by the Spanish Fork City to prepare a Storm Drainage Master Plan for Spanish Fork City. The purpose of this Storm Drainage Master Plan Report is to identify recommended improvements that will resolve existing and projected deficiencies in the storm trunk lines and regional detention basins in Spanish Fork City. The storm drain master plan also identifies how implementing Low Impact Development (LID) practices may impact storm drain facilities in the future. The impacts of in-street detention in the Blocks Area on the storm drain system were also evaluated.

BACKGROUND INFORMATION

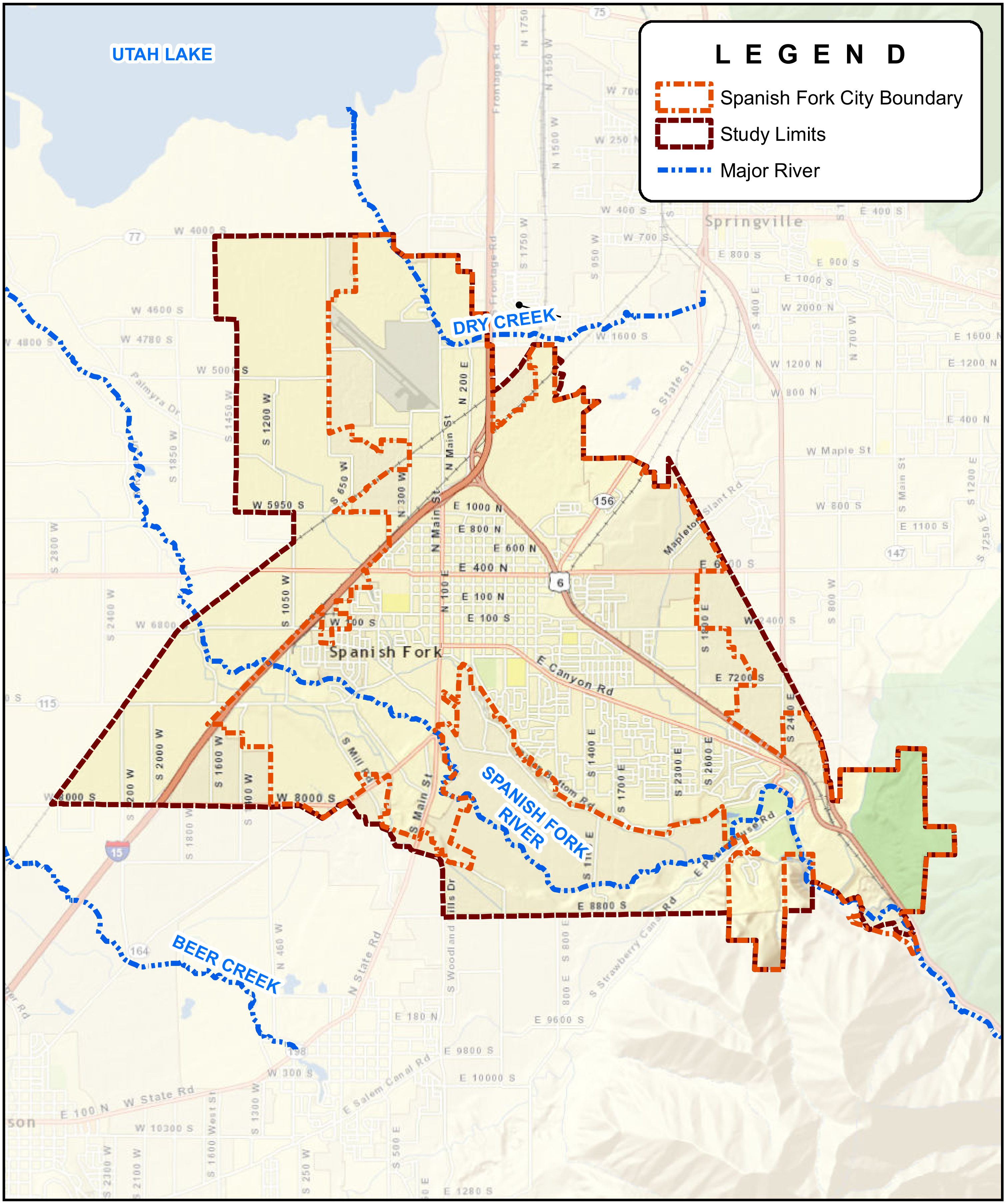
Spanish Fork City is located at the mouth of Spanish Fork Canyon in Utah County. Most of the land area in Spanish Fork City ultimately drains to either the Spanish Fork River or to Dry Creek (see Figure 1-1). A small portion of the land area in the City drain will drain to Beer Creek or directly to Utah Lake in the future.

The City's existing storm drainage facilities consist of pipes, open channels, culverts, detention, LID, and retention basins and sumps. This study includes an inventory of existing trunk lines and regional detention facilities. Recommended major storm drain facilities are also proposed based on hydrologic and hydraulic modeling.

LIMITATIONS OF MASTER PLAN DATA

This document is a working document. The information presented in this report is intended to be used to plan for the funding and design of needed storm drainage facilities. The design discharges associated with the recommended improvements are associated with projected full build-out conditions. More detailed analyses should be completed during the design phase of the recommended storm drainage projects. Some of the needed projects could be phased to match available funding streams. For example, a detention or retention facility could initially be constructed with a volume smaller than what is ultimately recommended if a significant portion of the storm drainage collection system in developed parts of the City will not be constructed for some time. In addition, the actual locations of some of the drainage corridors, pipelines, and regional detention/retention facilities may be changed to better fit conditions not known when this plan was developed. Also, pipelines should be designed to convey the estimated design discharges based on slope available in the field rather than the assumed available slopes used in the master planning process.

The report should also be updated if the projected development and land use patterns used to develop this Master Plan change.



Bowen Collins & Associates, Inc. CONSULTING ENGINEERS	STUDY AREA AND MAJOR DRAINAGE CHANNELS	NORTH: NORTH	SCALE: 0 3,000 6,000 Feet
	SPANISH FORK CITY STORM DRAIN MASTER PLAN		FIGURE NO. 1-1

SCOPE OF SERVICES

The general scope of this project involved an analysis of Spanish Fork City's storm drainage system. As part of this project, BC&A completed the following tasks:

Task 1: Coordination Meetings

Task 2: Hydraulic and Hydrologic Model Update

Task 3: Update Capital Facilities Plan

Task 4: Report Preparation

PROJECT STAFF

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

Craig Bagley, P.E., CFM	Project Manager/Senior Review
Kameron Ballentine	Project Engineer, Hydrologic/Hydraulic Modeling

CHAPTER 2
EXISTING INVENTORY AND HYDRAULIC ANALYSIS

A hydraulic computer model of the study area was developed in ASSA for the purpose of routing runoff and estimating the capacity of the existing 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. See Chapter 3 for a description of the hydrologic modeling.

STORM DRAINAGE PIPES

Spanish Fork City developed a GIS (Geographic Information System) database of the City's storm drainage pipes before work commenced on this Master Plan. The City provided BC&A with a GIS shapefile of all the trunk lines in the study area, which included manhole inverts, pipe sizes, inlet offsets, and an ID. Figure 2-1 for the inventory of existing storm drainage facilities.

DETENTION BASINS

Spanish Fork City provided information for all of the detention basins. The information consisted of as-built drawings when possible. If as-built drawings were not available, the City provided design drawings or detention volumes.

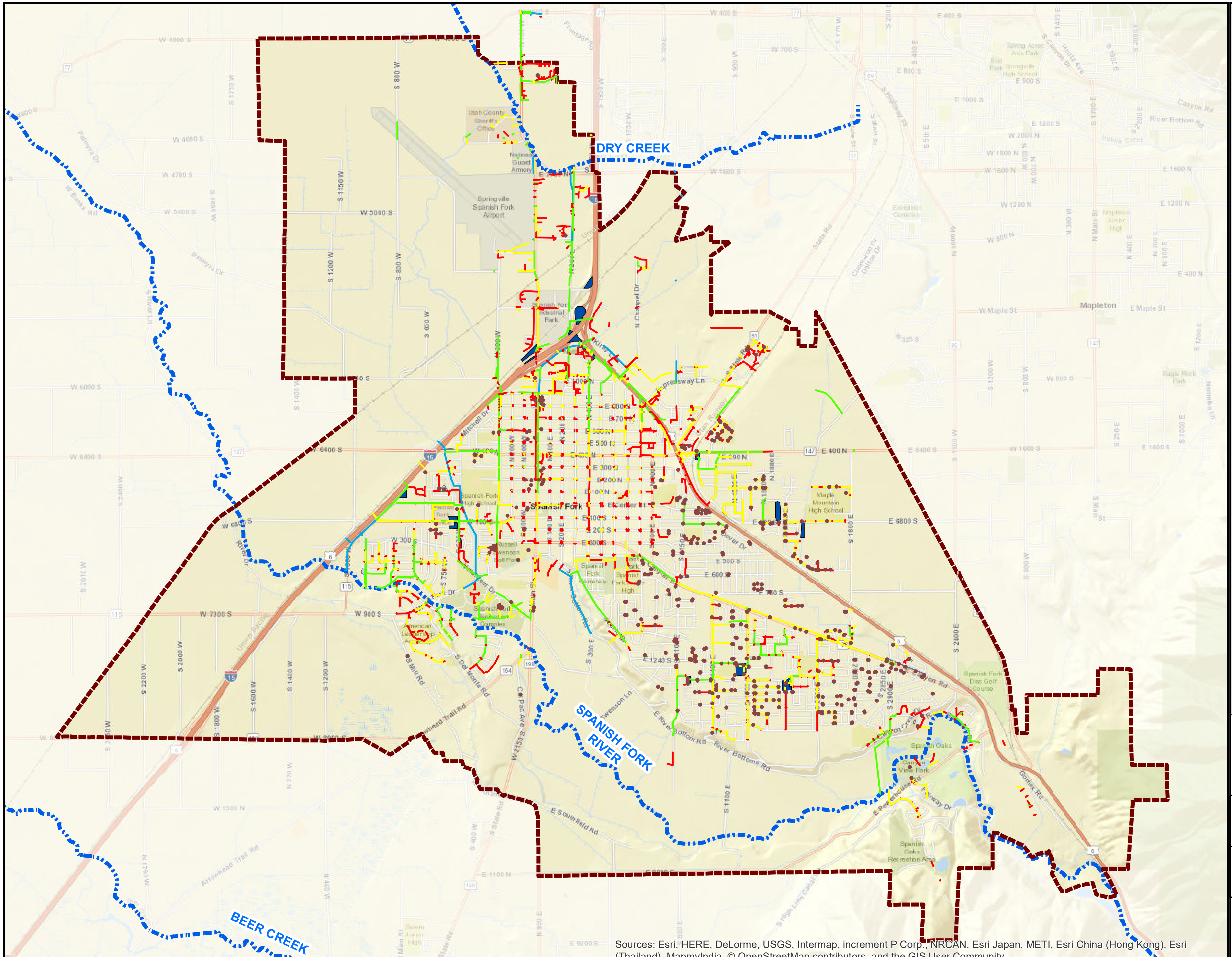
STORM DRAIN SUMPS

The City provided locations of existing storm drain sumps. A storm drain sump generally consists of a storm drain manhole that, does is not connected to an outlet pipe. In lieu of an outlet pipe, the sump contains penetrations through its walls and a gravel bottom that allows collected runoff to percolate into the ground. The sumps were not critical to the analysis because they were not included in the hydraulic analysis. Spanish Fork City has adopted a policy that does not allow for new sumps to be constructed.

Appendix A contains a list of sumps and other areas of frequent flooding.

LID FACILITIES

Spanish Fork City is a pioneer in Utah in implementing LID to manage storm water runoff. Various LID facilities have been implemented across the City. The existing LID facilities are shown on Figure 2-2.



P:\Spanish Fork City\204-16-03 - SDMP Update\4.0 GIS\4.4 Figures\Figure 2-1 Existing Facilities.mxd kballentine 11/10/2016

LEGEND

- Major Recieving Stream

Existing Storm Drain Facilities

Diameter (Inches)

- 0 - 12
- 15 - 21
- 24 - 36
- 42 - 60
- Storm Sump
- Regional Detention Facility
- Local Detention Facility
- Study Limits

NORTH:

SCALE: 0 1,750 3,500 Feet

EXISTING STORM DRAIN FACILITIES

SPANISH FORK CITY

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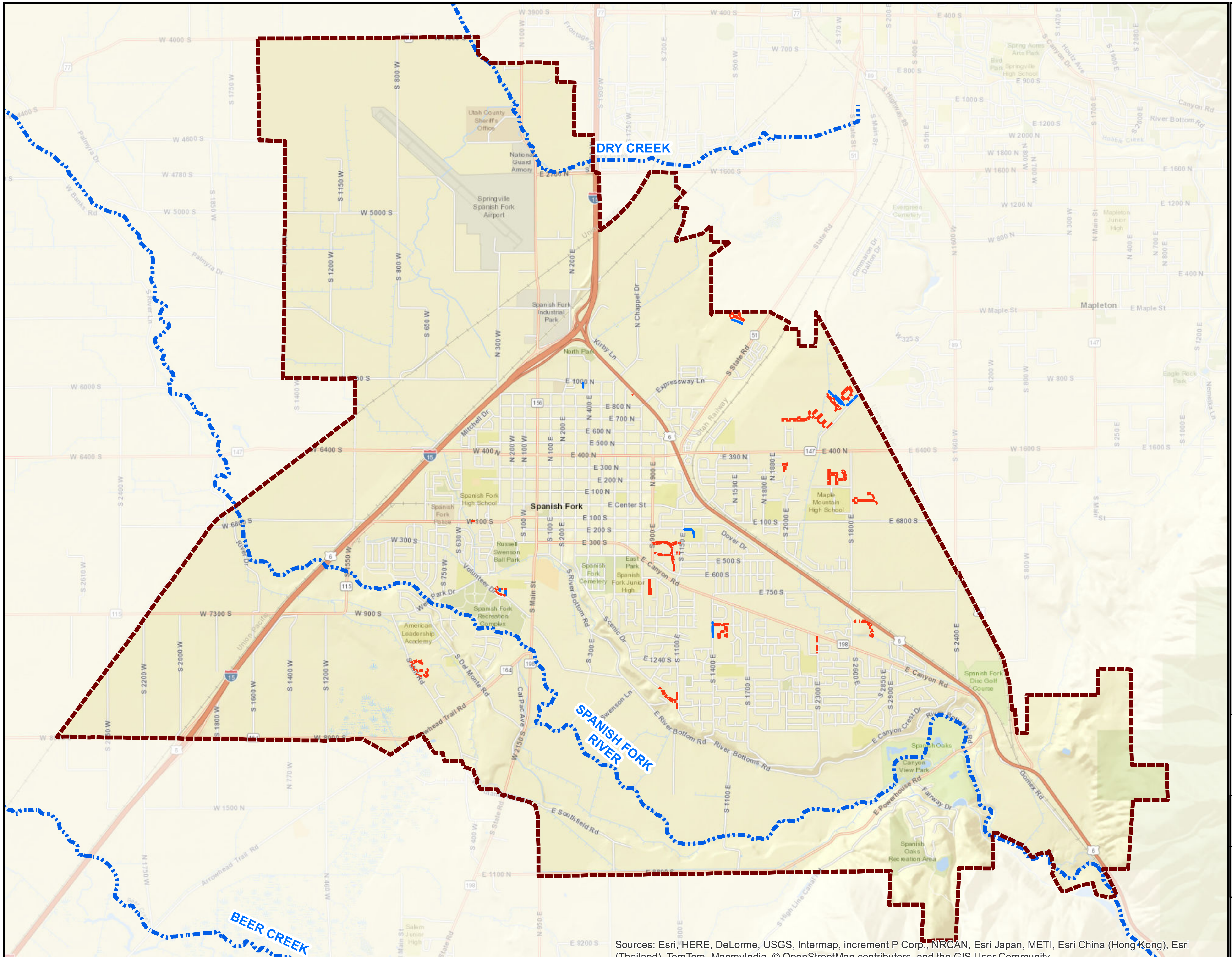
FIGURE NO. 2-1



LEGEND

- Major Recieving Stream

Existing LID Facilities

- R-tank
- StormTech Facility
- Study Limits

NORTH:

SCALE: 0 1,750 3,500 Feet

EXISTING LID FACILITIES

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FIGURE NO. 2-2

CHAPTER 3
HYDROLOGIC ANALYSIS

A hydrologic computer model of the study area was developed using ASSA computer program for the purpose of estimating storm water runoff volumes and peak discharges generated by a design cloudburst event. The hydrologic model development process is outlined in the following general steps, with detailed information on each step provided below:

1. Delineate Drainage Basins
2. Input Hydrologic Modeling Parameters
3. Input Design Storm
4. Model Detention Basin
5. Calibrate Model

DELINEATE DRAINAGE BASINS

The first step to developing a hydrologic computer model is to delineate drainage basins and subbasins. Topographic mapping, 2009 aerial photography, and an existing storm drainage system inventory (provided by the City) were used to delineate drainage basins and subbasin boundaries in the study area. Drainage basin and subbasin boundaries associated with the hydrologic model are shown on Figure 3-1.

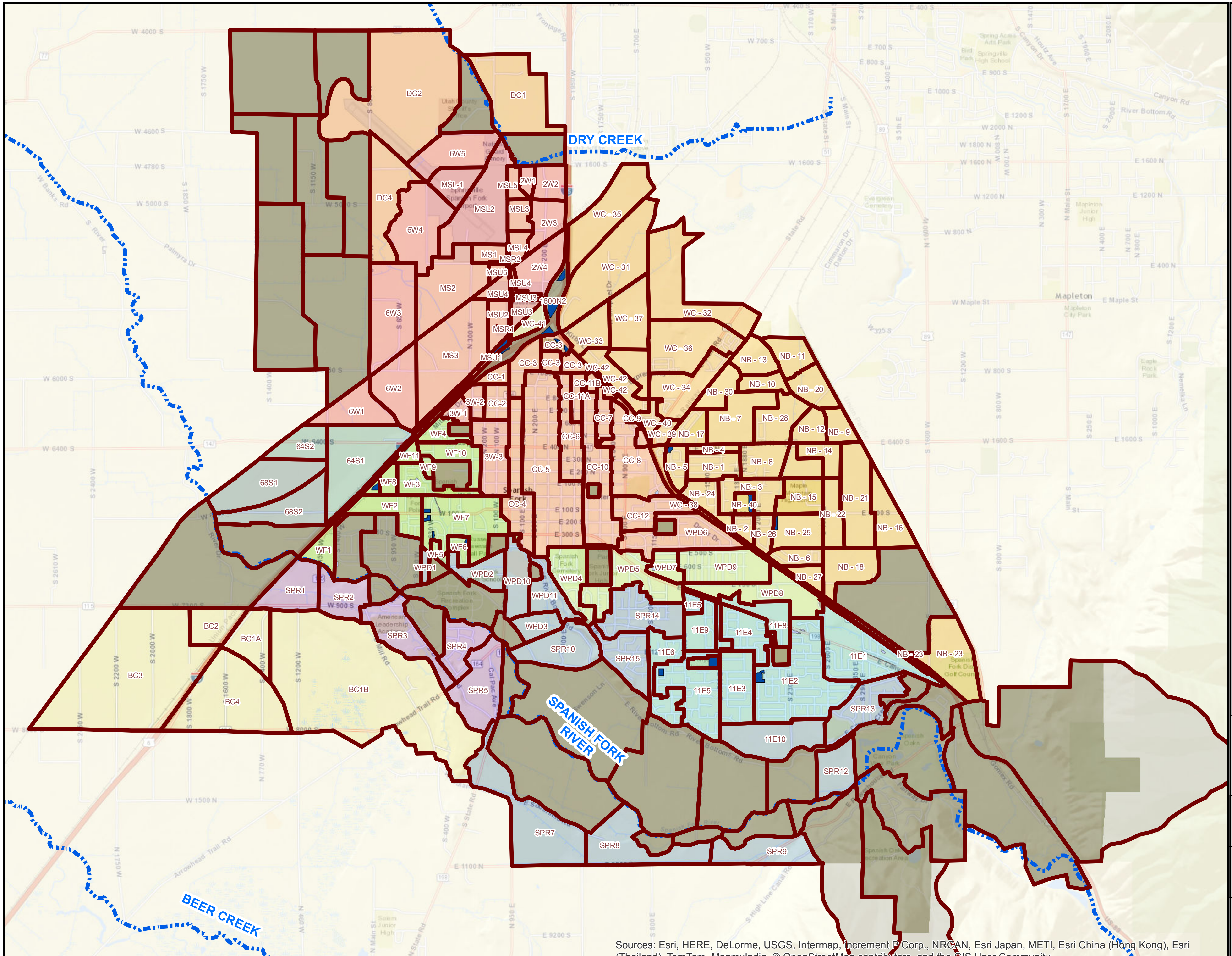
INPUT HYDROLOGIC MODELING PARAMETERS

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

Loss Method

The SCS Curve Number method was used in the hydrologic model to calculate infiltration losses for pervious areas (see NRCS TR-55 publication for additional information). This method requires the input of a composite Curve Number and the percent impervious for each subbasin. A composite Curve Number was estimated for each subbasin based on soil type and vegetative ground cover. The hydrologic soil type was obtained from the NRCS SSURGO dataset. Table 3-1 shows the Curve Numbers used in this study based on soil type and as assumed grass cover in developed areas.

A soils map for Spanish Fork City and the surrounding area is in the Storm Water Drainage Design Manual in Appendix B.



NORTH:

SCALE: 0 1,750 3,500 Feet

SUBBASINS AND DETENTION BASINS

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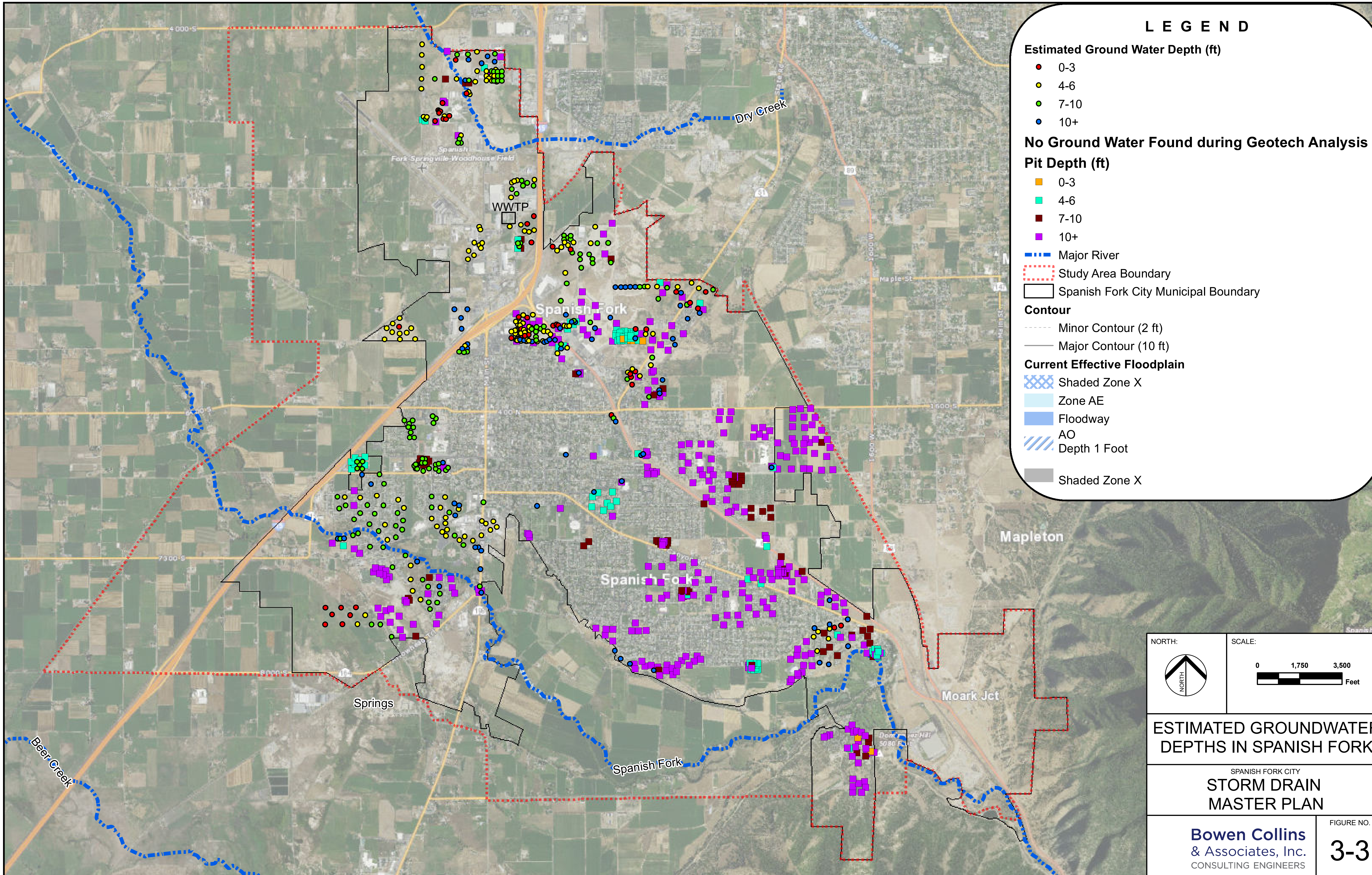
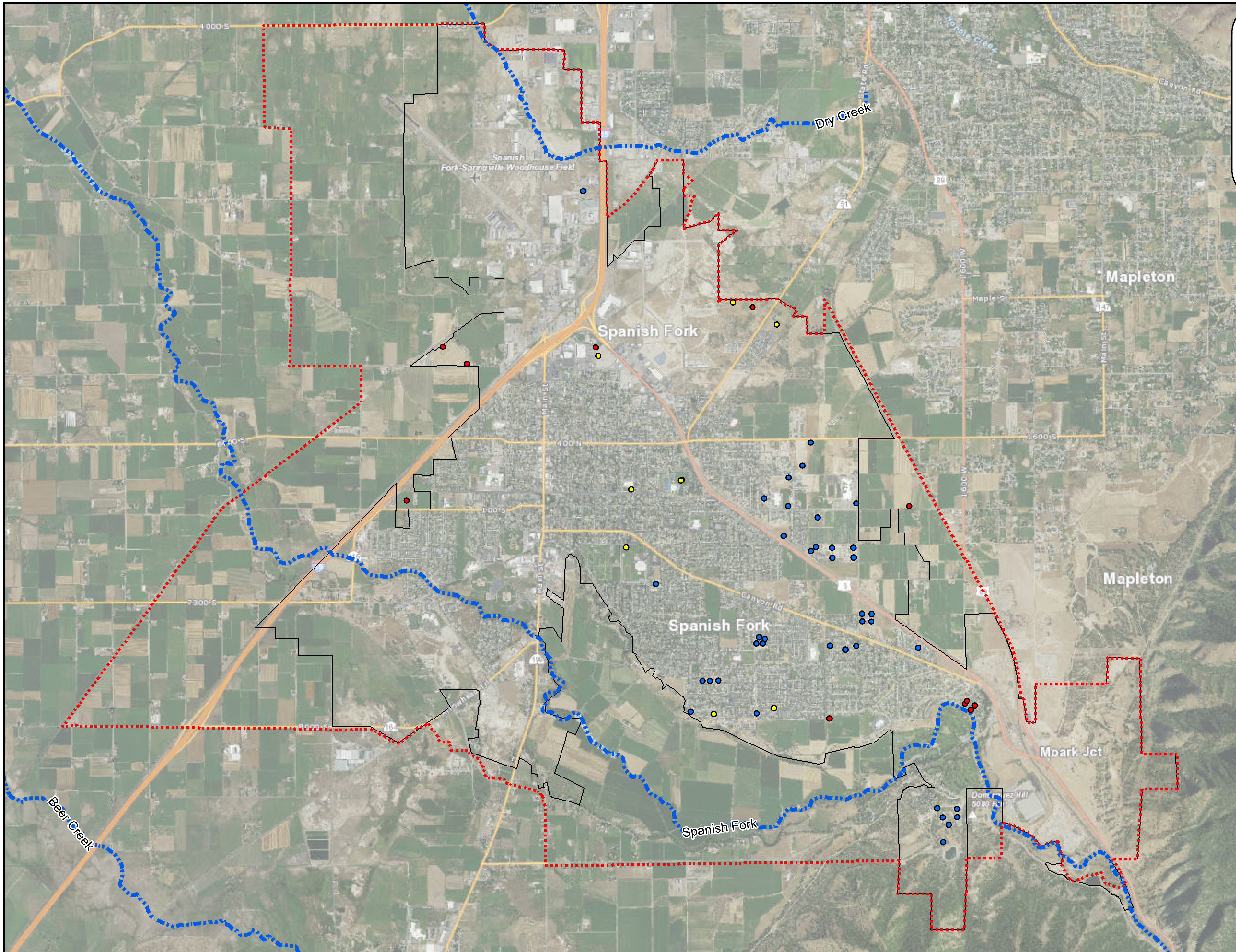
FIGURE NO. 3-1

P:\Spanish Fork City\204-16-03 - SDMP Update\4.0 GIS\4.4 Figures\Figure 3-1 Drainage Basins.mxd kballentine 6/29/2016



P:\Spanish Fork City\204-16-03 - SDMP Update\4.0 GIS\4.4 Figures\Figure 3-3 - Groundwater Depth.mxd kballentine 11/10/2016



ESTIMATED PERCOLATION RATES IN SPANISH FORK

SPANISH FORK CITY
STORM DRAIN MASTER PLAN

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FIGURE NO. 3-4

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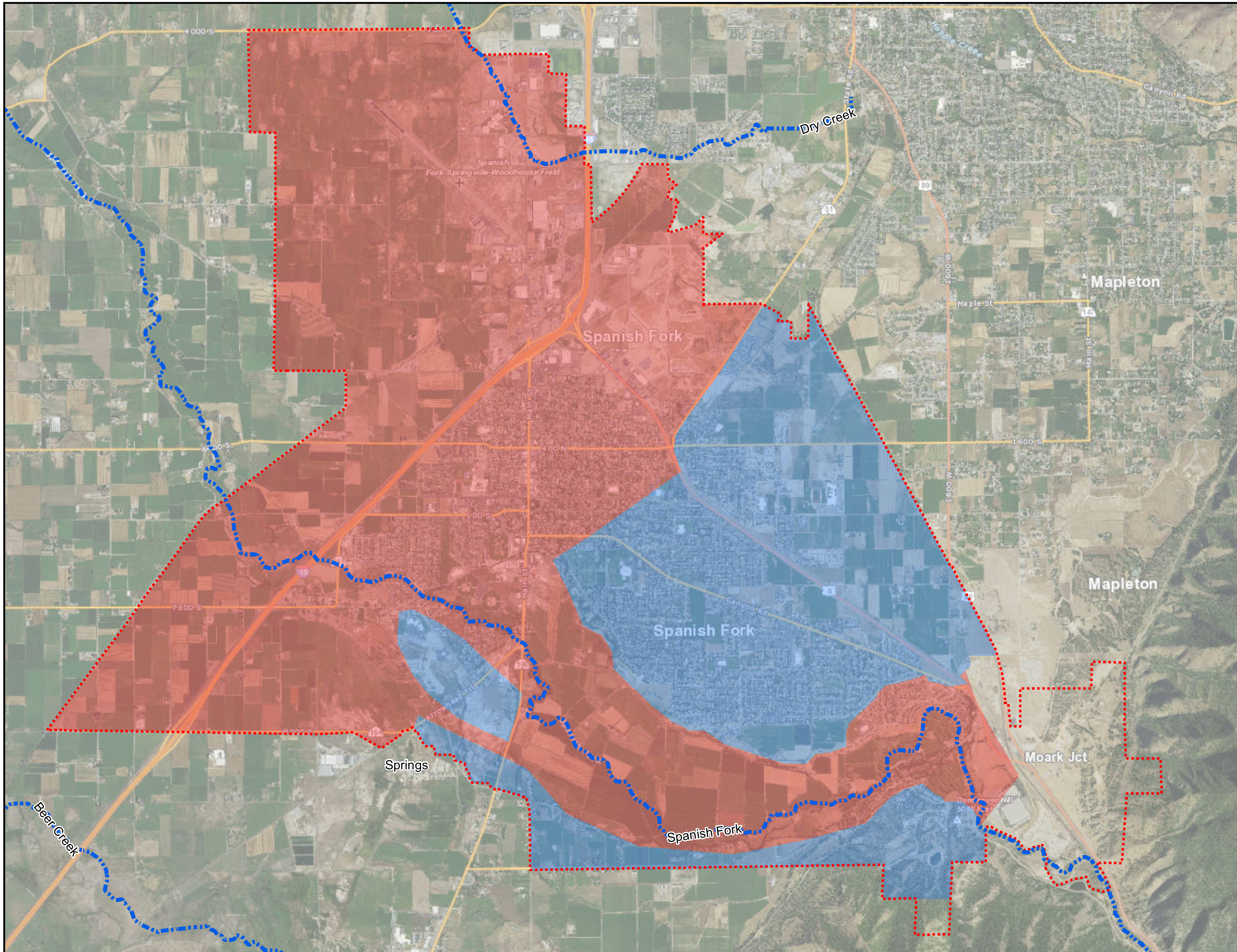

GROUND WATER AND PERCOLATION RATES

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FIGURE NO.
3-5

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Table 3-1
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%"

The amount of directly-connected impervious area for pre- and post-development conditions was estimated using projected full build-out land use conditions based on the General Plan. Table 3-2 shows the percent of directly connected impervious used in this study based on land use. The values in Table 3-2 were obtained using an aerial photograph and estimating the directly connected impervious area for multiple sample areas for each of the different land use types.

Table 3-2
Average Imperviousness Based on Lot Size

General Plan Land Use Type	Directly Connected Imperviousness (Percent)
Low Density Residential	20% - 26%
Medium Density Residential	35%
High Density Residential	40% - 85%
Commercial and Business	85%
Industrial	72%

Transform Method

The SCS Unit Hydrograph was used in the hydrologic model to convert rainfall to runoff. This method requires "lag time" as an input parameter. Worksheet 3 in 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.

Routing Method

The Muskingum-Cunge routing method was used in the hydrologic model to compute the effects of routing runoff hydrographs in the computer model. The input parameters for this routing method require the geometry and Manning's "n" of the conveyance facility.

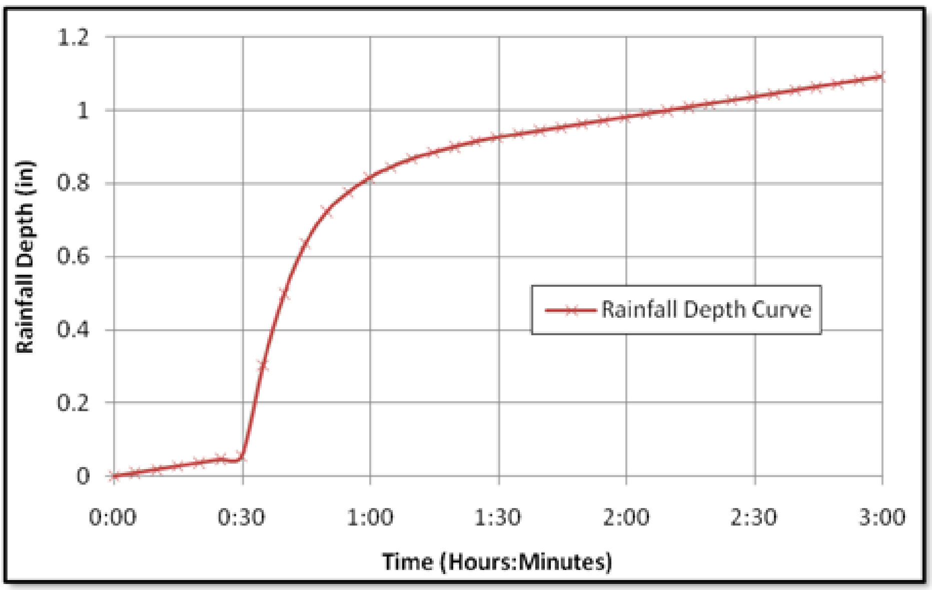
DESIGN STORM PARAMETERS

The following data was used to define the design storm for this study:

- Storm Duration: 3 Hours
- Storm Distribution: Modified Farmer and Fletcher
- Storm Depth Recurrence Interval(From NOAA Atlas 14):
  10-Year: 1.09 inches
  25-Year: 1.38 inches

The distribution of the storm used for mater planning purposes model is shown in Figure 3-2. For more detailed information on the design storm, including the tabular form of the curve in Figure 3-2, see the Storm Water Drainage Design Manual in Appendix B.

Figure 3-2: 10-Year Design Storm Depth-Duration Rainfall Curve



DETENTION BASIN MODELING

Existing detention basin parameters were provided by the City. Detention facilities were analyzed as either Regional or Local detention basins.

Regional Detention Basins

The capacity of existing Regional Detention facilities were analyzed in the hydrologic computer model. Regional detention facilities are identified on Figure 3-1. In addition to providing the capacity of existing detention basins, the City identified preferred locations for additional future regional detention facilities.

Local Detention Facilities

Local detention facilities were not analyzed for capacity issues or size. Spanish Fork City staff provided the location of some of the existing local detention facilities, and they are shown on Figure 3-1. The effects of local detention facilities were simulated by the model using one of two methods as listed below.

1. Local detention facilities were input into the hydrologic computer model with the 10-yr design storm as a single detention basin unit, similar to a regional detention facility. Future commercial or industrial development was modeled this way because future development is required to detain to 0.15 cfs per acre (cfs/ac) (see Appendix B - Storm Water Drainage Design Manual). Because there is typically undetained flow coming from the major roads, the overall release rate from large areas of future commercial or industrial development was assumed to be an average of 0.2 cfs/ac. Based on conversations with City personnel, existing industrial or commercial development west of I-15 and north of Highway 6 was modeled to detain runoff to 0.15 cfs/ac, whereas existing industrial and commercial development east of I-15 and south of Highway 6 was modeled to not have any local detention facilities.
2. The effects of small local detention facilities were incorporated into the hydrologic computer model by decreasing the percentage of directly connected impervious area, thus decreasing the overall model-generated runoff from a drainage basin at the city's request. For example, assume that a drainage basin of 150 acres has a peak runoff of 39 cfs (0.26 cfs/acre) without local detention. If that basin were to contain three local detention facilities, each of which serve 10 acres and attenuate the peak discharge to a rate of 0.15 cfs/ac, then the percent of directly connected impervious area was decreased in the model until the overall peak runoff rate was 35.7 cfs (120 acres @ 0.26 cfs/ac and 30 acres @ 0.15 cfs/ac).

MODEL CALIBRATION

The final step in the hydrologic modeling process was 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 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. The rainfall-runoff model generally produces peak runoff rates that range from 0.25 cfs/ac to 0.32 cfs/ac runoff medium density residential, which falls within the calibration range.

CN Values

In some instances the simulated peak runoff initially exceeded the calibration target range. In these instances, the CN Value for the subbasin 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 previous area of the development.

Lag Time

As indicated above, Worksheet 3 in TR-55 was initially used to estimate the time of concentration, which is approximately equal to Lag Time in urban areas.

EXISTING INLET CAPACITY ISSUES

The collective assumption was made that there are enough existing storm water 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 collect 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 as necessary.

BLOCKS AREA

The Blocks Drainage Basin in Spanish Fork City is located in one of the oldest parts of the City. It is generally bounded by 300 West, I-15, Highway 6, and Center Street. Most of this area was developed before traditional storm management practices (inlets and pipes) were widely used. Roads in this area have concrete gutters along either side that were primarily designed to convey secondary water to irrigate gardens and yards. Small (12-18 inch) Corrugated Metal Pipes (CMP) have been drains were installed at most intersections to convey irrigation water to gutters across intersections.

As the area redeveloped with higher density residential or commercial lots, the storm water management system for the majority of the Blocks Area was left in place. Today, storm water runoff from the Central Area collects in the irrigation gutters on either side of the streets, and the irrigation gutters are no longer used for irrigation purposes. Because the driveway entrances along the road are undersized, and the CMP cross drains at each intersection have limited capacity, storm water runoff from a design storm event will overflow the tops of the gutters and pond at the upstream side of each driveway and at each intersection, creating an attenuating effect on the peak discharge. Therefore, the peak storm water runoff rates from the Blocks Area are significantly lower than areas with traditional storm water management systems (i.e. curb and gutter, storm drain pipes, etc.) because of the local detention and flooding caused by the limited capacity of the driveway entrances and cross drains.

A detention element was added to each subbasin in the Blocks Area to simulate the effects of detention storage at each intersection with cross drains.

LOW IMPACT DEVELOPMENT

Low Impact Development (LID) is a comprehensive approach to micromanaging storm water where it is generated. The goal of LID is to develop a storm water management strategy that mimics pre-development conditions in a cost-effective, flexible manner. It also involves treating and filtering storm water near the source, before it infiltrates into the ground. LID practices typically include underground R tanks, drainage swales, rain barrels, rain gardens, and other forms of storing and treating storm water on site, and allowing it infiltrate into the ground.

Spanish Fork City is a pioneer in Utah in implementing LID to manage storm water runoff. The City has a desire to implement LID practices more widely across the City. To that end, several dozen geotechnical reports from local developments were reviewed to obtain recorded groundwater level and percolation rate information. A database of the complied information was developed and indexed on a map of the City. Figures 3-3 and 3-4 show the groundwater levels and percolation rates from the geotechnical reports, respectively.

Areas that have high groundwater levels and/or low percolation rates may not be feasible to implement standard LID practices. Whereas areas that have no shallow groundwater and/or high percolation rates may be suitable to implement LID practices. Figure 3-5 shows the approximate boundary of areas where LID is more feasible based on the geotechnical reports and input from representatives from Spanish Fork City. Because groundwater levels fluctuate through the year and also change from year to year, and most of the geotechnical reports did not include percolations rates, the areas defined in Figure 3-5 is only approximate. During the design stage of development or re-development, a geotechnical analysis should be completed to determine if implementing LID is feasible. The area where LID is feasible as shown in Figure 3-5 is to be used for planning purposes only.

Future developments in areas that are feasible for LID (as shown in Figure 3-5) were modeled as areas with no runoff that discharge in to the central storm drain system. Because the design storm for minor facilities is a 10-year design storm, and the LID requirements for Spanish Fork City can collect and retain runoff from storms larger than the 50-year storm, it is not anticipated that there will be any runoff from the 10-yr design storm that get collected in the central storm drain system.

HYDROLOGIC MODELING ASSUMPTIONS

The hydrologic analysis of the study area was performed using the ASSA computer software. The model input parameters were developed using multiple data sources, including drainage basin delineations, soil surveys, land use maps, recent aerial photography, and model input data used in similar hydrologic studies within or in the vicinity of the study area.

The following general 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 each drainage basin.
3. Normal (SCS Type 2) antecedent soil moisture conditions exist at the beginning of the design storm.
4. The hydrologic computer model adequately simulates watershed response to precipitation.

CHAPTER 4
DEBRIS STRUCTURE ANALYSIS

INTRODUCTION

Spanish Fork City personnel requested that alternative means of collecting floating debris on the Spanish Fork River be evaluated as part of this study. City personnel have concerns that floating debris in the river can damage existing irrigation diversion structures, collect on and damage bridges, or create debris dams that could cause channel erosion and damage homes and other infrastructure. Floating debris is generally only a concern during periods of high spring runoff (caused by melting snow) or following large and intense cloudburst storms in Spanish Fork Canyon. It is common for city personnel to utilize large equipment at hydraulic structures during periods of high runoff to remove floating debris. The goal of installing debris control structures on the Spanish Fork River would be to collect the debris in one or more desired locations and limit the use of maintenance equipment and personnel to protect downstream structures and facilities.

ALTERNATIVES ANALYSIS

Two types of structures were considered in this cursory analysis: an in-stream structure with a trash rack, and a floating boom. BC&A personnel performed field reconnaissance and evaluated aerial mapping to identify potential locations for these types of structures. The analysis is summarized below.

In-Stream Structure with Trash Rack

An in-stream concrete debris structure is a structure that would be constructed in the river channel and would be designed to convey flow through the structure while collecting floating debris. This structure would be constructed out of cast-in-place concrete and include a trash rack on its upstream face. The structure would include a deck or platform that crosses the river above the trash rack where a track hoe could collect debris collected on the trash rack. Such an in-stream concrete structure should be designed to safely pass runoff from a one-percent-annual-chance flood (100-year flood) and be designed so that it could safely overtop if the trash rack becomes plugged with debris. An in-stream structure like this should also include a rock trap located just upstream of the trash racks to collect rock that may not pass through the trash rack. It is important to have sufficient property available to stack debris removed from the trash racks and for driving on and off of the platform. The Figure 4.1 shows an example of an in-stream debris structure that was recently constructed on Little Cottonwood Creek in Salt Lake County.

Figure 4-1
Debris Collecting Structure on Big Cottonwood Creek, Salt Lake County, Utah

Floating Booms

Floating booms are designed to remove floating debris on rivers, lakes and reservoirs, and can also serve as a protective barrier in large water bodies. Floating booms typically have solid foam cores and are manufactured in short lengths of approximately 10 feet. Floating booms can be manufactured in various colors, including natural earth tone colors that better blend into the surrounding environment. For covering large spans, boom sections are connected with steel shackles. A span of floating booms can be anchored on each side of the river with a buried concrete deadman. A screen can be attached to the bottom of floating booms to make them more effective in removing debris. Floating booms have been used on rivers and flood plains that only see water flow during flooding events such as spring runoff. They may be out of the water or set on the bottom of a channel for much of the year when stream discharges are low. Floating booms on rivers should be designed and installed on an angle so that the stream current will push debris to a desired location where it can be removed with large equipment. Floating booms work most effectively in channels with flow velocities of 3 feet per second or less, but for installations on rivers where flow velocities exceed 3 feet per second, the booms still remove up to 70 percent of the floating debris. Floating booms work well just upstream of control structures such as irrigation diversions because the river is often backed up, reducing flow velocities. An area on a river bank could be excavated to create a dead pool where the water velocity is below 3 feet per second to increase the amount of debris collected by the floating booms. It is important to provide access for large equipment to the site where the debris will collect and to have sufficient property available to temporarily store the removed debris. Figure 4.2 shows an example of a functioning floating boom installation on a river channel.

Figure 4-2
Floating Boom on a River
(Courtesy of Tuffboom.com)

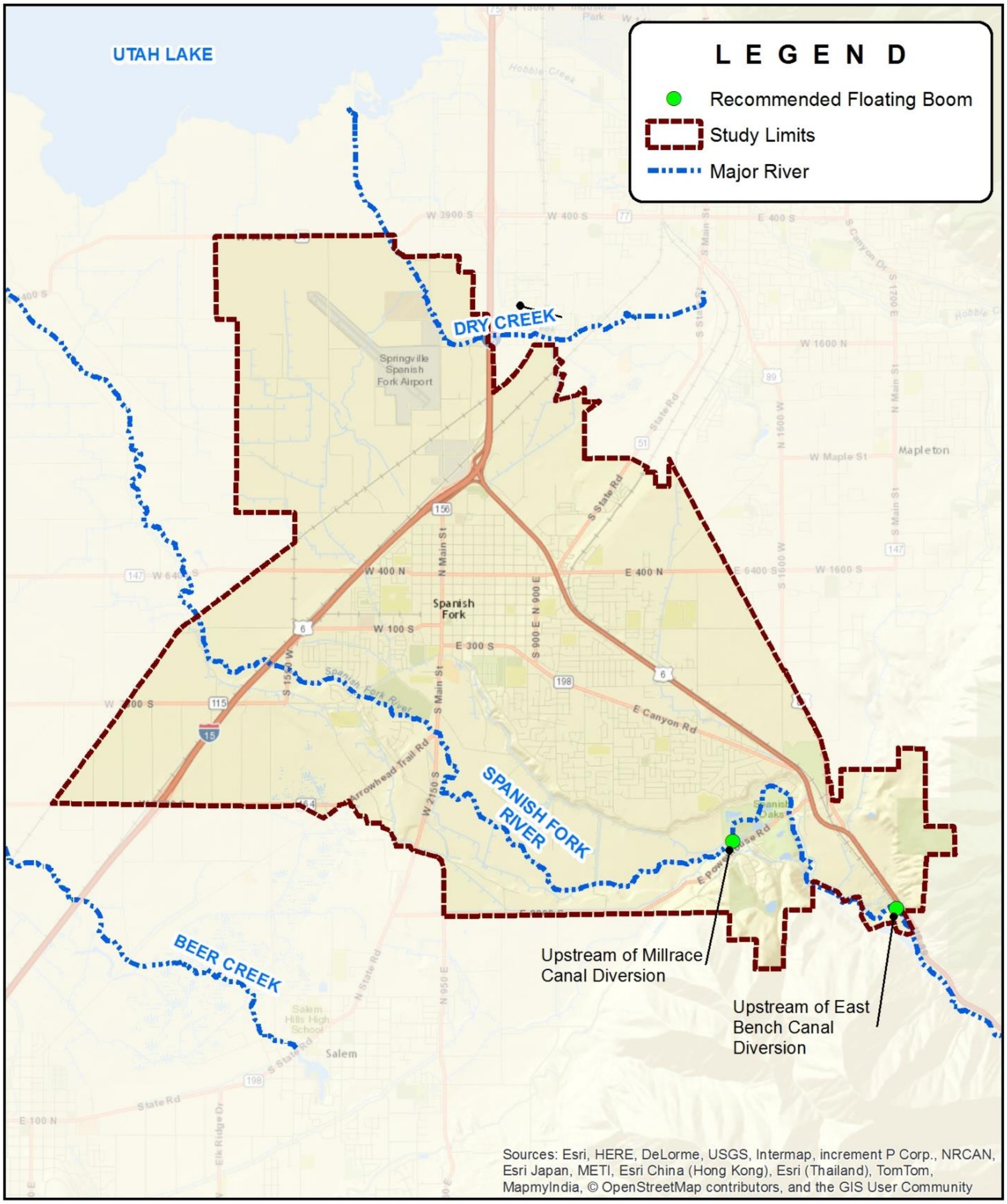
LOCATION ANALYSIS

There is approximately 10.5 miles of stream channel on the Spanish Fork River between Thistle Dam and the Mill Race Diversion located near the west end of the Spanish Fork City Golf Course. There are four major irrigation diversions in that reach of river: The Power Canal Diversion, just downstream of the Diamond Fork confluence; the Each Bench Canal Diversion near the mouth of the canyon; a small diversion near the east end of the golf course; and the Mill Race Diversion near the west end of the golf course. Most of this section of river and the river reach between the Mill Race Diversion and I-15 has a lot of trees on the river bank that could potentially contribute to the debris that could cause damage to existing hydraulic structures and increase flooding risk to private property in the City. In some areas, many of those trees have low hanging branches that hang over the river that would be covered with water in a large runoff event. By installing in-stream debris structures or floating booms, it may be possible to reduce the risk of debris damaging the diversion structures, bridges, City infrastructure, and private property.

RECOMMENDATIONS

Because in-stream concrete structures need to be constructed in an area where high discharges would be confined within the main channel, an in-stream debris structure would need to be constructed upstream of the East Bench Diversion structure near the mouth of the canyon. The conceptual cost to build such a structure would be approximately $1,000,000. This conceptual cost does not include property easements or easements for access to the structure.

Because much of the river channel west of the East Bench Diversion does not contain all the flow associated with the 100-year flood and an in-stream diversion could significantly raise the water surface during a flood, the floating boom alternative would be more appropriate to collect floating debris in the reach of the Spanish Fork River between the canyon mouth and I-15. It is recommended that floating booms be installed just upstream of the East Bench Canal Diversion near the canyon mouth and just upstream of the Millrace Diversion near the west end of the Spanish Fork City Golf Course, as shown in Figure 4-3. The estimated length of boom would be approximately 100 feet in each case with an associated design and construction cost of approximately $60,000. This cost does not include property easements or easements for access to the site or significant site improvements. The effectiveness of these two floating booms should be monitored after installation. If the floating booms do not function well or if issues like large rock collection and removal that the booms do not address an important issue, then an in-stream concrete structure could be considered for construction in a location above East Bench Canal Diversion near the mouth of the canyon.



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RECOMMENDED LOCATION OF FLOATING BOOMS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

NORTH:

SCALE: 0 3,000 6,000 Feet

FIGURE NO. 4-3

P:\Spanish Fork City\204-16-03 - SDMP Update\4.0 GIS\4.4 Figures\Figure 4-3 Boom Location.mxd kballentine 9/2/2016

CHAPTER 5
RECOMMENDED STORM DRAINAGE SYSTEM
CAPITAL IMPROVEMENTS PLAN

GENERAL APPROACH

The following major tasks were completed to identify the recommended improvements:

1. **Existing Capacity** – The capacities in existing storm drain pipelines were estimated using ASSA.
2. **Existing Flow** – The peak flow rates for existing development conditions were estimated using ASSA.
3. **Existing Deficiencies** – Existing system capacity deficiencies in the storm drain system were identified using the peak flow estimates from the hydrologic computer model, and the estimated capacities for existing system facilities.
4. **Future Flow** - The peak flow rates for the design storm based on projected full build-out conditions were estimated using ASSA.
5. **Future Demand** - Future demands on the storm drain system were identified using the peak flow estimates from the hydrologic computer model and the estimated capacities for existing system facilities.
6. **Recommended Improvements** – Needed storm drain projects were identified to meet demands associated with future development.

GENERAL RECOMMENDATIONS

Spanish Fork City has a Storm Water Drainage Design Manual that defines general design requirements for new storm drain facilities. The analyses used to identify recommended improvements is based on projected future development conditions and the design criteria defined in the Storm Water Drainage Design Manual, including post-construction peak discharge requirements.

Low Impact Development

LID practices should be implemented for all areas of new development or redevelopment, wherever it is feasible. LID should be used based on the criteria described in the Storm Water Drainage Design Manual. Though it is anticipated that runoff from areas that utilize LID practices will be minimal, there are still some recommended pipe improvements to collect and convey runoff from storm events larger than the design storm or if the LID system does not function properly.

Retention Requirements

To further encourage the use of LID, any new development or redevelopment projects that disturb greater than or equal to one acre must collect and retain storm water runoff from the 90th percentile storm onsite. The storm water runoff water must be retained using LID features and practices, as defined in the Storm Drain Design Manual. If meeting this retention standard is not feasible, documentation will need to submitted and approved by the City. The documentation must summarize how LID facilities have been used to the maximum extent feasible on their particular site.

Blocks Area

To avoid costly improvements to storm water facilities downstream of the Blocks Area, the Blocks Area will need to continue to discharge at its current rate for design storm events. As the area re develops, storm water runoff will need to be collected and detained to a runoff rate that reflects the attenuated peak flow rate. This can be done through the use of LID or other storm water management practices.

RECOMMENDED CAPITAL IMPROVEMENTS

The results of the hydrologic and hydraulic analyses completed in the course of this study were used to identify storm drainage facilities that have the potential for flooding during the design storm event. The trunk lines are numbered by Figure on Figure Set 5-1 as indicated in Table 5-1. A detailed list of recommended projects for trunk lines and regional detention basins is presented in Tables 5-2 and Table 5-3. The conceptual construction cost estimate calculations for the recommended projects are included in Appendix D.

Table 5-1
Trunk Line ID Numbering

Figure Number	Trunk Line ID
5-1A	100-199
5-1B	200-299
5-1C	1-99
5-1D	300-399

As shown in Tables 5-2, 5-3 and 5-4 estimated costs for recommended improvement projects were divided based on the percentage of each project attributable to existing system deficiencies and the portion of the project necessitated by future development. A more detailed description of the cost ratio calculation methodology is found in Appendix E.

MASTER PLAN LIMITATIONS

The hydrologic and hydraulic models developed as part of the Spanish Fork Master Drainage Study are based on data obtained during field surveys and inventories, information obtained from Spanish Fork City. BC&A and Spanish Fork City are not responsible for the results or accuracy of these models when modified by others.

The master plan process is used to develop general storm drain pipe sizing, location, cost estimating and scheduling for the next several years. The estimated flow and pipe diameters developed from the results of the model are approximate and are only for planning purposes. This master plan is developed based on common assumptions and uniform design criteria to ensure uniformity in the recommended improvements and the cost estimate. This master plan does not include details such as exact alignment, slope, depth and capacity of the pipe; exact location of the

Recommended Pipe Sizes

ID	Existing Flow (cfs)	Future Flow (cfs)	Existing Diameter (in)	Average Slope (%)	Manning's n	Estimated Existing Full pipe Capacity (cfs)[1]	Recommended Future Diameter (in)	Estimated Future Pipe Capacity (cfs)[1]
R104		14.7		2.3	0.013		21	24
R105		17.1		0.3	0.013		24	13
R106		15.7		0.4	0.013		24	15
R107		0.5		0.2	0.013		18	5
R108		14.3		0.2	0.013		30	18
R109		19.6		0.1	0.013		36	22
R110		12.3		0.2	0.013		30	18
R111		61.5		0.4	0.013		42	60
R112		85.4		0.3	0.013		48	83
R113		116.9		0.4	0.013		54	127
R148		19.1		0.2	0.013		30	16
R150		19.1		0.1	0.013		30	14
R151		33.5		0.3	0.013		36	34
R152		72.1		0.3	0.013		54	106
R153		19.3		0.2	0.013		30	20
R157		23.9		0.3	0.013		30	24
R158		9.6		0.2	0.013		24	11
R159		28.0		0.4	0.013		30	26
R160		54.6		0.8	0.013		36	60
R161		65.0		0.3	0.013		48	77
R163		92.6		0.7	0.013		54	168
R164		118.0		0.4	0.013		60	155
R165		120.0		0.4	0.013		60	157
R199-C		47.0		0.3	0.013		42	53

[1] Capacity based on Manning's equation

Detention Facilities

Name	Existing Vol (ac-ft)	Future Vol (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)
1450 East	0.0	1.6	4.6	0.024
1st South	0.0	2.2	7.7	0.055
1100 East	0.0	13.5	39	0.021
2550 East	0.0	1.8	3.7	0.02
400 South	0.0	2.0	7.7	0.022
Arrowhead Trail	0.0	13.5	7.4	0.01
Fair Grounds	2.2	3.4	9.6	0.04
Mill Road	1.1	0.6	17.6	0.02
RB 1	0.0	7.8	0	0

RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

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FIGURE NO.

5-1A

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Recommended Pipe Sizes

ID	Existing Flow (cfs)	Future Flow (cfs)	Existing Diameter (in)	Average Slope (%)	Manning's n	Estimated Existing Full pipe Capacity (cfs)[1]	Recommended Future Diameter (in)	Estimated Future Pipe Capacity (cfs)[1]
R199-D		15.6		0.5	0.013		36	46
R201		0.0		30.1	0.013		18	58
R203		5.5		0.6	0.013		18	8
R204	18.9	22.1	18	0.5	0.013	29.1	30	29
R207	10.6	10.6	18	0.1	0.015	11.1	30	11
R208	20.3	20.3	18	0.5	0.013	29.7	30	30
R209	39.7	39.7	24	0.1	0.013	46.7	48	47
R212	18.5	18.6	18	0.2	0.013	19.5	30	20
R216	14.6	14.6	18	0.2	0.013	20.0	30	20
R219	19.6	19.6	24	0.4	0.013	25.4	30	25
R220	12.2	12.2	18	0.1	0.013	15.0	30	15
R221	34.5	34.7	24	0.5	0.013	46.1	36	46
R224		9.9		0.4	0.013		24	15
R225	23.1	23.2	24	0.5	0.013	28.3	30	28
R232		1.6		0.2	0.013		18	5
R234		5.9		0.7	0.013		18	9
R237		9.5		0.5	0.013		24	16
R238		23.3		0.3	0.013		30	21
R244		28.8		0.4	0.013		36	42
R245	21.0	21.0	18	0.1	0.013	15.0	30	15
R246	19.5	19.5	24	0.3	0.013	22.9	30	23
R247	40.2	40.2	24	0.6	0.013	52.5	36	52
R249		10.7		1.5	0.013		42	124
R250		Overflow[2]					18	
R251		Overflow[2]					18	
R252		Overflow[2]					18	
R253		Overflow[2]					18	
R254		Overflow[2]					18	
R256		6.6		0.4	0.013		18	7
R261		7.0		0.7	0.013		24	18
R262		7.7		2.4	0.013		18	16
R267		7.7		1.3	0.013		24	25
R268		6.5		2.1	0.013		18	15
R270		17.5		1.8	0.013		24	30
R274		5.4		0.2	0.013		18	5
R275		5.8		0.4	0.013		18	6
R277		21.9		0.2	0.013		42	46
R278		5.2		0.6	0.013		18	8

[1] Capacity based on Manning's equation

[2] Pipe will function as an overflow for LID storm drain infastructure and may not collect runoff from traditional storm drain infastucture

Detention Facilities

Name	Existing Vol (ac-ft)	Future Vol (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)
1450 East	0.0	1.6	4.6	0.024
1st South	0.0	2.2	7.7	0.055
1100 East	0.0	13.5	39	0.021
2550 East	0.0	1.8	3.7	0.02
400 South	0.0	2.0	7.7	0.022
Arrowhead Trail	0.0	13.5	7.4	0.01
Fair Grounds	2.2	3.4	9.6	0.04
Mill Road	1.1	0.6	17.6	0.02
RB 1	0.0	7.8	0	0

RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

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FIGURE NO.

5-1B

Recommended Pipe Sizes								
ID	Existing Flow (cfs)	Future Flow (cfs)	Existing Diameter (in)	Average Slope (%)	Manning's n	Estimated Existing Full pipe Capacity (cfs)[1]	Recommended Future Diameter (in)	Estimated Future Pipe Capacity (cfs)[1]
R1		3.2		0.8	0.013		18	10
R2		12.8		0.8	0.013		24	21
R3		12.8		0.5	0.013		24	16
R4		19.1		0.3	0.013		30	21
R5		23.9		0.3	0.013		30	23
R6		42.9		0.4	0.013		42	63
R7		43.7		0.3	0.013		42	58
R8		23.2		0.8	0.013		30	38
R9		16.4		0.4	0.013		30	25
R10		9.5		0.5	0.013		24	16
R11		22.5		0.3	0.013		30	21
R12		45.8		1.2	0.013		30	45
R13		106.3		0.5	0.013		54	136
R14		42.0		0.2	0.013		42	43
R19		18.2		0.3	0.013		30	23
R20		151.1		0.3	0.013		66	173
R21		33.9		0.3	0.013		36	35
R22		22.8		0.3	0.013		30	23
R23		85.2		0.2	0.013		54	94
R24		51.2		0.3	0.013		48	77
R25		136.3		0.3	0.013		66	180
R26		10.9		0.4	0.013		24	13
R28		3.9		2.8	0.013		18	17
R29		4.2		1.1	0.013		18	11
R34		30.7		1.7	0.013		30	54
R35		67.9		2.6	0.013		36	108
R43		11.5		0.6	0.013		24	18
R44	20.4	25.8	24	0.6	0.013	18	30	30
R47		0.8		0.0	0.013		18	0

[1] Capacity based on Manning's equation

Detention Facilities				
Name	Existing Vol (ac-ft)	Future Vol (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)
1450 East	0.0	1.6	4.6	0.024
1st South	0.0	2.2	7.7	0.055
1100 East	0.0	13.5	39	0.021
2550 East	0.0	1.8	3.7	0.02
400 South	0.0	2.0	7.7	0.022
Arrowhead Trail	0.0	13.5	7.4	0.01
Fair Grounds	2.2	3.4	9.6	0.04
Mill Road	1.1	0.6	17.6	0.02
RB 1	0.0	7.8	0	0

RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY
STORM DRAIN MASTER PLAN

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FIGURE NO.
5-1C

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Recommended Pipe Sizes								
ID	Existing Flow (cfs)	Future Flow (cfs)	Existing Diameter (in)	Average Slope (%)	Manning's n	Estimated Existing Full pipe Capacity (cfs)[1]	Recommended Future Diameter (in)	Estimated Future Pipe Capacity (cfs)[1]
R300	23.63	25.93	18	0.55	0.013	30.31	30	30
R302	45.22	49.2	24	1.64	0.013	52.5	30	53
R303	44.91	48.69	24	1.7	0.013	53.46	30	53
R304		Overflow[2]					24	
R305		Overflow[2]					18	
R306		Overflow[2]					24	
R308		Overflow[2]					18	
R309		Overflow[2]					18	
R310		Overflow[2]					24	
R311		Overflow[2]					18	
R312		Overflow[2]					24	
R313		Overflow[2]					24	
R315		78.56		1.11	0.013		42	106
R316		Overflow[2]					24	
R317		Overflow[2]					18	
R318		Overflow[2]					18	
R319		Overflow[2]					18	
R321		Overflow[2]					18	
R322		Overflow[2]					18	
R323		Overflow[2]					18	
R324		Overflow[2]					15	
R326		Overflow[2]					18	
R327		Overflow[2]					18	
R330	8.49	20.67	15	0.24	0.013	19.95	30	20
R331	8.51	20.82	18	0.24	0.013	20.03	30	20
R332	0	11.31	15	0.29	0.013	12.26	24	12
R333		Overflow[2]					18	
R338		47.28		0.98	0.013		36	66
R339		23.39		1.43	0.013		24	27
R341		19.5		0.34	0.013		30	24
R345		27.41		2.5	0.013		24	36
R346		28.13		0.78	0.013		30	36
R347		20.69		0.38	0.013		30	25

[1] Capacity based on Manning's equation
[2] Pipe will function as an overflow for LID storm drain infastructure and may not collect runoff from traditional storm drain infastucture

Detention Facilities				
Name	Existing Vol (ac-ft)	Future Vol (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)
1450 East	0.0	1.6	4.6	0.024
1st South	0.0	2.2	7.7	0.055
1100 East	0.0	13.5	39	0.021
2550 East	0.0	1.8	3.7	0.02
400 South	0.0	2.0	7.7	0.022
Arrowhead Trail	0.0	13.5	7.4	0.01
Fair Grounds	2.2	3.4	9.6	0.04
Mill Road	1.1	0.6	17.6	0.02
RB 1	0.0	7.8	0	0

RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY

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FIGURE NO. 5-1D

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Table 5-2
Estimated Costs of Capital Improvements
Recommended Storm Drain Trunk Lines

		Percentage of Cost Attributable to:		Cost Attributable to:	
Project Identifier	Total Estimated Cost	Existing Development	Future Development	Existing Development	Future Development
R1	$ 317,811.62	0%	100%	$ -	$ 317,811.62
R2	$ 320,458.57	0%	100%	$ -	$ 320,458.57
R3	$ 649,144.20	0%	100%	$ -	$ 649,144.20
R4	$ 368,678.31	0%	100%	$ -	$ 368,678.31
R5	$ 345,136.85	0%	100%	$ -	$ 345,136.85
R6	$ 310,122.44	0%	100%	$ -	$ 310,122.44
R7	$ 1,541,257.73	0%	100%	$ -	$ 1,541,257.73
R8	$ 538,766.95	0%	100%	$ -	$ 538,766.95
R9	$ 955,768.45	0%	100%	$ -	$ 955,768.45
R10	$ 977,820.89	0%	100%	$ -	$ 977,820.89
R11	$ 224,543.76	0%	100%	$ -	$ 224,543.76
R12	$ 642,282.94	0%	100%	$ -	$ 642,282.94
R13	$ 1,732,878.18	0%	100%	$ -	$ 1,732,878.18
R14	$ 2,260,061.65	0%	100%	$ -	$ 2,260,061.65
R19	$ 1,525,621.05	0%	100%	$ -	$ 1,525,621.05
R20	$ 2,162,512.90	0%	100%	$ -	$ 2,162,512.90
R21	$ 1,292,328.74	0%	100%	$ -	$ 1,292,328.74
R22	$ 717,573.55	0%	100%	$ -	$ 717,573.55
R23	$ 851,992.45	0%	100%	$ -	$ 851,992.45
R24	$ 1,418,473.25	0%	100%	$ -	$ 1,418,473.25
R25	$ 2,030,826.98	0%	100%	$ -	$ 2,030,826.98
R26	$ 302,441.38	0%	100%	$ -	$ 302,441.38
R28	$ 993,212.35	50%	50%	$ 496,606.17	$ 496,606.17
R29	$ 726,929.18	50%	50%	$ 363,464.59	$ 363,464.59
R34	$ 724,812.08	30%	70%	$ 220,656.61	$ 504,155.47
R35	$ 259,002.68	30%	70%	$ 78,452.14	$ 180,550.54
R43	$ 230,807.30	83%	17%	$ 191,469.71	$ 39,337.59
R44	$ 434,448.29	79%	21%	$ 343,517.26	$ 90,931.04
R47	$ 101,192.79	100%	0%	$ 101,192.79	$ -
R104	$ 746,883.03	3%	97%	$ 22,817.20	$ 724,065.82
R105	$ 459,621.36	3%	97%	$ 11,564.49	$ 448,056.87
R106	$ 459,555.78	3%	97%	$ 13,197.20	$ 446,358.58
R107	$ 140,380.28	96%	4%	$ 134,276.79	$ 6,103.49
R108	$ 530,443.25	0%	100%	$ -	$ 530,443.25
R109	$ 419,879.52	0%	100%	$ -	$ 419,879.52
R110	$ 134,429.25	0%	100%	$ -	$ 134,429.25
R111	$ 1,444,207.23	0%	100%	$ -	$ 1,444,207.23
R112	$ 1,945,361.85	0%	100%	$ -	$ 1,945,361.85
R113	$ 2,438,134.55	0%	100%	$ -	$ 2,438,134.55
R148	$ 359,297.95	34%	66%	$ 123,895.84	$ 235,402.11

Table 5-2
Estimated Costs of Capital Improvements
Recommended Storm Drain Trunk Lines

		Percentage of Cost Attributable to:		Cost Attributable to:	
R150	$ 83,088.65	34%	66%	$ 28,651.26	$ 54,437.39
R151	$ 1,252,116.70	0%	100%	$ -	$ 1,252,116.70
R152	$ 1,709,950.38	0%	100%	$ -	$ 1,709,950.38
R153	$ 611,450.40	0%	100%	$ -	$ 611,450.40
R157	$ 496,030.94	0%	100%	$ -	$ 496,030.94
R158	$ 442,734.30	0%	100%	$ -	$ 442,734.30
R159	$ 1,062,464.35	76%	24%	$ 802,455.19	$ 260,009.17
R160	$ 828,496.96	51%	49%	$ 420,010.36	$ 408,486.61
R161	$ 717,144.47	44%	56%	$ 317,688.71	$ 399,455.76
R163	$ 302,146.42	60%	40%	$ 182,351.68	$ 119,794.74
R164	$ 796,539.29	67%	33%	$ 537,078.48	$ 259,460.81
R165	$ 1,354,250.57	68%	32%	$ 919,495.74	$ 434,754.83
R199-C	$ 1,299,251.43	100%	0%	$ 1,299,251.43	$ -
R199-D	$ 422,804.69	100%	0%	$ 422,804.69	$ -
R201	$ 275,335.30	0%	100%	$ -	$ 275,335.30
R203	$ 445,680.37	0%	100%	$ -	$ 445,680.37
R204	$ 677,276.98	86%	14%	$ 579,908.81	$ 97,368.16
R207	$ 708,509.61	100%	0%	$ 708,509.61	$ -
R208	$ 425,892.44	100%	0%	$ 425,892.44	$ -
R209	$ 780,928.81	100%	0%	$ 780,928.81	$ -
R212	$ 99,638.52	100%	0%	$ 99,316.59	$ 321.93
R216	$ 786,388.33	100%	0%	$ 786,388.33	$ -
R219	$ 224,217.80	100%	0%	$ 224,217.80	$ -
R220	$ 399,640.45	100%	0%	$ 399,640.45	$ -
R221	$ 353,728.90	100%	0%	$ 353,728.90	$ -
R224	$ 178,981.87	100%	0%	$ 178,981.87	$ -
R225	$ 478,397.81	100%	0%	$ 478,397.81	$ -
R232	$ 61,237.50	99%	1%	$ 60,625.13	$ 612.38
R234	$ 603,403.86	69%	31%	$ 415,859.41	$ 187,544.44
R237	$ 317,191.99	69%	31%	$ 218,672.76	$ 98,519.23
R238	$ 201,882.50	70%	30%	$ 141,109.98	$ 60,772.52
R244	$ 817,388.09	100%	0%	$ 817,388.09	$ -
R245	$ 572,252.83	100%	0%	$ 572,252.83	$ -
R246	$ 231,851.52	100%	0%	$ 231,851.52	$ -
R247	$ 281,920.77	100%	0%	$ 281,920.77	$ -
R249	$ 126,454.97	0%	100%	$ -	$ 126,454.97
R250	$ 1,953,592.88	0%	100%	$ -	$ 1,953,592.88
R251	$ 1,028,810.27	0%	100%	$ -	$ 1,028,810.27
R252	$ 698,488.29	0%	100%	$ -	$ 698,488.29
R253	$ 194,459.83	0%	100%	$ -	$ 194,459.83
R254	$ 1,489,383.10	0%	100%	$ -	$ 1,489,383.10
R256	$ 299,208.93	49%	51%	$ 147,567.49	$ 151,641.44
R261	$ 332,835.67	0%	100%	$ -	$ 332,835.67
R262	$ 600,307.76	85%	15%	$ 513,216.48	$ 87,091.28
R267	$ 124,184.50	85%	15%	$ 106,168.10	$ 18,016.40

Table 5-2
Estimated Costs of Capital Improvements
Recommended Storm Drain Trunk Lines

		Percentage of Cost Attributable to:		Cost Attributable to:	
R268	$ 189,302.84	85%	15%	$ 161,678.00	$ 27,624.84
R270	$ 113,594.43	89%	11%	$ 101,435.21	$ 12,159.22
R274	$ 211,778.25	99%	1%	$ 209,817.34	$ 1,960.91
R275	$ 829,422.62	100%	0%	$ 829,422.62	$ -
R277	$ 323,288.50	100%	0%	$ 322,109.16	$ 1,179.35
R278	$ 290,432.50	86%	14%	$ 249,423.66	$ 41,008.84
R300	$ 451,683.79	91%	9%	$ 411,619.28	$ 40,064.51
R302	$ 148,213.08	92%	8%	$ 136,223.49	$ 11,989.60
R303	$ 309,384.73	92%	8%	$ 285,365.95	$ 24,018.78
R304	$ 80,111.88	0%	100%	$ -	$ 80,111.88
R305	$ 244,544.10	0%	100%	$ -	$ 244,544.10
R306	$ 247,618.14	0%	100%	$ -	$ 247,618.14
R308	$ 136,723.22	0%	100%	$ -	$ 136,723.22
R309	$ 273,741.98	0%	100%	$ -	$ 273,741.98
R310	$ 399,567.50	0%	100%	$ -	$ 399,567.50
R311	$ 107,619.16	0%	100%	$ -	$ 107,619.16
R312	$ 271,126.88	0%	100%	$ -	$ 271,126.88
R313	$ 363,888.25	0%	100%	$ -	$ 363,888.25
R315	$ 645,437.50	84%	16%	$ 541,753.42	$ 103,684.08
R316	$ 327,139.35	0%	100%	$ -	$ 327,139.35
R317	$ 287,327.50	0%	100%	$ -	$ 287,327.50
R318	$ 405,858.00	0%	100%	$ -	$ 405,858.00
R319	$ 170,496.13	0%	100%	$ -	$ 170,496.13
R321	$ 147,144.15	0%	100%	$ -	$ 147,144.15
R322	$ 332,324.13	0%	100%	$ -	$ 332,324.13
R323	$ 77,451.49	0%	100%	$ -	$ 77,451.49
R324	$ 295,944.54	0%	100%	$ -	$ 295,944.54
R326	$ 247,000.59	0%	100%	$ -	$ 247,000.59
R327	$ 246,736.53	0%	100%	$ -	$ 246,736.53
R330	$ 121,524.81	41%	59%	$ 49,915.13	$ 71,609.69
R331	$ 84,195.64	41%	59%	$ 34,414.26	$ 49,781.38
R332	$ 261,751.90	0%	100%	$ -	$ 261,751.90
R333	$ 415,333.46	0%	100%	$ -	$ 415,333.46
R338	$ 291,121.45	100%	0%	$ 291,121.45	$ -
R339	$ 374,414.26	100%	0%	$ 374,414.26	$ -
R341	$ 740,168.75	42%	58%	$ 312,389.17	$ 427,779.58
R345	$ 120,189.99	28%	72%	$ 33,895.24	$ 86,294.74
R346	$ 562,416.24	27%	73%	$ 154,549.50	$ 407,866.74
R347	$ 320,669.56	50%	50%	$ 161,652.18	$ 159,017.38
Total	**$ 72,649,731**	**-**	**-**	**$ 20,214,642**	**$ 52,435,090**

Table 5-3
Estimated Costs of Capital Improvements
Recommended Detention Basin Facilities

Detention Facility Name/Location	Needed Additional Volume (ac ft)	Estimated Land Acquisition Cost	Estimated Construction Cost (with Legal, Engineering, and Admistration Costs) Without Land Acquisition Cost	Total Estimated Cost	Percentage of Cost Attributable to: Existing Development	Percentage of Cost Attributable to: Future Development	Cost Attributable to: Existing Development	Cost Attributable to: Future Development
1450 East	1.6	$ 81,040	$ 294,171	$ 375,211	100%	0%	$ 375,210.84	$ -
1st South	2.2	$ 110,290	$ 380,856	$ 491,146	73%	27%	$ 360,889.52	$ 130,257
1100 East	13.5	$ 676,040	$ 2,057,513	$ 2,733,553	0%	100%	$ -	$ 2,733,553
2550 East	1.8	$ 90,290	$ 321,584	$ 411,874	100%	0%	$ 411,874.14	$ -
400 South	2.0	$ -	$ 315,465	$ 315,465	100%	0%	$ 315,465.00	$ -
Arrowhead Trail	13.5	$ 676,040	$ 2,057,513	$ 2,733,553	0%	100%	$ -	$ 2,733,553
Fair Grounds	2.2	$ 110,290	$ 380,856	$ 491,146	100%	0%	$ 491,146.14	$ -
Mill Road	1.1	$ 56,290	$ 220,822	$ 277,112	100%	0%	$ 277,111.74	$ -
RB 1	7.9	$ 394,825	$ 1,224,103	$ 1,618,928	0%	100%	$ -	$ 1,618,928
Total				**$ 9,447,988**			**$ 2,231,697**	**$ 7,216,291**

Table 5-4
Estimated Costs of Capital Improvements
Recommended Debris Mitigation Facilities

Name	Total Estimated Cost	Percentage of Cost Attributable to: Existing Development	Percentage of Cost Attributable to: Future Development	Cost Attributable to: Existing Development	Cost Attributable to: Future Development
Millrace Canal Diversion Floating Boom	$ 60,000	100%	0%	$ 60,000	$ -
East Bench Canal Diversion Floating Boom	$ 60,000	100%	0%	$ 60,000	$ -
Total	**$ 120,000**	**100%**	**0%**	**$ 120,000**	**$ -**

future storm drain facilities; utility conflicts; permitting requirements; economic climate; inflation costs; means and methods of construction; etc. Prior to design, a detailed hydrologic and hydraulic analysis should be developed to identify the final pipe size, flow rate, and slope of the proposed storm drain pipe. A pre-design report that documents the pipe sizes, flow rates, models results, detailed cost estimate, and addresses other pertinent design questions should also be developed prior to design and construction.

CHAPTER 6
SYSTEM RENEWAL

In addition to the capacity related improvements described in previous chapters, it is recommended that Spanish Fork City consider and prepare for expected future expenditures associated with the general maintenance and renewal of the existing storm drainage system. The purpose of this chapter is to present recommendations regarding system maintenance and renewal. This is not a comprehensive evaluation of existing maintenance procedures or system conditions, nor is it a complete asset management plan. Instead, it is a collection of general recommendations developed and assembled during the master planning process relative to system maintenance and renewal.

SYSTEM RENEWAL

Along with system capacity improvements, effective infrastructure planning must also include asset rehabilitation and replacement, commonly termed renewal. To effectively identify which system facilities need replacement and plan for future asset renewal projects, Spanish Fork City needs to accurately assess and document the current condition of system assets. Towards this goal, BC&A would recommend improvements to its data collection and storage practices regarding system facilities and how the condition of existing facilities is assessed.

City personnel should inspect all pipes about once every 10 years. This will require City personnel to inspect at least 10 percent of the City's storm drainage system every year and will require the city to provide sufficient inspection frequency to identify most pipe deterioration issues before they become problems. In some cases, however, groundwater, vegetation, and/or sediment concerns may merit more frequent inspection. When possible, inspections should be conducted during, and immediately after, major precipitation events to assess conditions.

SYSTEM RENEWAL BUDGET

The total cost to replace all of the pipes in the Spanish Fork Collection system would be approximately $60 million based on 2016 construction costs. For the purposes of this evaluation, BC&A recommends that Spanish Fork assume a 100-year system service life. To replace 1 percent of the collection system every year (or 100 percent every 100-years), it would cost approximately $600,000/year in 2016 dollars.

CFP-A - MASTER PLAN UPDATES

This report, the associated recommendations, and the Capital Facilities Plan should be updated about every 6 years, or more frequently, depending on how and where the City has developed and proposed or adopted zoning or land use changes. We would also recommend the existing conditions model be updated on an ongoing basis, as development occurs in Spanish Fork City. Regular updates to the model will allow the City to analyze the impact of development on the City's storm water facilities. The costs associated with updates to this report, model updates, and other analyzes associated with this report are anticipated by Spanish Fork City to be about $15,000 per year.

APPENDIX A
AREAS OF FREQUENT FLOODING

Sump Problems

1- 1100 East 800 South
2- 1400 East 500 South
3- 1560 East 850 South
4- 820 East Canyon Rd.
5- 2600 East 1420 South
6- 2250 East SR-6
7- 470 West Center St.
8- Sterling Drive
9- Nebo Drive
10- Flonette Drive

Heavy/Extended Rainfall Checklist

This list is of all problem areas in town that need regular attention during rain storms.

The order is prioritized by flood potential and then geographical from Southeast to Northwest

Areas to check during storms when on call

Potential Flood Areas

1. Ditch head on **400 E** and **200 N** (SE corner) is a priority. When it is clogged the SE corner house usually floods.
2. Ditch head on **500 E 200 N** (SW corner) may plug. If plugged, water runs down sidewalk and adds to the problem listed above.
3. Ditch at **180 S 200 E**. This ditch is somewhat flat and floods easy. If there is any blockage in the ditch it will back up over the homeowners old irrigation ditch and floods their basement. Blockage usually occurs under the driveway of the house to the north or @ the ditch head on the SW corner of **100 S 200 E**.
4. Ditch **200 East 300 South** needs to be checked. The house on the corner floods if it is plugged.
5. Ditch head on **100 W 100 N** (SE corner) gets clogged and floods Bar and Stogies Parking Lot.
6. Ditch head on **100 W 400 N** gets clogged and floods the SW corner house.

Other Problem areas

1. Storm Grates on Approximately **970 E 100 S**, and **900 E 100 S**
   - These two boxes connect through the block and can cause problems & flooding.
2. Ditches on **700, 600, 500, and 400 E** from **Canyon Road to 800 N**
3. Ditches on **100 E from 300 N to 800 N**
   - Ditch is somewhat flat and floods easily
4. Ditches on **Main St. from Center to 1000 N.**
5. Ditches on **100 W from Center to 500 N.**
6. Ditches on **300 W from Center to 800 N.**
   - Inlets connect into west field canal.
   - If there are problems with canal overflowing call Roy Monk (801-361-8965)
7. Ditches on **400 N from 400 E to 900 E**
8. Ditches on **800 N from Main St. to 800 East**
9. Grate on **1000 N between Cal Ranch and USPS**
10. Grates on **Scenic Drive** behind the cemetery

Areas that may need Jet for flood problems

1. **460 W Center St**
    - Sump fills up and floods street
    - Consider using a trash pump to pump north across center instead of using jet truck.
2. **800 S 1150 E**
    - Sump fills and floods corner house
3. **850 S 1560 E** (east side)
    - Sump may overflow
    - We've connected it to the sump across the street which should prevent some of the flooding but it still overflows with extended/heavy rainfall.
4. **850 S 2550 E** (East side)
    - Sump overflows and floods intersection of **2550 East and U. S. 6**
5. Rail Road Crossing on **400 N and 1300 E**
    - Floods over rail road tracks sometimes

If there is a heavy storm the mill race needs to be checked. We are responsible to clean the two grates in the fairgrounds and the grate at river bottoms Rd and Bradford Lane (300 East). If it is overflowing and the grates are clean, call Roy Monk (801-361-8965) and follow the flow.

Also check the detention/retention ponds in town to make sure they are ok. The only one known to cause a lot of flooding is the Jex detention pond located at **600 South and 1150 East**. It may flood the street.

If other problems are found, write down the address and a description of the problem and turn it in to Brett so it can be added to the list.

This list will be updated as problems may be fixed or as new ones arise.

This List will also be included in the Storm Drain SOPs.

APPENDIX B
DRAINAGE MANUAL REPORT

STORM WATER DRAINAGE DESIGN MANUAL

Prepared for:

City of Spanish Fork
40 South Main Street
Spanish Fork, UT 84660

Prepared by

Bowen, Collins & Associates
154 East 14000 South
Draper, UT 84020

October 2016

CITY OF SPANISH FORK STORM WATER DRAINAGE DESIGN MANUAL

October 2016

PROFESSIONAL ENGINEER
8280086
KAMERON D.
BALLENTINE
10/27/16
STATE OF UTAH

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TABLES

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SECTION 1
PURPOSE

This manual has been prepared to document the approval process, design standards and regulations, hydrologic and hydraulic computation methods for evaluating and designing storm drain and flood control facilities in the City of Spanish Fork (City). The objective of this manual is to ensure that drainage planning and facility design for small areas and local developments within the City are consistent with the City's Storm Drain Master Plan. All drainage projects shall conform to requirements in this Storm Water Drainage Design Manual, the City's Storm Drain Master Plan, and shall be approved by City Engineer.

SECTION 2
APPROVAL PROCEDURE

2.1 INTRODUCTION

The following procedures shall be followed for evaluating the need for and designing storm water facilities.

2.2 CONCEPTUAL DRAINAGE PLAN

A Conceptual Drainage Plan and Report is required for all multi-lot developments and single lot developments larger than 0.5 acres. The report shall contain the following information:

1. General description of the development, including location (township, range, section, subdivision and lot).

2. General description of property, area, existing site conditions including all existing drainage facilities such as ditches, canals, washes, swales structures, storm drains, springs, detention and retention basins, and any proposed modifications to drainage facilities.

3. General description of off-site drainage features and characteristics upstream and downstream of the site and any known drainage problems.

4. General description of existing and proposed on-site drainage features, characteristics and facilities.

5. General description of the proposed facilities that will be used to manage on-site and off-site storm water runoff associated with the development.

6. General description of master planned drainage facilities and proposed drainage features and how the development and proposed drainage facilities conform to the storm drain master plan.

7. Preliminary Drainage Calculations if required by the City Engineer. See Section 4 for design criteria.

8. Estimate of minimum depth to groundwater level on the site.

One or more drawings shall also be submitted. The drawing(s) shall include:

1. Existing and proposed property lines.

2. Existing and proposed topography (2-foot maximum contour interval) extending at least 100 feet beyond the site.

3. Existing and proposed streets, easements, and rights-of-way.

4. Existing drainage and irrigation facilities.

5. FEMA floodplain and floodway.

6. Required setbacks for structures from the nearest top bank of the Spanish Fork River, if applicable.

7. Drainage basin boundaries and subbasin boundaries on a topographical map.

8. Existing flow patterns and paths.

9. Proposed flow patterns and paths.

10. Location of proposed drainage facilities including: storm drain pipes, inlets, manholes, cleanouts, swales, channels, and retention and detention basins.

11. Location of drainage easements required.

12. Other relevant drainage features

13. Scale, north arrow, legend, title block showing project name, date, preparers name, seal and signature.

The Conceptual Drainage Plan shall be submitted to the City for review and approval prior to the development of the Final Drainage Design Plan and Report.

2.3 FINAL DRAINAGE PLAN AND REPORT

A final Drainage Plan and Report is required for all proposed developments and shall be prepared by a professional civil engineer registered in the State of Utah. The report portion of the Drainage Plan and Report shall contain the following:

1. Title page showing project name, date, preparer's name, seal and signature.

2. Description of the development, including location (township, range, section, subdivision and lot).

3. Description of property, area, existing site conditions including all existing drainage facilities such as ditches, canals, washes, swales structures, storm drains, springs, detention and retention basins.

4. Description of off-site drainage features and characteristics upstream and downstream of the site and any known drainage problems.

5. A description of proposed facilities that will be used to manage on-site and off-site storm water runoff associated with the development, including calculations used to estimate runoff and size storm water facilities. See Section 4 for design criteria and Section 5 for approved rainfall-runoff computation methods.

6. Description of existing and proposed on-site drainage features, characteristics and facilities.

7. Description of master planned drainage facilities and how the development and proposed drainage facilities conform to the storm drain master plan.

8. Description of downstream receiving facilities for storm water discharges and the capacities of those facilities. Include calculations.

9. Description of existing FEMA floodplain, if applicable.

10. Description of other drainage studies that affect the site.

11. Preliminary drawings of proposed drainage facilities that also show existing storm drain facilities on or adjacent to the site.

12. Description of compliance with applicable flood control requirements and FEMA requirements, if applicable.

13. Description of design runoff computations. See Section 5 for approved rainfall-runoff computation methods.

14. Design calculations to support inlet spacing and sizing of facilities. Include a description of drainage facility design computations. See Section 4 for design criteria.

15. Description of any needed drainage easements or rights-of-way.

16. Description of FEMA floodway and floodplain calculations if applicable.

17. Description of field work performed to estimate minimum depth to groundwater at the site.

18. Conclusions stating compliance with drainage requirements and opinion of effectiveness of proposed drainage facilities and accuracy of calculations. See Section 4 for design criteria.

19. Appendices showing all applicable reference information.

One or more 22-inch by 34-inch drawings shall be submitted with the Drainage Plan and Report and shall include the following information if applicable.

1. Existing and proposed property lines.

2. Existing and proposed topography (2-foot maximum contour interval) extending at least 100 feet beyond the site.

3. Existing and proposed streets, easements, and rights-of-way.

4. Existing drainage and irrigation facilities.

5. FEMA floodplain and floodway.

6. Required setbacks for structures from the nearest top bank of the Spanish Fork River, if applicable.

7. Drainage basin boundaries and subbasin boundaries on a topographical map.

8. Existing flow patterns and paths.

9. Proposed flow patterns and paths.

10. Location and size of proposed drainage facilities including: storm drain pipes, inlets, manholes, cleanouts, swales, channels, and retention and detention basins. Include spot elevations of proposed grade, flowline and top, back curb.

11. Details of proposed storm drain facilities, including storm drain inlets. Include maintenance and monitoring plan for storage facilities.

12. Details of proposed improvements to existing irrigation facilities and any facilities to be used to manage high groundwater conditions on the site.

13. Location of drainage easements required.

14. Other relevant drainage features.

15. Scale, north arrow, legend, title block showing project name, date, preparers name, seal and signature.

SECTION 3
LOW IMPACT DEVELOPMENT

The MS4 permit for Spanish Fork City requires the following: "For new development or redevelopment projects that disturb greater than or equal to one acre, the program shall include a process which requires the evaluation of a Low Impact Development (LID) approach which encourages the implementation of BMPs that infiltrate, evapotranspire or harvest and use storm water from the site to protect water quality" (Small MS4 General Permit No. UTR090000). As Spanish Fork City continues to develop and redevelop, LID practices will need to be implemented to comply with State and Federal regulations.

3.1 WHAT IS LID?

LID is a comprehensive approach to micromanaging storm water where it is generated. The goal of LID is to develop a storm water management strategy where post-development hydrologic conditions mimic pre-development conditions through utilizing storm water features that infiltrate and evapotranspirate in a cost-effective, flexible manner. It also involves protecting water quality by treating and filtering storm water near the source, before it infiltrates into the ground.

LID practices focus on preventing flooding, erosion, and pollution by utilizing natural processes to filter, treat, and allow storm water to infiltrate into the ground. It typically preserves, restores, and creates green infrastructure using soils and vegetation. By implementing LID principles and practices, water can be managed in a way that reduces negative environmental impacts often associated with developed areas and promotes the natural movement of water within the area.

LID strategies include several techniques to generate less runoff from developed land. LID practices are flexible, offering a wide variety of techniques to reduce runoff timing and volume. LID practices control storm water runoff at the lot level, using a series of integrated strategies that rely on natural processes. LID principles:

- preserve and recreate natural landscape features
- minimize directly-connected impervious area
- comprehensive, landscape-based approached to sustainable development
- utilize natural hydrologic functions and processes
- focus on prevention, rather than mitigation
- emphasize simple, low-tech, low cost methods
- manage storm water runoff as close to the source as possible
- minimize disturbance
- increase drainage flow paths
- utilize onsite filtering and treatment methods

3.2 POTENTIAL LID FEATURES AND PRACTICES

There are many practices that can be utilized when implementing LID principles. Some are listed below.

Xeriscape Swale/Grassy Swale – A swale landscaped with xeriscape plants or grass can be used to infiltrate storm water in place. Curb cuts along roads can be used to discharge storm water runoff generated in paved streets and parking lots into the swale.

Underground Storage Tanks – Underground storage can include R-tanks, StormTech systems, or other underground storage facilities that are designed to detain or retain storm water runoff and allow it to infiltrate into the ground. Underground storage facilities should have an overflow to a centralized storm drain system. Treatment should be included on any underground storage facility. See Section 4.10 for treatment criteria.

Rain Barrels – Some runoff can be captured in rain barrels and utilized for non-potable purposes. It is important to keep in mind that in Utah, only 2500 gallons per parcel of rain water runoff is allowed to be collected and stored onsite.

Roof Drains – Roof drains should be connected to grassy/xeriscape areas or underground facilities, such as infiltration trenches or dry wells. Infiltration trenches or dry wells consist of perforated manholes and pipe surrounded by gravel and a geotextile fabric. The purpose of the infiltration trench or dry well is to store water and allow it to percolate into the ground. It is important that the roof runoff be treated prior to infiltrating into the ground.

Grass Filter Strips – Grass Filter Strips are low-angled vegetated slopes that drain away from the parking lot or roadway.

Bioretention – Biorentention includes the use of vegetation and soils to clean storm water runoff in an earthen basin lined with plants and mulch.

Permeable Pavement – Permeable pavement could include grass pavers, paving stones, porous asphalt, or pervious concrete. It can be used on parking stalls, overflow parking, driveways, walkways and plazas.

Soil Amendments – In areas where native soils have low infiltration rates, the native soils can be amended by mixing in organics or other materials to increase infiltration capacity. Soil amendments can also improve water quality, depending on the materials added. It is important that the soil is not compacted during construction.

Preserve Vegetation – The natural vegetation of an area to be developed should be preserved by reducing the total impervious area for a site by clustering buildings close together, reducing building footprints, reducing road widths, and other methods to preserve as much of the native vegetation as is feasible for a given site.

Storm Water Planters – Storm water planters are boxes with drought resistant vegetation that are used to capture storm water runoff from roofs and other impervious surfaces. They function like bioretention on a small scale.

The concepts listed above do not represent all the approaches for implementing LID. Ultimately, the developer and their engineer are responsible to research the most effective methods for implementing LID practices on a development site. Additional resources to research, plan and design LID are listed below:

MacAdams, James. Green Infrastructure for Southwestern Neighborhoods. (Oct 2012) Watershed Management Group. EPA Website.
https://www.epa.gov/green-infrastructure/green-infrastructure-design-and-implementation

Dorman, T., M. Frey, J. Wright, B. Wardynski, J. Smith, B. Tucker, J. Riverson, A. Teague, and K. Bishop. 2013. San Antonio River Basin Low Impact Development Technical Design Guidance Manual, v1. San Antonio River Authority. San Antonio, TX.
https://www.epa.gov/green-infrastructure/green-infrastructure-design-and-implementation

Environmental Protection Agency. (April 2009) Managing Stormwater with Low Impact Development Practices: Addressing Barriers to LID. EPA 901-F-09-003.
https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/AddressingBarrier2LID.pdf

Environmental Protection Agency. (1995, November). Pollution Control Programs for Roads, Highways and Bridges. (EPA-841-F-95-008c). Office of Water. Washington, DC: Environmental Protection Agency.
http://www.epa.gov/owow/nps/education/control.html

Environmental Protection Agency. (2008, March 7). NPS Categories | Roads, Highways and Bridges | Polluted Runoff (Nonpoint Source Pollution) | US EPA.
http://www.epa.gov/owow/nps/roadshwys.html

Spanish Fork City. Low Impact Development. (Dec 2013). Project Engineering Consultants.
http://www.spanishfork.org/dept/pubworks/utilities/storm/pdf/Low_Impact_Development_Report.pdf

National Cooperative Highway Research Program. Evaluation Of Best Management Practices For Highway Runoff Control. Low Impact Development Design Manual for Highway Runoff Control. (2006)
http://www.coralreef.gov/transportation/evalbmp.pdf

3.3 IMPLEMENTING LID PRACTICES

All development and redevelopment in Spanish Fork City is required to consider an LID approach for managing storm water. The planning and design process are critical for the successful implementation of LID. Below are the criteria to consider during the planning and design process.

3.3.1 PLANNING

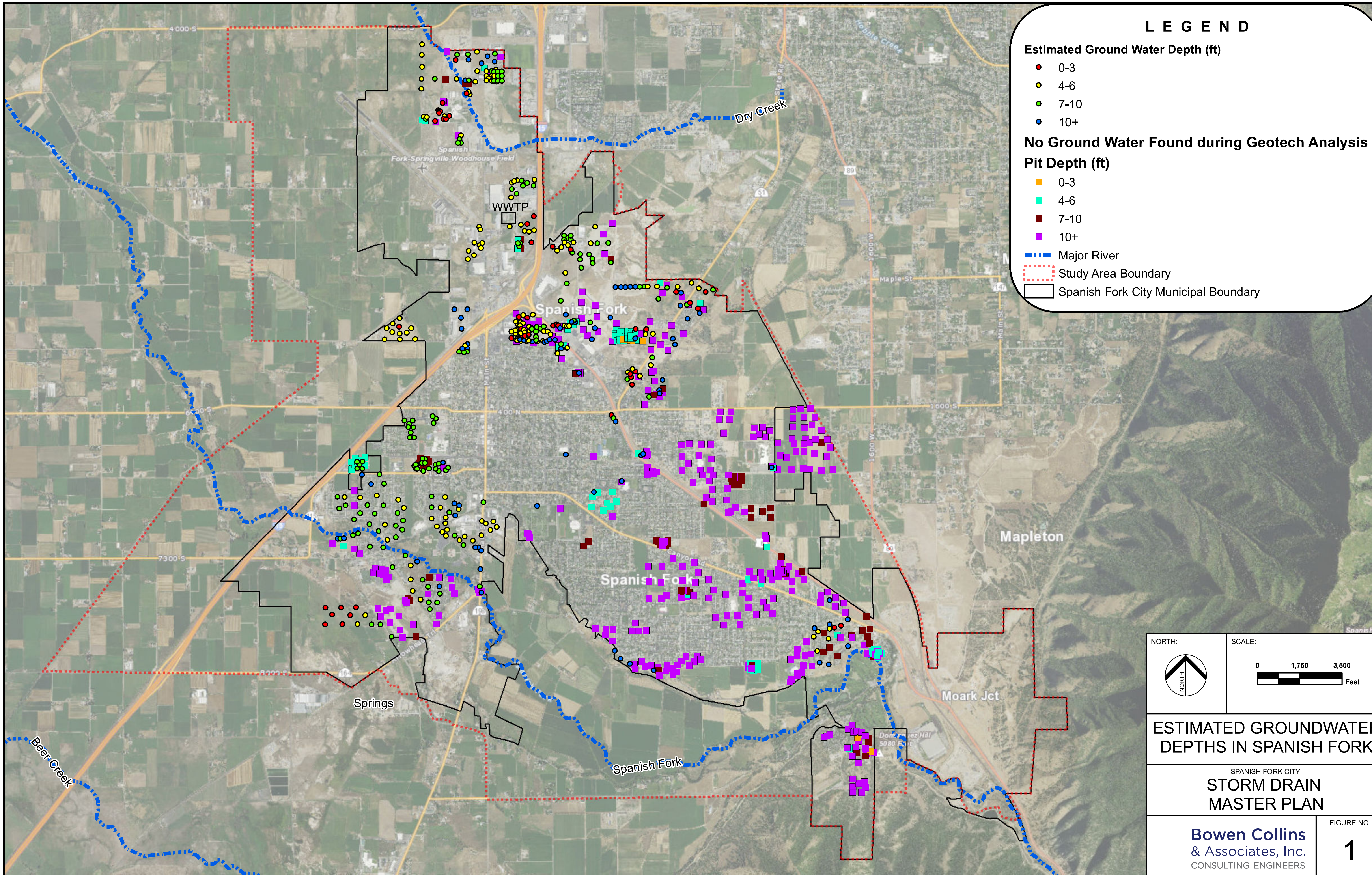
As part of the Drainage Plan Report (see Section 2.2), the following criteria will need to be addressed.

LID Feasibly - All plans for LID facilities will need to be approved by the City prior to design. During the planning process, groundwater levels, and source protection zones, and other concerns with subsurface conditions need to be considered. Site conditions such as collapsible soils, low percolation rates, wetlands, and high groundwater levels will limit the types of LID facilities that can be used. We encourage the developer and his engineer to be creative in developing innovative means to implement LID. If the developer believes that LID facilities cannot be utilized on their particular site, documentation will need to submitted and approved by the City explaining the reasons why LID cannot be utilized. The documentation must illustrate that infiltration, evapotranspiration and rainwater harvesting has been used to the maximum extent technically feasible and that full employment of LID facilities are not feasible due to site constraints.

Geotechnical Analysis - In an effort to locate areas with high groundwater and low percolation rates around the City, several dozen geotechnical reports from local developments were reviewed to obtain recorded groundwater level and percolation rate information. A database of the complied information was developed and indexed on a map of the City. Figures 1, 2 and 3 show general groundwater levels and percolation rates from the geotechnical reports on file for sites throughout the City. The data on the figures should only be used as an initial analysis of subsurface conditions. Prior to proceeding with design, soils testing and an associated soils report need to be completed and submitted to the City to document subsurface conditions at each individual site. The geotechnical report must include (at a minimum) percolation rates, groundwater levels, and soil type (including whether the soils are collapsible). The geotechnical report is usually added to the Drainage Report as an appendix.

Source Protection Zones - Some LID practices may not be appropriate in Zone 1 water source protection areas (Zone 1 Areas) because they require infiltration. Zone 1 Areas are defined as the "area within a 100-foot radius from the wellhead or margin of the collection area." (Utah State Code (R309-600-9)(2)(a)(i)). LID practices may be implemented in Zones 2, 3, and 4 water source protection areas (Zones 2, 3 and 4). However, LID facilities in Zones 2, 3, and 4 may require additional treatment at the discretion of the City. Figure 4 shows the drinking Water Source Protection areas in Spanish Fork City.

Hydrologic Calculations - During the planning process, hydrologic calculations of pre-development conditions, that includes the peak storm water runoff rate and volume needs to be completed. Post-development hydrologic calculations also need to be completed. The peak runoff rate and volume from pre-development and post-development calculations need to be similar, as one of the goals of LID is for post-development hydrologic conditions to closely mimic pre-development conditions. See Section 5 for acceptable criteria for hydrologic evaluations.



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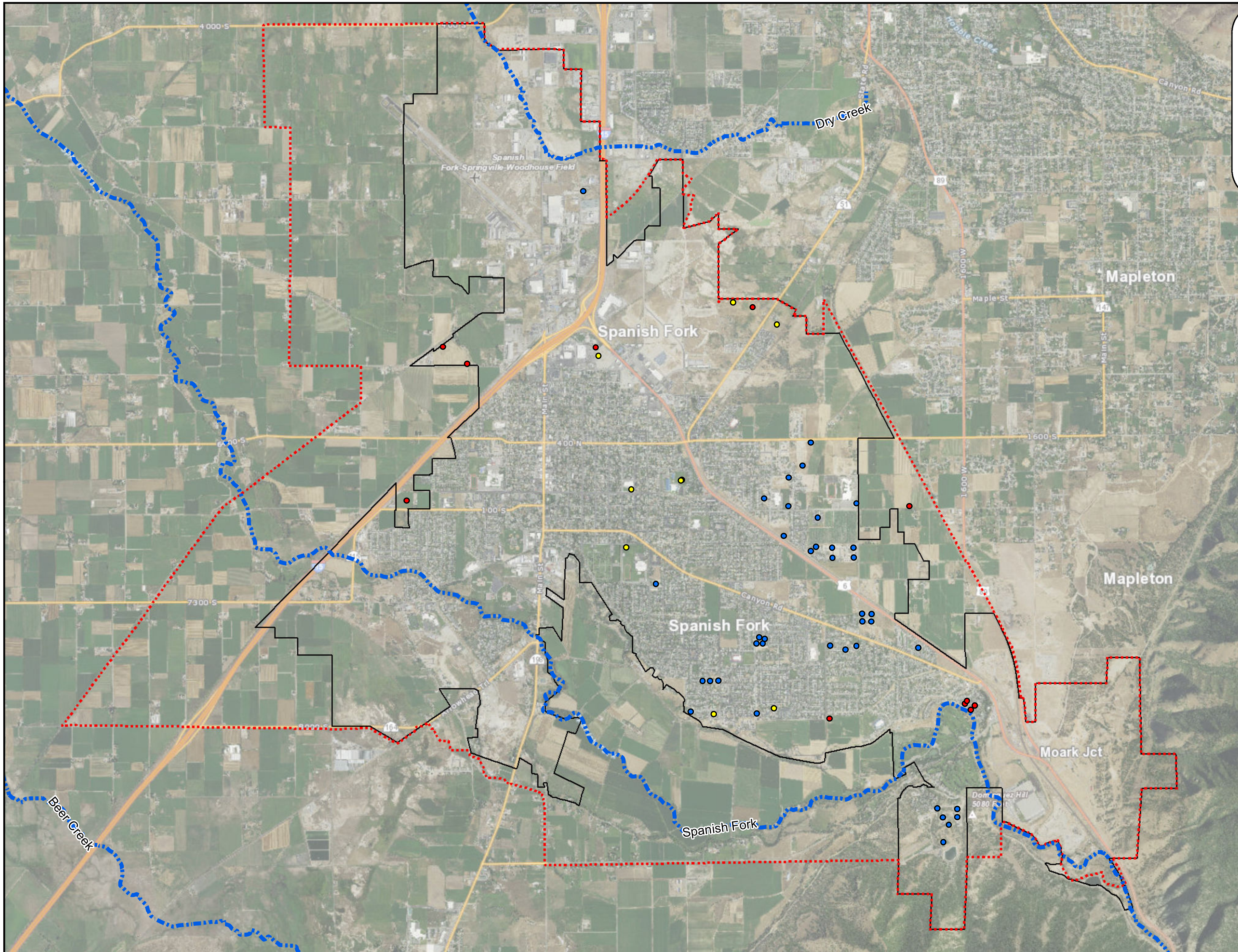

ESTIMATED PERCOLATION RATES IN SPANISH FORK

SPANISH FORK CITY
STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO. 2

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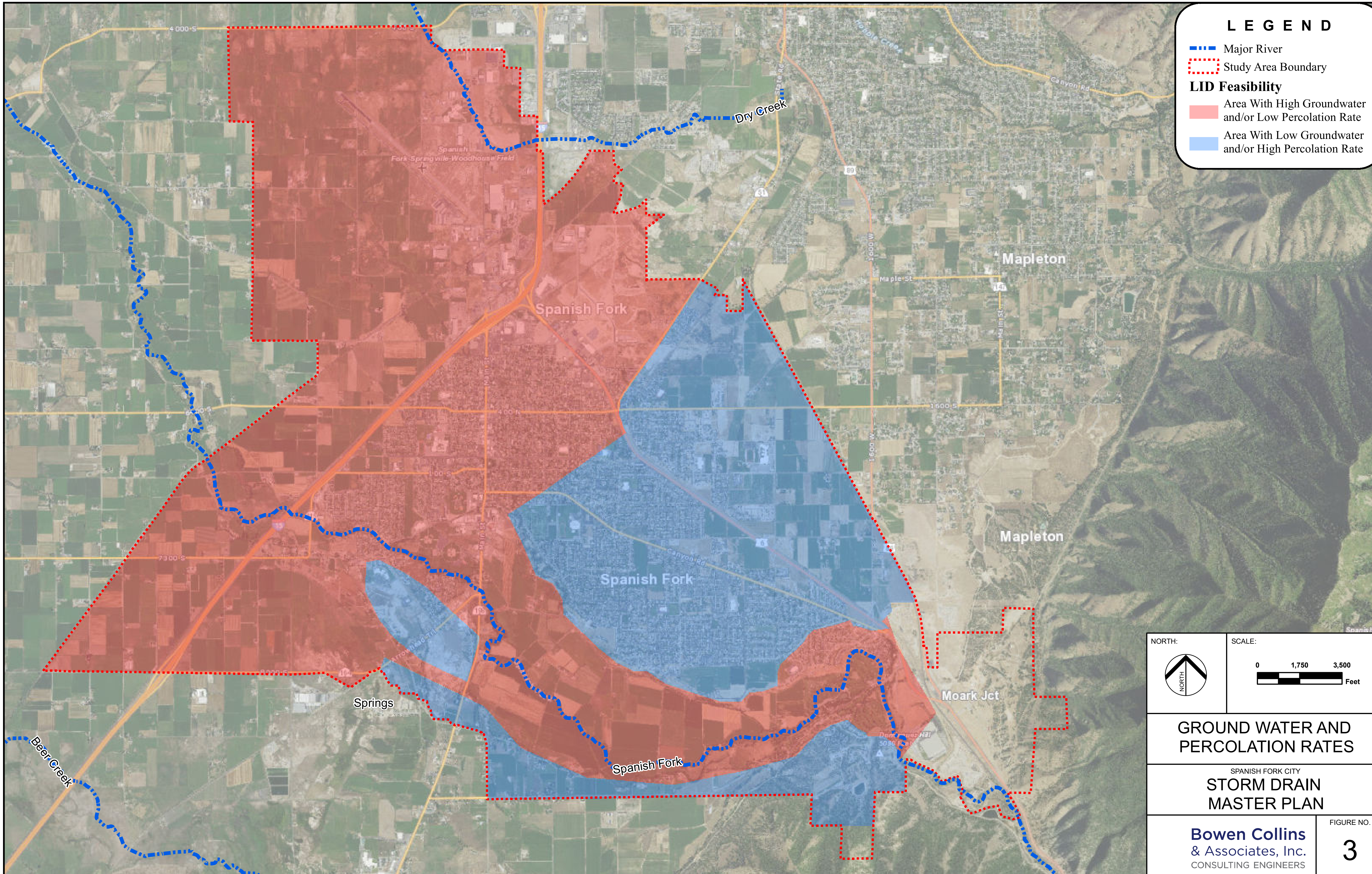

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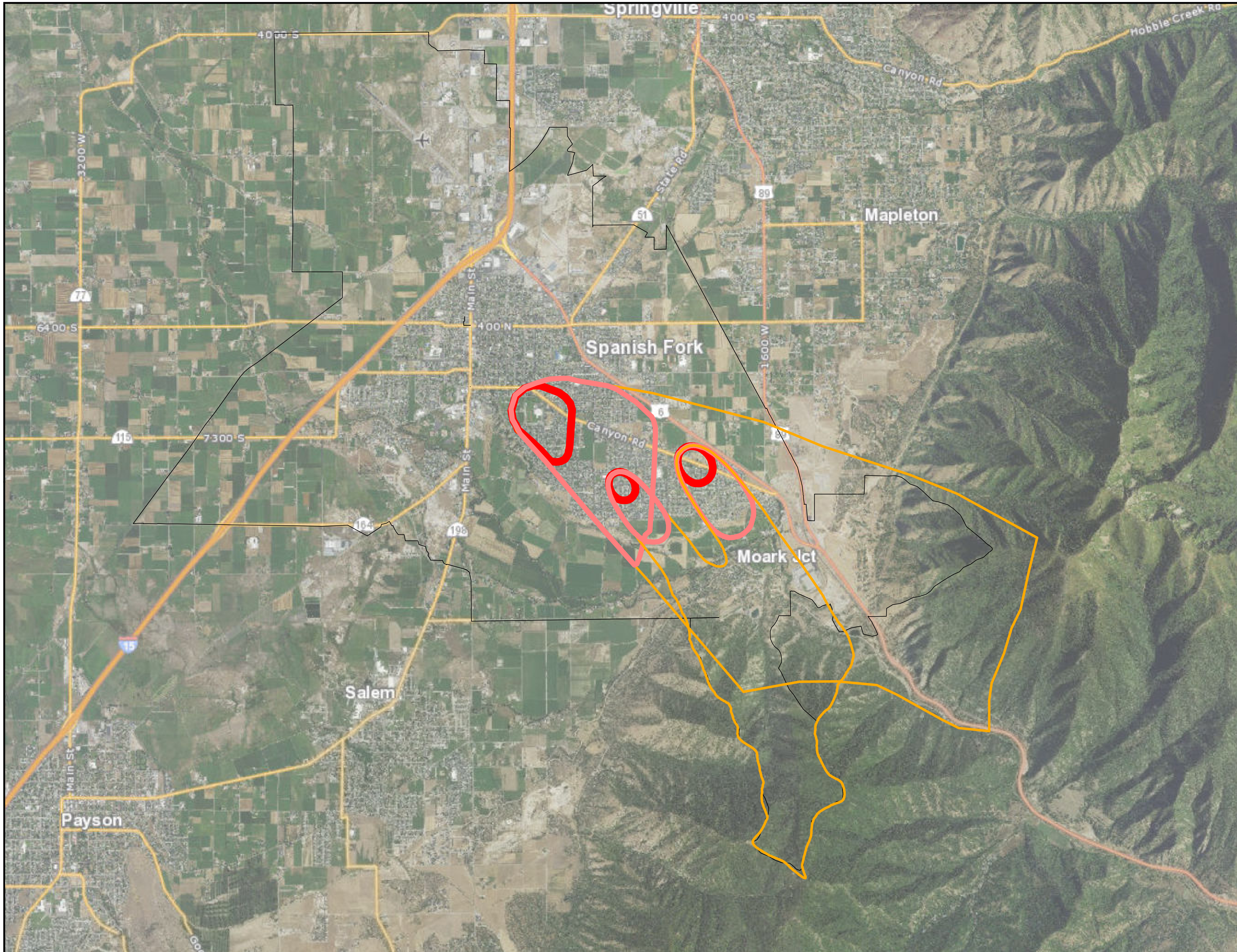

SOURCE PROTECTION ZONES

SPANISH FORK CITY
STORM DRAIN DESIGN MANUAL

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO. 4

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3.3.2 ONSITE RETENTION REQUIREMENT

The EPA requires that each state adopt an ordinance that requires developments to retain storm water onsite. The State Division of Water Quality is planning to adopt an ordinance that requires developments to retain 90th percentile storm event on site. To prepare for that change, and to further encourage the use of LID, it is required that any new development or redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, must collect and retain storm water runoff from the 90th percentile storm onsite.

In order to calculate the 90th percentile storm the following steps were taken:

1.) Download data from Utah Climate Center Website (https://climate.usurf.usu.edu/mapGUI/mapGUI.php)
   a.) Data must consist of a minimum of 30-years of data. The gage selected for this report was the BYU Campus.
2.) Delete time steps having less than 0.1 inches of rainfall.
3.) Delete time steps where precipitation came in the form of snowfall.
4.) Calculate the rank of each precipitation event.
5.) Calculate the exceedance probability percentile using the following equation:
   Exceedance Probability = Rank/(Total # of Values +1)
6.) Calculate the depth of the 90th percentile storm.

Following these steps, the 90th percentile storm has been estimated to be 0.67 inches in Spanish Fork City. Retention of storm water must be accomplished by the use of LID practices, as described in previous sections of this report. If meeting the retention standard is technically infeasible, documentation shall be provided on a case by case basis for the use of alternative design criteria. The documentation must illustrate that infiltration, evapotranspiration and rainwater harvesting have been used to the maximum extent technically feasible and that full employment of LID facilities are infeasible due to site constraints.

3.5 DESIGN

Design of LID facilities should include the following:

- **Design Storm** – LID facilities in the City should be designed to accommodate, at a minimum, the peak runoff rate and volume generated from a 25-year storm (see Section 4 – Design storm). Calculations will need to be completed and submitted to the City documenting the design parameters of the LID facilities.
- **Retention** – Onsite retention of the 90th percentile storm is required, which has been estimated to be 0.67 inches in Spanish Fork City.
- **Overflow** - LID facilities need to have an overflow that connects to a centralized storm drain system for larger storm events.
- **Treatment** – Underground storage and infiltration facilities need to include treatment as defined in Section 4.10.
- **Inventory** – All LID facilities should be inventoried by the City to be included in their GIS database.

Generally, Above-ground LID facilities will be owned and maintained by the property owner, unless the City agrees otherwise. Underground storage and infiltration facilities should be maintained by City personnel, after construction has been completed and approved by the City. Underground retention/detention infiltration facilities will need to be designed in a way that allows the City to access and maintain them.

SECTION 4
DESIGN STANDARDS AND REGULATIONS FOR STORM DRAIN FACILITIES

4.1 DESIGN STORM

4.1.1 FREQUENCY

Storm drain facilities shall be designed to include major and minor conveyance facilities and storage facilities as described below:

Minor System

Minor system facilities shall be designed to collect and convey storm water runoff from a storm with a return frequency of 10 years. Minor system facilities include local catch basins, storm drain pipes and manholes.

Major System

Major system facilities shall be designed to collect and convey storm water runoff from a storm with a return frequency of 100 years. Major system facilities include:

- Streets
- Storm drain pipes to regional facilities
- Open Channels
- Culverts and Bridges

Storage Facilities

Detention basins shall be designed to detain runoff from a storm with a return frequency of 25 years. Retention basins shall be designed to retain runoff from a storm with a return frequency of 100 years.

4.1.2 DEPTH AND INTENSITY

Rainfall depth and intensity shall be obtained from the National Weather Service's Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/ut_pfds.html) using the annual maximum time series option. Appendix A contains a depth-duration-frequency and an intensity-duration-frequency table for the Spanish Fork Power House.

4.1.3 DISTRIBUTION AND DURATION

In order to evaluate and design storm drain conveyance facilities (i.e. pipes, culverts), the 3-hour synthetic storm durations shall be evaluated.

In order to evaluate and design storm drain storage facilities (i.e. detention and retention basins), the 3-, 6- and 24-hour synthetic storm durations shall be evaluated. The maximum peak volume from these three storm durations shall be used to evaluate and design the storage facility.

Storm distributions for the 3-, 6- and 24-hour storms are provided in Appendix B.

4.2 POST-CONSTRUCTION PEAK DISCHARGE

Post-construction peak discharges for the design recurrence interval (see Section 4.1.1) shall not be greater than 0.15 cfs per acre, unless the subject property is located in an area identified on the Storm Drain Master Plan where undetained discharge is allowed. LID practices and facilities may also be used to limit discharge peaks, as discussed in section 4 of this manual.

4.3 STORAGE FACILITIES

All above ground storage facilities shall be designed according to the following criteria:

1. A minimum of 1 foot of freeboard shall be provided.
2. Maximum side slope is 4H:1V.
3. Provide a plan to maintain and monitor the facility.
4. Provide vehicular access to the facility.
5. All facilities shall be landscaped in accordance with City Standards.
6. Design an emergency overflow spillway to safely discharge runoff from the facility assuming the outlet is inoperable or the inflow exceeds the outlet capacity.
7. The storage facility maximum depth shall be approved by the City Engineer.

4.3.1 RETENTION BASINS

The use of retention basins will only be allowed under the following conditions as approved by the City Engineer, or his designee.

1. Retained water for the design recurrence interval (see Section 4.1.1) and duration (see Section 4.1.3) must drain completely within 48 hours of the end of the storm event.
2. All retention basins shall be constructed for drainage areas designated in the general plan. Retention basin for smaller areas may be allowed only with prior written approval of the City Engineer or his/her designee.

4.3.2 DETENTION BASINS

1. The minimum area of the discharge orifice is 6 square inches.
2. Detained water for the design recurrence interval (see Section 4.1.1) and duration (see Section 4.1.3) must drain completely within 12 hours of the end of the storm event.
3. Detention basins may be constructed in landscape or parking areas. Maximum depth of water is 6 inches deep in commercial parking lots and 8 inches deep in industrial parking lots.
4. Each detention basin shall have an outlet to the City storm drain system. A trash rack shall be installed at the outlet(s) to prevent debris from entering the storm drain system.

4.4 Underground LID/Storage

LID facilities that are designed to infiltrate storm water into the ground may be underground storage facilities. The underground facilities should be designed according to the following criteria:

1. Provide a plan to maintain and monitor the facility.

2. Underground facilities will need to be designed to retain, at a minimum, 0.67 inches of storm water runoff. They will also need to be designed to drain in less than 48 hours, unless approved by the City. It is important to remember that if the underground facilities only retain 0.67 inches, the additional runoff from the design storm event will need to be managed using other LID practices.

3. The underground storage facility will need to be connected to a storm drain trunkline as an overflow. An adjustable gate will need to be installed on the overflow that can be used in times of emergency or as prescribed by the city.

4. Treatment will need to be included prior to discharging to the underground storage/infiltration facilities. Treatment will need to meet the criteria defined in section 4.10.

4.5 PIPELINES

1. Storm drain pipelines shall be located within the street right-of-way or a dedicated easement.

2. Storm drain pipelines shall be designed to convey the design discharge (see Section 4.1.1) under full pipe capacity, but with no surcharging.

3. The minimum allowable pipe diameter is 15 inches.

4. Acceptable pipe materials include: reinforced concrete, nonreinforced concrete, and HDPE.

4.6 INLETS AND OUTLETS

A concrete apron shall be constructed around inlets to allow sediment to be easily cleaned up.

Storm drain pipe that discharges to an earth-lined channel shall be stabilized to mitigate erosion potential.

4.7 MANHOLES AND CLEANOUT STRUCTURES

1. A Manhole or cleanout structure shall be located at the upstream end of the storm drain pipe and at all changes in pipe size, horizontal alignment, slope and material of the storm sewer.

2. Maximum horizontal distance between manholes is 500 feet.

4.8 ROADWAY DRAINAGE

1. Roads must provide for routing of the 100-year flood discharge to adequate downstream conveyance facilities.

2. The 100-year flood flows in streets should be contained within street right-of-way.

3. Provision shall be made to allow runoff within the street to enter any downstream detention basins or other such facilities.

4. Downhill cul-de-sacs and dead ends will not be allowed unless specifically approved by the City Engineer.

5. Special consideration shall be given to downhill “T’ intersections to ensure that flooding will not occur outside of the right-of-way.

4.9 INLETS

1. Storm drain catch basins or inlets shall generally be located on both sides of the street.

2. Inlet spacing and configuration shall be designed to collect runoff from a 10-year design storm.

3. Inlet spacing shall also be designed to meet the design spread requirements from the FHA Urban Drainage Manual as shown in Table 4-1.

4. As a general rule, inlets shall be installed at intervals not to exceed 500 feet. Inlet spacing shall be addressed during the design phase.

Table 4-1
Design Gutter Spread

Street Classification	Design Frequency	Design Gutter Spread
High Volume		
< 45 MPH	10-Year	Shoulder plus 3 feet
> 45 MPH	10-Year	Shoulder
Sag Point	50-Year	Shoulder plus 3 feet
Collector		
< 45 MPH	10-Year	½ Driving Lane
> 45 MPH	10-Year	Shoulder
Sag Point	10-Year	½ Driving Lane
Local Streets	10-Year	½ Driving Lane

4.10 STORM WATER TREATMENT

1. Storm water treatment for oil, grease and other pollutants shall be provided at all sites with more than 6 parking spaces.

2. Engineer design and calculations shall be submitted showing the effectiveness of the treatment.

3. Provide a maintenance plan for the storm water treatment facility.

4.11 CULVERTS

1. The minimum culvert size is 24 inches.

2. Culverts shall be designed to convey the 100-year flood event without overtopping the road.

3. A culvert blockage factor of 50 percent shall be used for culverts placed in drainages with upstream debris producing potential as determined by the City.

4. Backwater surface computations upstream of culverts shall be performed and shown to be non-damaging to upstream properties.

5. Improvements must be installed at entrance and exit structures to minimize erosion and accommodate maintenance.

4.12 BRIDGES

1. Bridges must pass the 100-year flood event with a minimum of 2 feet of freeboard.

2. Local and regional scour analyses shall be performed on the structure, upstream and downstream. All potential scour shall be properly mitigated.

4.13 OPEN CHANNELS

Open channels shall be designed to meeting the following criteria:

1. Convey the 100-year flood event with a minimum freeboard of 1 foot.

2. Have low maintenance requirements.

3. Provide maintenance access through easements the entire channel length

4. Sideslope of 2H:1V or flatter.

5. Bank stabilization shall be designed to minimize erosion and maintenance.

6. Irrigation ditches located in areas of new development shall be enclosed (pipe or culvert).

4.14 FLOODPLAINS

Development near the Spanish Fork River shall be in accordance with the National Flood Insurance Program and the City's Flood Damage Ordinance floodplain ordinance. A copy of the City's Flood Damage Ordinance is provided in Appendix E.

The Flood Damage Ordinance requires, among other things:

1. A bank stability/erosion hazard analysis shall be performed by a licensed professional engineer (15.4.20.030 C.5).

2. A geotechnical report shall be prepared that includes (15.4.20.040 A.2.b):

   a. At least one measurement of the ambient groundwater surface elevation on the site of proposed development collected between May 1 and May 31.

b. An engineer's estimate of the maximum anticipated groundwater elevation anticipated on the site during periods of flooding on the Spanish Fork River, referencing nearby base flood elevations on the current FIRM and all other available sources.

c. An engineer's recommendations with regard to the lowest elevation(s) that the lowest floor(s) (including basements) of all new and substantially improved structures should be constructed to be protected from flooding from groundwater and groundwater that could be influenced by surface water during periods of flooding.

3. The lowest finished floor (including basement), shall be elevated a minimum of two feet above the base flood elevation (15.4.20.040 B.1)

4. All permanent structures shall be set back a minimum of 60 feet from the top of bank of the nearest open channel that conveys runoff water (15.4.20.040 A.2.b).

SECTION 5
RAINFALL-RUNOFF COMPUTATION METHODS

5.1 MODELING APPROACH

There are three acceptable methods for estimating the peak runoff: the Rational Method, TR-55 and HEC-HMS. These three methods are described below. Tr-55 and HEC-HMS can also be used to estimate runoff volume for storage facility sizing. See Section 4 for design criteria.

Other methods for estimating peak runoff and runoff volume must first be approved by the City Engineer. Table 6-1 indicates the applicable total drainage area for each modelling approach.

Table 5-1
Drainage Models and Applicable Total Drainage Area

Drainage Model	Maximum Drainage Area
Rational Method	< 200 Acres
TR-55	< 2000 Acres for Urban Areas
HEC-HMS	Any

5.2 DRAINAGE BASIN DELINEATION

For the purposes of estimating storm water runoff, major drainage patterns should be identified based on topography and the location of major natural drainage channels. Within major drainage basins, subbasins should be delineated for storm water runoff analysis using available local information including, but not limited to:

1. Topography
2. Aerial photography
3. Locations of storm water collection, conveyance, and detention facilities
4. Land use and zoning maps
5. Hydrologic soil maps

5.3 PROJECTED FUTURE LAND USE CONDITIONS

Impacts that proposed development will have on downstream drainage storm drain facilities shall be evaluated. New development will nearly always increase storm water runoff volume and peak flow. In analyzing the effect of future development, four factors should be evaluated:

1. Increase in percent of impervious area

2. Decrease in subbasin time of concentration due to local storm drain improvements

3. Decrease in runoff routing time due to trunk line and main channel improvements

4. Concentration of runoff to discharge points where the undeveloped condition was predominantly shallow sheet flow

Projected land use for a given area can be obtained from City zoning and planning maps.

5.4 RATIONAL METHOD

5.4.1 RUNOFF COEFFICIENT

Table 6-2 shall be used to estimate the runoff coefficient.

Table 5-2
Rational Method Runoff Coefficients

Type of Drainage Area	Runoff Coefficient, C*	Type of Drainage Area	Runoff Coefficient, C*
Business:		Railroad yard areas	0.20 – 0.35
Downtown areas	0.70 – 0.95	Unimproved areas	0.10 – 0.30
Neighborhood areas	0.50 – 0.70	Lawns, sandy soil:	
Residential:		Flat, 2%	0.05 - 0.10
Single-family areas	0.30 - 0.50	Average, 2 – 7%	0.10 – 0.15
Multi-units, detached	0.40 - 0.60	Steep, 7%	0.15 – 0.20
Multi-units, attached	0.60 – 0.75	Lawns, heavy soil:	
Suburban	0.25 – 0.40	Flat, 2%	0.13 – 0.17
Apartment dwelling areas	0.50 – 0.70	Average, 2 – 7%	0.18 – 0.22
Industrial:		Steep, 7%	0.25 – 0.35
Light areas	0.50 – 0.80	Pavement:	
Heavy areas	0.60 – 0.90	Asphaltic and Concrete	0.70 – 0.95
Parks, cemeteries	0.10 - 0.25	Brick	0.75 – 0.85
Playgrounds	0.20 – 0.35	Roofs	0.75 – 0.95

Table 5-2
Rational Method Runoff Coefficients
(Continued)

Type of Drainage Area	Runoff Coefficient, C*
Streets:	
Asphaltic	0.70 – 0.95
Concrete	0.80 – 0.95
Brick	0.70 – 0.85
Drives and walks	0.75 – 0.85
Roofs	0.75 – 0.95

*Higher values are usually appropriate for steeply sloped areas and longer return periods because infiltration and other losses have a proportionally smaller effect on runoff in these cases.

5.4.2 TIME OF CONCENTRATION

Time of concentration shall be calculated using the method found in SCS Technical Release 55 (SCS, 1986). Appendix C contains a sample worksheet from that publication, which can be used to calculate the time of concentration. The minimum allowable time of concentration to be used in runoff calculations shall be 10 minutes.

5.4.3 RAINFALL INTENSITY

The rainfall intensity shall be selected from the intensify-duration-frequency curve in Appendix A. The duration is assumed to equal the time of concentration. The design storm frequency can be obtained from Section 4.1.1.

5.5 TR-55

- The 24-hour SCS Type II storm distribution shall be used (see Appendix B) if the TR-55 method is used.
- The storm depths shall be selected from the depth-duration-frequency curve in Appendix A.
- Table 2-2a-d in TR-55 shall be used to estimate the runoff Curve Number. Table 2-2a-d and associated information is located in Appendix C.

For urban drainages, pervious and impervious areas shall be modeled as separate subbasins. Impervious area in small urban areas can be estimated by direct measurements from aerial photography. The method in TR-55, or any similar method, that suggests modeling developed subbasins using a revising Curve Number based on the percent impervious will not be allowed. Those methods can severely underestimate the runoff potential from a subbasin.

Typical values of effective percent impervious area based on land use are shown in Table 6-3.

Table 5-3
Average Percent Impervious Area by Land Use Category

Land Use Category	Average Percent Impervious Area (%)	Housing Density (Residential Only)
Commercial	95	
Business / Industrial	60	
Institutional	60	
High Density Multi-family Residential	50	10 to 12 units/acre
Medium Density Multi-family Residential	45	6 to 10 units/acre
High Density Single Family Residential	35	3 to 6 units/acre
Medium Density Single Family Residential (Traditional Neighborhood)	20	2 to 3 units/acre
Low Density Single Family Residential	15	1 to 2 units/acre
Very Low Density Single Family Residential	8	< 1 unit/acre
Parks	1	
Open Space	1	

Worksheet 3: Time of Concentration, and Worksheet 4: Graphical Peak Discharge Method, are included in Appendix C.

5.6 HEC-HMS

There are four main input categories in HEC-HMS which are: design storm, loss method, transform method and routing method. The design storms shall be obtained using the procedure described below. For the loss, transform and routing methods, there are multiple options within HEC-RAS than can be used. Below is a description of the preferred method. Other methods may be allowed, but must first be approved by the City Engineer.

5.6.1 DESIGN STORM

The design storm shall be developed in accordance with Section 4.1.

5.6.2 LOSS METHOD

The SCS Curve Number loss method shall be used. The primary input parameter for this method is the Curve Number. As described below, for developed areas, the percent impervious is also entered. The initial abstraction is typically left blank. The program will calculate the initial abstraction based on the Curve Number using the equation documented in TR-55.

Curve Number

Table 2-2a-d in TR-55 shall be used to estimate the pervious runoff Curve Number (CN). Table 2-2a-d and associated information is located in Appendix C. The categories most often used to estimate the pervious CN are highlighted.

Soil Classification

In order to estimate the CN, the hydrologic soil group classification for the drainage basin must be determined. The hydrologic soil group shall be obtained from the NRCS SSURGO dataset. SSURGO data can be obtained from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/). A figure showing the hydrologic soil groups for Spanish Fork City is contained in Appendix D.

Modelling Impervious Areas

The directly connected impervious area (DCIA) should be entered for developed areas. The DCIA should be measured from aerials for existing developments, or should be obtained from the design plans for a proposed development. Typical values of average percent impervious areas based on land use are included in Table 2-2 of TR-55.

5.6.3 TRANSFORM METHOD

The SCS Unit Hydrograph transform method shall be used. This method requires the input of a single variable: lag time.

Lag Time for Natural Watersheds

The Corps of Engineers version of Snyder's equation shall be used to calculate the lag time for natural watersheds (USBR, 1989) as shown below:

$$\text{Lag Time} = C_t \left(\frac{LL_{ca}}{S^{0.5}} \right)^{0.33}$$

Where:

C_t = Constant between 1.3 and 2.2. 1.6 is typical for the Spanish Fork area
L = Length, in miles, of the longest watercourse
Lca = Length, in miles, along L to the centroid of the drainage basin
S = Overall drainage basin slope, in feet/mile.

Lag Time of Urban Areas

The lag time for small urban areas is assumed to be equal the time of concentration. Appendix C contains a sample worksheet from TR-55 that can be used to calculate the time of concentration.

5.6.4 ROUTING METHOD

The Muskingum-Cunge method shall be used for routing. The method requires the follow parameters are inputted:

Length – Total length of the reach element.

Slope – Average slope for the entire reach.

Invert – Optional. Typically not used.

Cross Section Shape – Multiple cross sections are available to select from. Depending on the cross section chosen, additional information is required (i.e. diameter, side slope).

Manning's "n" – Average value for the entire reach. Typical values for Manning's "n" used for storm drain conveyance facilities area shown in Table 6-4.

Table 5-4
Values of Manning's Coefficient (n) for Channels and Pipes
(Continued)

Conduit Material	**Manning's n***
Concrete-lined channel	0.013 – 0.020
Excavated or Dredge Channels	
Earth channel – straight and uniform	0.020 – 0.030
Earth channel – winding, fairly uniform	0.025 – 0.040
Rock	0.030 – 0.045
Unmaintained	0.050 – 0.140
Natural Channel	
Fairly regular section	0.030 – 0.070
Irregular section with pools	0.040 – 0.100
Pipe Material	
Plastic pipe	0.011 – 0.015
Steel/cast iron pipe	0.012 – 0.015
Concrete pipe	0.013 – 0.015
Corrugated metal pipe	0.012 – 0.026

* Lower values are usually for well-constructed and maintained (smother) pipes and channels.

5.7 OTHER MODELS

Other computer programs can be used to model the rainfall-runoff process that use similar hydrologic modeling methods, but care should be taken to make sure modeling methods are used correctly. The City Engineer must approve all computer programs and methods that are not described above, before they are used.

5.8 CALIBRATION

Peak runoff records are typically not available for local drainage studies. An effort should, however, be made to ensure that rainfall runoff analysis results for local drainage studies are consistent and compatible with the City's Storm Drain Master Plan and other pertinent local drainage studies.

It should be noted that the term "calibration" in this context refers to the process of adjusting parameters to achieve results consistent with available reference information, rather than adjusting for actual stream flow observations from the study area. Multiple hydrologic methods should be evaluated and compared to identify reasonable runoff computation results. These methods may include the Rational Formula, the SCS Curve Number Method, the SCS Pervious CN Method, and the Constant and Initial Loss Method. Regional regression equations may also be used to evaluate results depending on the basin size.

Calibration for Natural Watersheds

Results from hydrologic models should be compared to:

- Actual flow records for modeled drainage channels
- Stream flow records from hydrologically similar drainages in the vicinity of the study
- Regional stream flow data (in the event that stream flow records for the local area are not available).

Calibration for Urban Areas

For small urban (developed) areas, the USGS published regression equations than can be used to "calibrate" hydrologic models (see Peak-flow Characteristics of Small Urban Drainages Along the Wasatch Front, Utah).

The range of basin characteristics used to develop the regression equations are shown in Table 6-5.

Table 5-5
Range of Basin Characteristics Used
To Develop Regression Equations for Small Urban Drainages

Basin Characteristic	Unit	Range in Values
Drainage Area (DA)	mi^2	0.085 – 0.87
Basin Slope (BS)	%	0.3 – 15
Effective Impervious Area (EIA)	%	22 – 57

The equations shown in Table 5-6 are only applicable to drainage basins that meet the range of values shown above.

Table 5-6
Regression Equations for Peak Flows
For Small Urban Drainages

Recurrence Interval (Years)	Equations	Average Standard Error of Estimate (%)
10	$Q_{10} = 0.575\ DA^{0.285}\ BS^{0.410}\ EIA^{1.29}$	32
25	$Q_{25} = 66.1\ DA^{0.093}\ BS^{0.243}$	33
100	$Q_{100} = 120\ DA^{0.158}\ BS^{0.194}$	29

The unit peak runoff varies depending on slope and the drainage basin percent impervious. In general, the 10-year event for small urban drainages should be between 0.3 cfs/acre and 1.0 cfs/acre. Modification to input parameters should be considered if simulated runoff results are not within this range.

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APPENDIX C
GENERAL PLAN

Spanish Fork City Land Use Element of the General Plan

2011

Adopted April 5, 2011

2011 Land Use Element

Work on this edition of the Land Use Element started in January of 2010 and ended with the Plan's adoption in April of 2011. Spanish Fork City extends it's thanks to the following individuals for their effort in preparing this document:

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Mayor G. Wayne Andersen
Councilman Steve Leifson
Councilman Rod Dart
Councilman Richard Davis
Councilman Jens Nielson
Councilman Kier Scoubes

Appointed Officials
Chairman Michael Christiansen
Commissioner Del Robins
Commissioner Shane Marshall
Commissioner Dave Stroud
Commissioner Rick Evans
Commissioner Tyler Cope
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Table of Contents

I. Introduction

The Land Use Element of the General Plan is a state-mandated document that represents the long-range vision for the development of the City. It can also be said that the Land Use Element is an official collection of the City's major policies concerning future physical development. The Element states the City's objectives in terms of goals and policies. The policies outlined in the document are expressly designed to achieve the plan's goals.

The Element is more than a colored map indicating what is to be done with each parcel of land; it is an outline of the goals and policies that the citizens and government officials want for their community. When evaluating proposals, decision makers refer to the Element to measure whether the proposal achieves the goals prescribed therein. The document is forward looking in that it projects the vision for the community at buildout. As Spanish Fork City may not achieve buildout for many decades, the document must be periodically updated to reflect the City's current vision for its future.

This version of the General Plan was prepared throughout 2010 and was adopted by the City Council in 2011. It is anticipated that the program described in this document will be pursued through 2016 when the document will be updated again. More specifically, it is expected that the following policies will be implemented between 2011 and 2016:

- Develop an area plan to promote the development of a transit oriented development surrounding the planned Center Street I-15 Interchange.
- Create an area plan to promote development in the vicinity of the Salem/Benjamin I-15 Interchange.
- Develop a comprehensive strategy for City improvements so as to develop a recognizable character and identity throughout the City.
- Adopt standards for hillside development or properties that otherwise have steep slopes.
- Adopt maximum block length requirements, guidelines for phasing and other standards to require new development to create a network of local streets that ensures a high level of connectivity.
- Develop a comprehensive code enforcement program to address nuisances and other zoning violations in the City's neighborhoods.
- Implement form based zoning to more effectively integrate commercial uses in close proximity to residential areas.
- Adopt a set of design standards for non-residential development in Spanish Fork.
- Develop a corridor access management plan for State Road 164 in the vicinity of the Salem/Benjamin I-15 Interchange.
- Provide more detailed provisions in the City's Transportation Element to promote the development of trails and other routes for non-motorized vehicles.
- Collaborate with the Chamber of Commerce to develop specific goals and policies to incorporate into a Main Street area plan.
- Adopt design standards to ensure that development at the Airport is compatible with the City's long term vision for that facility.
- Adopt an area plan for the River Bottoms area.

The accompanying Land Use Map is intended to serve as a visual depiction of the land use patterns and land use arrangement that the City envisions for the community at buildout. It is understood that the City will not reach buildout for many decades and that it is not immediately appropriate to zone all properties in conformity to the Land Use Map. The vision portrayed by the map will be implemented incrementally over time. As opportunities to zone various areas of the City arise, current conditions will be evaluated to determine whether zoning should conform to the Land Use Map at that time.

II. Land Use Policies

A. Growth Management Policies

Goal A.1: To provide for an orderly and efficient expansion of Spanish Fork.

Policies:

- A.1.1 Allow urban residential and industrial land uses only within the adopted Growth Management Boundary.
- A.1.2 The Growth Management Boundary should be evaluated based on the amount of land within the Boundary, the City's ability to provide services outside the Boundary and the cost of providing those services outside the Boundary.
- A.1.3 Review the Boundary each January to determine if changes are warranted based upon recent growth trends.
- A.1.4 Allow new annexations of properties within the Growth Management Boundary where all urban services can readily be provided.
- A.1.5 Deny proposed annexations on properties outside the Growth Management Boundary except in cases where environmental, open space or safety concerns can better be managed if the property is within the City limits.
- A.1.6 Entertain proposed changes to the Land Use Element biannually, each January and July.
- A.1.7 When reviewing and designing potential developments, consider the impact they may have on the character of the surrounding area.
- A.1.8 Require that all implementing ordinances (i.e., zoning and subdivision regulations) be consistent with the General Plan.
- A.1.9 Allow development to occur only in areas where adequate streets, public facilities and services exist or where the developer will provide them. Do not approve developments that would be served by localized sewer lift stations.
- A.1.10 Collect Impact Fees to ensure that growth is not being subsidized by tax payers.
- A.1.11 Develop an area plan to promote the development of a transit oriented development surrounding the planned Center Street I-15 Interchange.
- A.1.12 Create an area plan to promote development in the vicinity of the Salem/Benjamin I-15 Interchange.
- A.1.13 Develop a comprehensive strategy for City improvements so as to develop a recognizable character and identity throughout the City.

Goal A.2: To manage development which is compatible with certain environmental limitations in the area.

Policies:

- A.2.1 Severely restrict development within the Zones A and X of the Spanish Fork River and any other open channels to minimize potential damage and loss should a flood occur.
- A.2.2 Require soils tests prior to any development.
- A.2.3 Adopt standards for hillside development or properties that otherwise have steep slopes.

Goal A.3: To provide high quality, stable residential neighborhoods.

Policies:

- A.3.1 Protect residential neighborhoods from commercial and most other non-residential uses through the uses of walls, landscaping, and setbacks appropriate to the use.

A.3.2 Design local streets in residential areas with discontinuous, but well connected, patterns to discourage through traffic.

A.3.3 Adopt maximum block length requirements, guidelines for phasing and other standards to require new development to create a network of local streets that ensures a high level of connectivity.

A.3.4 Develop a comprehensive code enforcement program to address nuisances and other zoning violations in the City's neighborhoods.

Goal A.4: To provide a range of housing types and price levels in the City.

Policies:

A.4.1 Allow a variety of lot sizes and housing types throughout the City.

A.4.2 Allow residential development projects that provide superior design features and amenities to be developed at the high end of the density ranges as shown on the General Plan Map.

Goal A.5: To ensure that adequate open space, buffering, and landscaped areas are provided in new developments.

Policies:

A.5.1 Follow the City's Parks and Recreation Element when planning and designing new developments.

B. Commercial Goals and Policies

Goal B.1: To provide conveniently located commercial areas to serve the residents of Spanish Fork and to expand the City's sales tax base.

Policies:

B.1.1 Plan for a hierarchy of commercial areas within the City to meet neighborhood, community and regional needs.
B.1.2 Plan for new commercial areas as nodes or centers, and not as a series of unrelated, freestanding businesses.
B.1.3 Limit points of access onto streets in commercial areas in accordance with the City's Transportation Element of the General Plan.
B.1.4 Plan for secondary vehicular and pedestrian access from commercial to residential areas where practical to do so.
B.1.5 Require sidewalks at the time of new construction or expansion of existing commercial uses for the full frontage of the parcel.
B.1.6 Restrict the size of neighborhood commercial areas to minimize the impact on the residential character of the area.
B.1.7 Preserve locations for community level commercial areas at major intersections.
B.1.8 Require community level and regional level commercial centers to be developed as integrated projects with shared parking, common architectural styling, landscaping, and signage.
B.1.10 Allow a mixture of General Commercial and Light Industrial uses to locate in the North Main Street area between Interstate 15 and 1600 North.
B.1.11 Adopt design standards that require non-residential buildings to orient to public rights-of-way or require other measures to ensure that right-of-way facing elevations are visually interesting and appealing.

Goal B.2: To provide opportunities and locations for small commercial operations and offices which are compatible with residential uses.

Policies:

B.2.1 Allow small office complexes to develop in similar locations as neighborhood commercial areas.
B.2.2 Allow home occupations in all residential areas if they have no exterior evidence of their existence and the use is compatible with the residential environment.
B.2.3 Implement form based zoning to more effectively integrate commercial uses in close proximity to residential areas.

Goal B.3: To develop visually attractive commercial centers that help create a distinct sense of place in Spanish Fork.

Policies:

B.3.1 Adopt a set of design standards for non-residential development in Spanish Fork.

C. Industrial/Employment Policies

Goal C.1: To provide a variety of employment opportunities for the residents of Spanish Fork and the surrounding area.

Policies:

C.1.1 Continue to develop the northern part of the community with Light Industrial uses. Prohibit residential development in these areas.

C.1.2 Attempt to maintain an adequate supply of industrial land in appropriate areas.

C.1.3 Allow industrial development in urban areas on sites where sanitary sewer, storm water management, water, and police and fire protection are available and adequate prior to or concurrent with development.

C.1.4 Require that industrial developments have good access, adequate public facilities and services, suitable topography and soils and minimal impact on surrounding areas.

C.1.5 Minimize the impact of industrial developments on adjacent non-industrial land uses through appropriate landscaping, screening, buffer strips, graduated land use intensity and similar methods.

C.1.6 Encourage master planning for industrial area, including the inclusion of such features as open space, landscaping, signage, traffic control and uniform maintenance through covenants or other property management techniques.

C.1.7 Locate and design new industrial sites and improve existing ones to facilitate access and circulation by transit, car and van pools, pedestrians, bicyclists and other alternative transportation modes.

D. Transportation Goals

Goal D.1: Provide a safe, convenient and efficient system for transporting both people and goods.

Policies:

D.1.1 Follow the provisions provided in the City's Transportation Element.
D.1.2 Develop a corridor access management plan for State Road 164 in the vicinity of the Salem/Benjamin I-15 Interchange.

Goal D.2: Provide pleasant, safe, and functional non-motorized transportation routes.

Policies:

D.2.1 Follow the provisions provided in the City's Transportation Element.
D.2.2 Provide more detailed provisions in the City's Transportation Element to promote the development of trails and other routes for non-motorized vehicles.

E. Main Street Goals and Policies

Goal E.1: Develop a plan to increase commercial activity through the Main Street corridor.

Policies:

E.1.1 Collaborate with the Chamber of Commerce to develop specific goals and policies to incorporate into a Main Street area plan.

E.1.2 Assign one Planning Commissioner to serve as a liaison to the Chamber of Commerce when developing a Main Street area plan.

F. Airport Goals and Policies

Goal F.1: Protect the Airports ability to operate and expand.

Policies:

F.1.1 Maintain appropriate zoning controls to prevent development on surrounding properties that is not compatible with the operation on the Airport.

F.1.2 Adopt design standards to ensure that development at the Airport is compatible with the City's long term vision for that facility.

F.1.3 Take appropriate steps to annex lands that now surround, or that may surround the airport at some future date.

G. River Bottoms Goals and Policies

Goal G.1: Plan for a variety of land uses in the River Bottoms, including agricultural uses, which will be arranged to maintain the areas character and beauty.

Policies:

G.1.1 Adopt an area plan for the River Bottoms area.

III. Land Use Map Designations

General Plan Designation	Corresponding Zones
Flood Plain	overlay
Hillsides/Geologic Hazards	overlay
Agricultural	Exclusive Agriculture
	Rural Residential
Low Density Residential	R-1-80
	R-1-60
	R-1-40
	R-1-20
	R-1-15
	R-1-12
Medium Density Residential	R-1-9
	R-1-8
	R-1-6
	In-Fill Overlay
High Density Residential	R-3
	In-Fill Overlay
Mixed Use	Urban Village
	Residential Office
	Commercial Office
	Commercial 1
Commercial	Residential Office
	Commercial Office
	Commercial 1
	Commercial 2
	Shopping Center
Industrial	Business Park
	Light Industrial
	Medium Industrial
	Heavy Industrial.
Public Facilities	Public Facilities

A. Environmentally Sensitive Uses

1. **Flood Plain.** Those areas along the Spanish Fork River within the 100-year Flood Pain have limited development potential because of the hazards associated with flooding. This designation will be "overlaid" upon the base land use designation with development allowed only in accordance with State and Federal standards.

2. **Hillsides/Geologic Hazards.** The steeper hillside areas in the extreme southeastern part of Spanish Fork have special limitations due to unstable soils, erosion and landslide potential, and proximity to an earthquake fault line. These areas will require careful site review, special construction standards, and should have reduced density of development because of the higher risk of natural disasters. This designation will be "overlaid" upon the base land use designation.

B. Residential Land Uses

1. **Agriculture: 1 to 40+ acre parcels.** These are areas where the predominant character is agricultural production, ranchettes, hobby farms, or large lots to accommodate upscale residential units. Streets will be paved, but curb, gutter and sidewalk will not be required. Community water systems and sewer will sometimes be available.

2. **Low Density Residential: 1.5 to 3.5 dwelling units per acre.** These are areas with predominately single-family detached units. Developments will have full urban services.

3. **Medium Density Residential: 3.5 to 8 dwelling units per acre.** These are areas with mostly single-family detached units and some areas with multi-family units. These areas will usually have somewhat smaller single-family lots, and/or a slightly higher percentage of attached units than are found in the Low Density Residential areas. Developments will have full urban services.

4. **High Density Residential: 9 to 12 dwelling units per acre.** These areas are a mix of single-family detached units and attached dwelling units. The mix of multi-family buildings will be higher in this area than in the Low and Medium areas. Developments will have full urban services.

C. Commercial Land Uses

1. **Mixed Use:** These areas provide for a mix of limited residential, retail, personal services, business services and office uses. Residential uses may be permitted when integrated into developments that also contain non-residential uses or at locations where the City has determined it is unfeasible to operate non-residential uses. Mixed Use developments typically serve as a transition between more intense commercial areas and residential land uses. They can also be used in certain areas to allow residential conversions to office use, subject to site and architectural review criteria. Parts are intended to promote and maintain the character of a pedestrian-oriented retail district. Building orientation should strongly encourage pedestrian use by having buildings close to the street. The architectural style of new or remodeled buildings shall be consistent with the area.

2. **Commercial:** These areas provide a wide range of commercial uses designed to serve neighborhood, community, and regional needs. Uses may be freestanding or integrated in a center.

D. Industrial Uses

1. **Industrial:** These areas accommodate employment related uses including large scale campus style development, administrative and research companies, offices, laboratories, manufacturing, assembling, warehousing, and wholesale activities. Associated office and support commercial uses are allowed. Uses that emit moderate amounts of air, water or noise pollution may be considered as conditional uses. Residential uses are not allowed.

E. Other Uses

1. **Public Facilities:** Public facilities are properties and structures that are owned, leased or operated by a governmental entity for the purpose of providing governmental services to the community. Some of these services are necessary for the efficient functioning of the local community, and others are desired services which contribute to the community's cultural or educational enrichment. In either case, public properties and buildings represent important components of the community's quality of life.

IV. Moderate Income Housing Element

A. Introduction

Moderate income housing has become a state-wide concern in Utah. To address this concern, the state has directed municipalities to adopt plans for "housing occupied or reserved for occupancy by households with a gross household income equal to or less than eighty percent (80%) of the median gross income for households of the same size in the county in which the city is located." These plans are required to include:

1. an estimate of the existing supply of moderate income housing located within the city;
2. an estimate of the need for moderate income housing located within the city;
3. an estimate of the need for moderate income housing in the city for the next five years as revised biennially;
4. a survey of total residential land use;
5. an evaluation of how existing land uses and zones affect opportunities for moderate income housing; and
6. a description of the city's program to encourage an adequate supply of moderate income housing (Utah Code 10-9a-103).

These requirements are shown below. With the Utah County median annual income being $65,100 (HUD), the eighty percent (80%) baseline would be set at $52,080 annually. Using this and the Affordable Housing Model from Mountainland Association of Governments, we will determine the need for and availability of moderate income housing in Spanish Fork City.

Figure 1 – Affordable Housing Supply & Affordability Gap by HUD AMI – Spanish Fork (May 2010)		**Affordable Shelter Cost**			**Number of Households (2010)**	**Number of DU (2010)**	**Affordable Housing Supply**		
		Owned		**Rent**			**Current (2010)**	**5 Years (2015)**	**10 Years (2010)**
		Single-family	**Multi-family**						
30% of Median	Up to $19,530	$77,000	$54,000	$488	1,112	5	(1,107)	(1,318)	(1.541)
fifty percent (50%) of Median	Between $19530 and $32,550	$131,000	$108,000	$814	940	417	(523)	(669)	(823)
sixty percent (60%) of Median	Between $32,550 and $39,060	$159,000	$136,000	$977	490	989	499	482	466
eighty percent (80%) of Median	Between $39,060 and $52,080	$213,000	$190,000	$1,302	1,051	2,722	1,671	1,682	1,697
Median	Between $52,080 and $65,100 (median)	$268,000	$245,000	$1,628	1,037	2,386	1,349	1,337	1,327
120% of Median	Between $65,100 and $78,120	$322,000	$299,000	$1,953	906	784	(122)	(233)	(350)
More	More				2,451	982	(1,469)	(1,858)	(2,269)

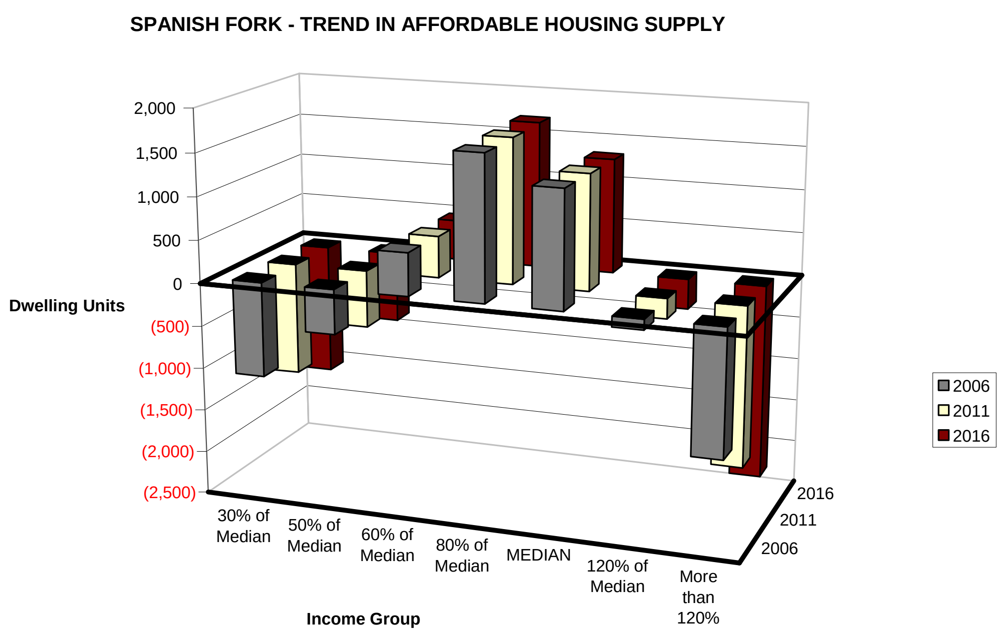
than 120%	than $78,120								
Total					7,988	8,285	297	(577)	(1,494)

B. Estimate of Existing Supply

According to our Model, using 2007 data from the County Assessor's Office and 2006 data from the Utah State Tax Commission, Spanish Fork City has 1,501 families earning between sixty-one percent (61%) and eighty percent (80%) of median gross income, and 2,722 dwelling units in their price range, for a surplus of 1,671 units. The City also has a surplus of 499 units for those earning sixty percent (60%) of median gross income, for a total surplus of 2,170 affordable units or 26% of the existing units in the City (see Fig. 1).

The Model shows a bell-shaped trend, where those with both the highest and the lowest incomes have a deficit of housing and those in the middle have a surplus (see Fig. 2). The model shows these trends becoming more pronounced in the future.

Figure 2



	30% of Median	50% of Median	60% of Median	80% of Median	MEDIAN	120% of Median	More than 120%
2006	(1,107)	(523)	499	1,671	1,349	(122)	(1,469)
2011	(1,318)	(669)	482	1,682	1,337	(233)	(1,858)
2016	(1,541)	(823)	466	1,697	1,327	(350)	(2,269)

C. Estimate of the Need for Moderate Income Housing for the Next Five Years

Spanish Fork City has experienced unprecedented growth during the last decade. That growth is expected to continue as development and annexation allow more people to move into the City. As this growth continues, the City anticipates taking steps to ensure that people of all income groups will have the ability to live in Spanish Fork City.

The Model shows that housing for those earning eighty percent (80%) of median gross income is the City's largest group, and it is expected to continue to grow over the next five years. The surplus for those earning sixty percent (60%) of median gross income is expected to shrink, but will still remain in five years.

However, as mentioned above, the predictions of the model show current trends becoming more pronounced, in that the deficits of housing for the lowest income groups will become more pronounced, as will the deficits for those in the highest income groups.

D. Survey of Residential Land Uses

Spanish Fork City has thirteen residential land use districts, one residential overlay district, and two commercial districts which allow residential uses.

The Exclusive Agriculture (A-E) and Rural Residential (R-R) zones are intended for single-family homes on large lots with animal rights that are generally used for farming. While the A-E zone is intended for the areas with soils most conducive to farming and areas that may have limitations on other types of development such as floodplain issues, the R-R zone also functions as a holding zone for areas that may be developable in the future.

The R-1-80, R-1-60, R-1-40 and R-1-30 zones are intended for large-lot, single-family homes that are in a rural atmosphere and may have animal rights.

The R-1-20, R-1-15 and R-1-12 zones are for low-density single-family neighborhoods with a suburban feel. Though the lots on these properties are still fairly large, they do not qualify for animal rights.

The R-1-9 and R-1-8 zones provide for a medium-density, single-family suburban atmosphere.

The R-1-6 zone provides for a medium-high density, single-family atmosphere. In certain situations, more than one single-family home can be allowed per lot, as will be explained below. Most of the original plat of the City is zoned R-1-6.

The R-3 zone is the highest density zone in the City, and allows for single-family development. In certain situations, more than one single-family home or multi-family housing can be allowed on a lot, as will be explained below. The R-3 zone is mostly located within the blocks surrounding the commercial areas along Main Street and a few other areas in the City.

The Residential Office (R-O) zone is a mixed-use zone that allows for both residential and office uses. In this zone, single-family homes (including more than one home per lot) and duplexes are allowed.

The In-Fill Overlay (I-F) zone can be applied to projects in the R-1-6 and R-3 zones. In the R-1-6 it will allow for more than one home per lot, while in the R-3 zone it allows for twin homes, duplexes, triplexes and fourplexes. The I-F zone requires that developments conform in materials and style to the surrounding neighborhood.

The Commercial Downtown (C-D) zone allows for residences above the first floor of a commercial building.

The Urban Village (C-UV) zone allows for multi-family housing along with commercial and other uses. It is intended to create areas that have mixed uses and where people would be able to walk for their daily needs instead of driving.

In addition, the City has a Master Planned Development ordinance that allows developers to develop at a higher density and with a greater mix of residential types in return for various amenities including "design features, architectural style, open space (including parks and trails), conservation elements, landscaping features, and recreational facilities." Master Planned Developments are a Conditional Use (meaning that they must apply for a

Conditional Use Permit) in all residential zones except for the A-E, R-R and R-O zones, where they are not permitted.

E. Evaluation of How Existing Land Uses Affect Opportunities for Moderate Income Housing

Spanish Fork City's land use regulations permit diverse land uses that include single-family, multi-family, and rental units at a wide range of prices throughout the City. The Model indicates that the City has a surplus of affordable units that fit all of these categories. Although there are not many options for those earning less than fifty percent (50%) of median gross income, Spanish Fork City staff does not believe that this is due to zoning; there are a number of developable properties in all zones, including those that would be most conducive to moderate income housing. The lack of development in these areas is due to market conditions and is beyond the control of the City.

F. The City's Program to Encourage an Adequate Supply of Moderate Income Housing

Spanish Fork City has pursued a number of routes to provide moderate income housing. The I-F zone is a recent effort to allow for higher-density, more affordable housing that will blend into neighborhoods, preserving property values and removing the negative stigma of affordable housing. The City has worked with Habitat for Humanity, which has been building in the area. Spanish Fork City also is home to 70 rent-subsidized units scattered throughout the City, where the Housing Authority of Utah County helps needy citizens to pay their rent. The City is also currently discussing the viability of accessory apartments in various parts of the City. Through these and other efforts, Spanish Fork City has provided a surplus of moderate income housing units, a surplus which has grown since our last General Plan was adopted. The City will continue to follow these practices in order to provide affordable housing for its citizens.

G. Goals and Policies for Moderate Income Housing

Goal G.1: Continue to encourage affordable housing in Spanish Fork City.

Policies:

- G.1.1 Encourage the use of Master Planned Developments to provide a mix of lot and home sizes and home types (townhomes, twin homes, accessory apartments and single-family detached homes) in residential zoning districts.
- G.1.2 Continue to provide HOME funds to the Housing Authority of Utah County to encourage 30-fifty percent (50%) AMI housing and removing barriers that block affordable housing.
- G.1.3 Continue to allow manufactured homes in all residential zones throughout the City.
- G.1.4 Continue to allow accessory apartments (basement, mother-in-law) in the R-3 and R-1-6 zoning districts.

Goal G.2: Encourage developments that target special groups like the elderly, disabled persons, and others people with special needs.

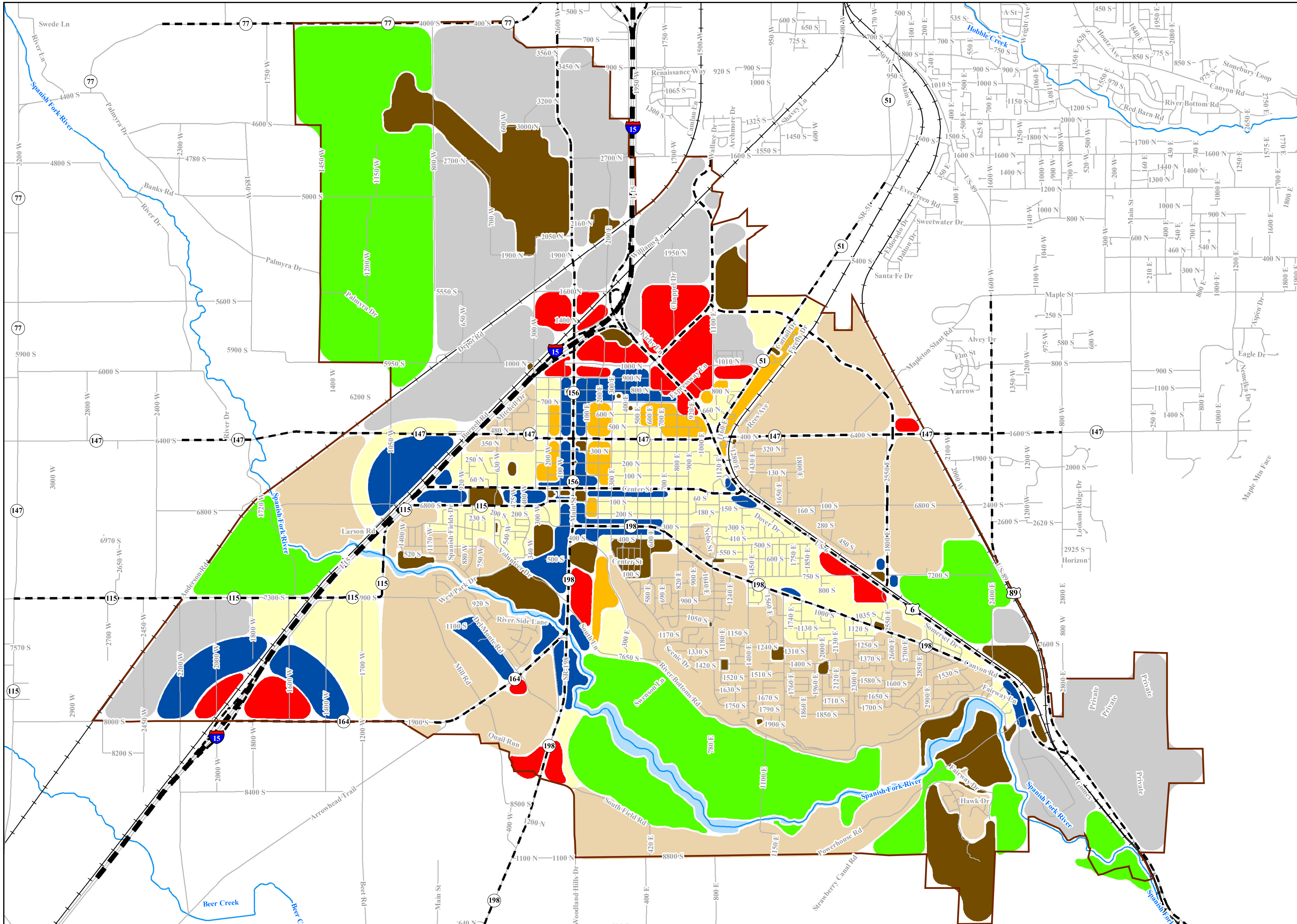
Policies:

- G.2.1 Provide HOME funds to the Housing Authority of Utah County encouraging them to fund 30-fifty percent (50%) AMI housing and removing barriers that block affordable housing for all individuals.

V. Land Use Map

Spanish Fork Land Use Element of General Plan

1 Inch = 3,400 Feet



Legend
- Roads
- Railroad
- Rivers

General Plan Proposal
- Agricultural
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Mixed Use
- Commercial
- Industrial
- Public Facilities
- Floodplain (Floodway)
- Hillside/Geologic Hazards

Print Date: 4/18/2011

SURROUND YOURSELF
Spanish Fork
UTAH

GEOGRAPHIC INFORMATION SYSTEMS

Spanish Fork City GIS
40 South Main Street
Spanish Fork, UT 84660
Administrator - (801) 804-4571
Interns - (801) 804-4570

APPENDIX D
UNIT COST ESTIMATE DATA

Table D-1
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Description	Unit	Unit Cost
Detention Basins		
Property Acquisition	Acre	$100,000
Excavation and Hauling	Cubic Yard	$15
Landscaping (Non-irrigated Native)	Square Foot	$0.30
Landscaping (Irrigated Turfgrass)	Square Foot	$3.00
Inlet Apron	Lump Sum	$15,000
Outlet Structure	Lump Sum	$20,000
Emergency Spillway	Lump Sum	$5,000
Riprap	Lump Sum	$25,000
Storm Drain Pipelines		
Permanent Easement Acquisition	Acre	$50,000
12-inch RCP	Linear Foot	$90
15-inch RCP	Linear Foot	$100
18-inch RCP	Linear Foot	$110
21-inch RCP	Linear Foot	$120
24-inch RCP	Linear Foot	$130
30-inch RCP	Linear Foot	$160
36-inch RCP (1)	Linear Foot	$190
42-inch RCP (1)	Linear Foot	$230
48-inch RCP (1)	Linear Foot	$280
54-inch RCP (1)	Linear Foot	$330
60-inch RCP (1)	Linear Foot	$370
66-inch RCP (1)	Linear Foot	$420
72-inch RCP (1)	Linear Foot	$470
78-inch RCP (1)	Linear Foot	$550
84-inch RCP (1)	Linear Foot	$610
90-inch RCP (1)	Linear Foot	$680
96-inch RCP (1)	Linear Foot	$740
102-inch RCP (1)	Linear Foot	$810
Manhole (1)	Each	$4,000
Catch Basin (1)	Each	$3,500
Traffic Control	Linear Foot	$16
Storm Drain Culvert Road Crossings for Creeks and Washes		
Pipe Culvert	See RCP Storm Drain Costs Above	
Headwalls	Lump Sum	$10,000
Riprap	Lump Sum	$64,000
Traffic Control	Lump Sum	$6,000
Other		
Utility Conflicts, Unanticipated Geotechnical Conditions, etc.	25 Percent of Construction Cost	
Engineering, Legal, and Administrati	15 Percent of Construction Cost	

(1) - Includes trenching, installation, backfill, and asphalt surface restoration.

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