STORM DRAINAGE MASTER PLAN

Prepared for:

Prepared by:

154 East 14000 South
Draper, Utah 84020

Updated May 2012

Project No. 204-10-01

STORM DRAINAGE MASTER PLAN

Prepared by:

Bowen Collins
& Associates, Inc.
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Updated May 2012

Project No. 204-10-01

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ACRONYMS AND ABBREVIATIONS

BC&A – Bowen, Collins and Associates

City – Spanish Fork City

CN – Curve Number

GIS – Geographic Information System

I-CORE – UDOT Utah County Corridor Expansion Project

UDOT – Utah Department of Transportation

CHAPTER 1
INTRODUCTION

INTRODUCTION

Bowen Collins & Associates (BC&A) was retained by the Spanish Fork Cityto prepare a Storm Drainage Master Plan for Spanish Fork City. The purpose of this Storm DrainageMaster Plan Report is to identify recommended improvements that willresolve existing and projected deficiencies in the storm trunk lines and regional detention basinsin Spanish Fork City. Additional pertinent information is included in the attachments including: Storm Water Drainage Manual, Levee Operation and Maintenance Procedures, Spanish Fork River Bank Stability Analysis, Spanish Fork River Maintenance Procedures and the Spanish Fork Floodplain Ordinance.

BACKGROUND INFORMATION

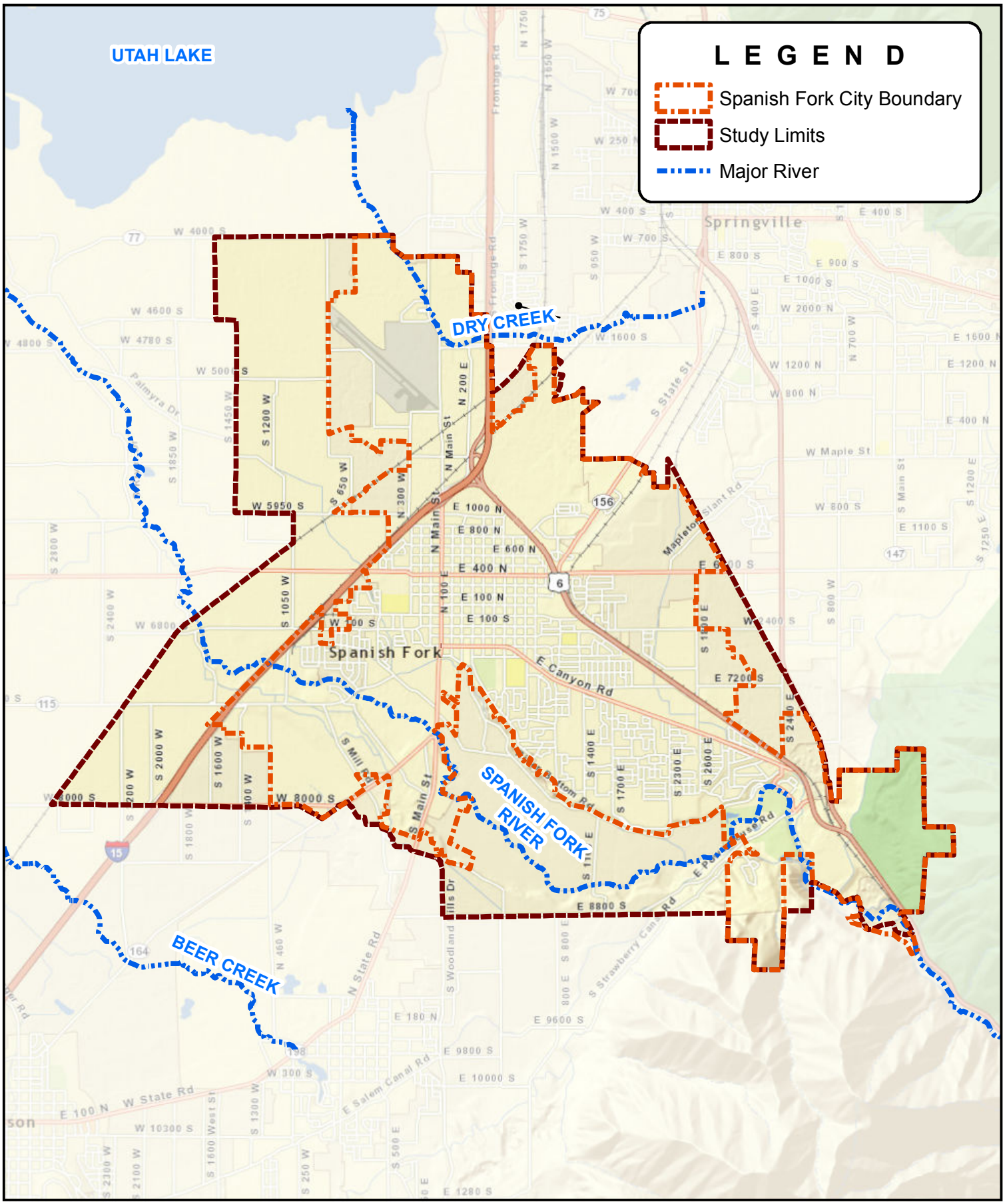
Spanish Fork City is located at the mouth of Spanish Fork Canyon in Utah County. A majority of the land area in Spanish Fork City drains to either the Spanish Fork River or Dry Creek (see Figure 1-1). A small portion of the land area in the City drains either to Beer Creek or directly to Utah Lake.

The existing storm drainage facilities consist of pipes, open channels, culverts, detention and retention basins and sumps. This is the first detailed citywide Storm Drain Master Plan for Spanish Fork City. This study includes an inventory of existing trunk lines and regional detention facilities. Recommended 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 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 sized to convey the estimated design discharges based on slope available in the field.

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



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STUDY AREA AND MAJOR DRAINAGE CHANNELS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

NORTH:

SCALE: 0 3,000 6,000 Feet

FIGURE NO. 1-1

P:\Spanish Fork City\Task 2 - Flood Consulting\SDMP\Report\Figures\Figure 1-1 Study Area.mxd mstayner 10/31/2011

SCOPE OF SERVICES

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

Task 1: Obtained inventory of existing trunk lines and regional detention basins from Spanish Fork City based on survey data the City collected for this study. Also obtained hydraulic capacity estimates of existing trunk lines from Spanish Fork City.

Task 2: Developed a hydrologic computer model of the study area (see Figure 1-1) to simulate the rainfall-runoff process for almost 200 subbasins for existing and full build-out land use conditions.

Task 3: Used results from the hydraulic analysis performed in Task 1 to identify existing and future deficiencies.

Task 4: Identified recommended improvements to resolve the deficiencies identified in Task 3.

Task 5: Prepared a master plan report to document the analytical procedures used in completing the study and to summarize the recommendations and conclusions.

Task 6: Conducted progress and coordination meetings as required to keep City staff involved and informed of progress and activities.

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 Matt Stayner, Project Manager at (801) 495-2224.

Craig Bagley, P.E., CFM	Senior Review
Matt Stayner, P.E., CFM	Project Manager
Kameron Ballentine	Project Engineer, Hydrologic/Hydraulic Modeling
Angela Hansen	Word Processing

CHAPTER 2
INVENTORY EXISTING STORM DRAINAGE FACILITIES

Spanish Fork City provided BC&A with information on existing storm drainage facilities as described below.

STORM DRAINAGE PIPES

Spanish Fork City developed a GIS (Geographic Information System) database of the City's storm drainagepipesbefore work commenced on this Master Plan. However, the database did not contain pipe sizes and manhole inverts for all of the trunkline pipes. Additionally, it was discovered that some of the pipe sizes and inverts in the database were incorrect. Therefore, Spanish Fork City elected to collect new survey data for all of the trunk lines and associated manholes in the City's storm drain system. The City provided BC&A with a GIS shapefile of all the existing pipes in the study area. The shapefile included pipe inverts, calculated slope and estimated hydraulic capacity based on Manning's Equation. See Figure 2-1 for the resulting inventory survey of existing storm drainage facilities.

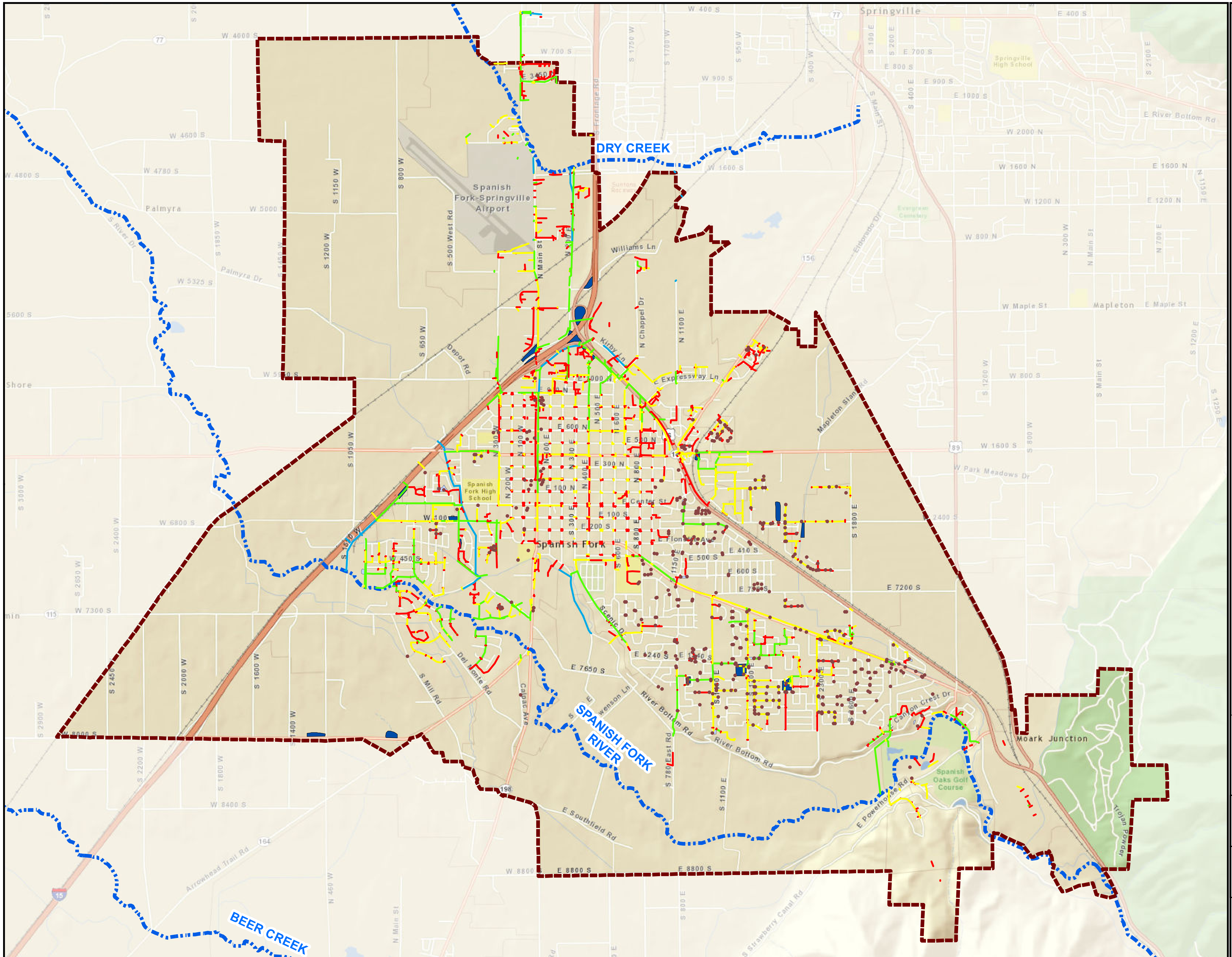
DETENTION BASINS

Spanish Fork City provided information for all of the detention basins shown on Figure 2-1. 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, which are indicated on Figure 2-1. A storm drain sump consists of a storm drain manhole that, in lieu of an outlet pipe, contains penetrations through its walls that allow 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. See Chapter 3 for more information regarding proposed facilities and storm drain sumps.

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



LEGEND

- Storm Sump

Existing Storm Drain Pipes

Diameter (Inches)

- 0 - 12
- 15 - 21
- 24 - 36
- 42 - 60
- Regional Detention Facility
- Local Detention Facility
- Study Limits
- Major River

NORTH:

SCALE: 0 1,750 3,500 Feet

EXISTING STORM DRAIN FACILITIES

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

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FIGURE NO.
2-1

P:\Spanish Fork City\Task 2 - Flood Consulting\SDMP\Report\Figures\Figure 2-1 Existing Facilities.mxd mstayner 10/31/2011

CHAPTER 3
HYDROLOGIC ANALYSIS

A hydrologic computer model of the study area was developed in HEC-HMS (version 3.4) for the purpose of estimating storm water runoff volume and peak discharges generated by a design cloudburst event. The 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

1. Delineate Drainage Basins

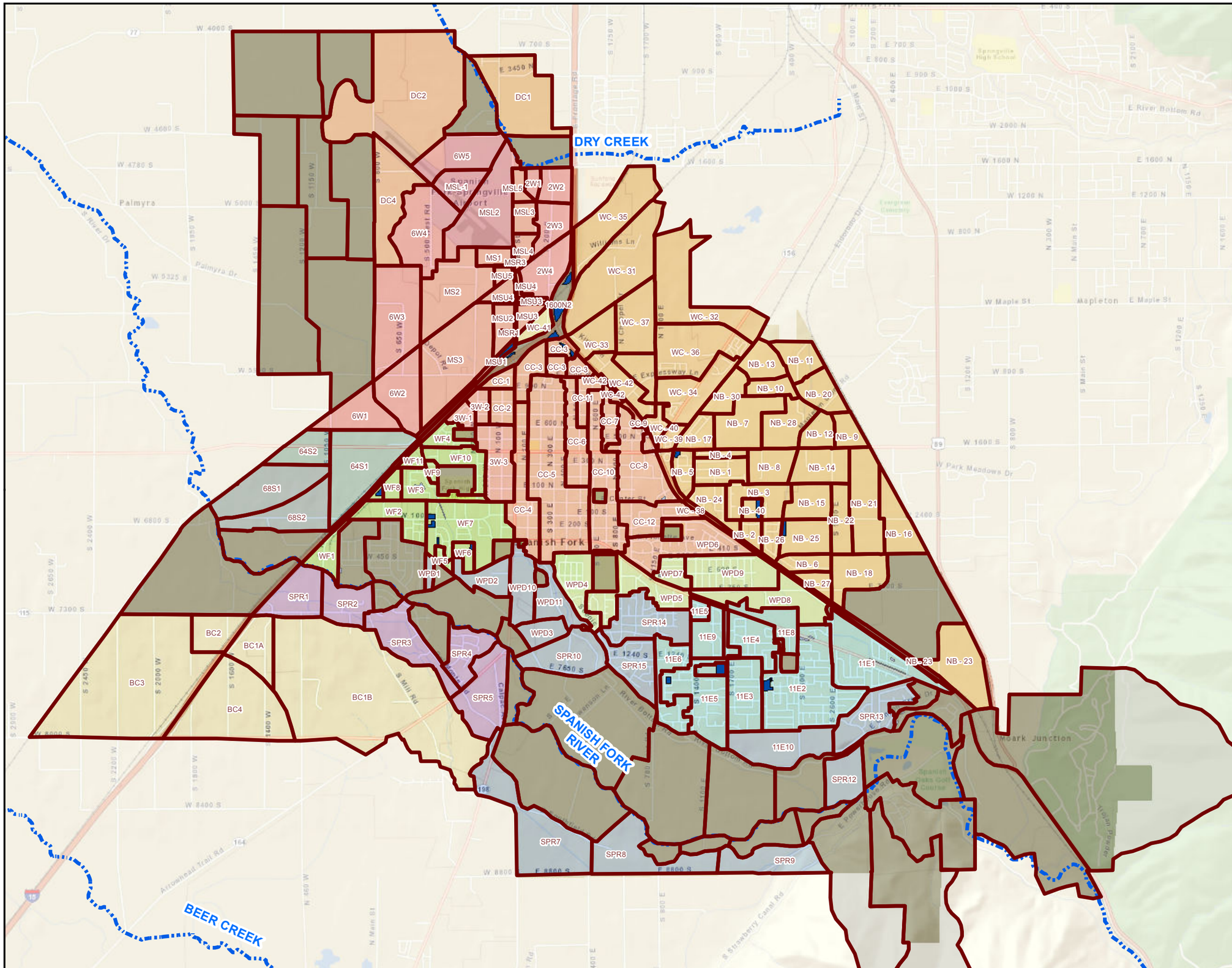
The first step to developing a computer hydrologic model is to delineate drainage basins and subbasins. Topographic mapping, 2009 aerial photography, and an existing storm drainage system inventory (provided by the City) were used to delineate drainage basins and subbasin boundaries in the study area. The subbasins for this analysis are based on the best available data. Subbasin boundaries associated with the hydrologic model are shown onFigure3-1.

2. Input Hydrologic Modeling Parameters

The following hydrologic parameters were used to develop the HEC-HMS computer model.

Loss Method. The SCS Curve Number method was used in the hydrologic model to calculate infiltration losses (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.

See Attachment 1 – Storm Water Drainage Design Manual – for a soils map for Spanish Fork City and the surrounding area. In some instances the Curve Number based on soil type was adjusted to reflect development. See “Model Calibration” below for a more detailed description.



LEGEND

- Drainage Subbasin
- Major River
- Mask_CITY

Detention Basins

- Regional Detention Facility
- Local Detention Facility

NORTH:

SCALE: 0 1,750 3,500 Feet

SUBBASINS AND DETENTION BASINS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

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FIGURE NO. 3-1

P:\Spanish Fork City\Task 2 - Flood Consulting\SDMP\Report\Figures\Figure 3-1 Drainage Basins.mxd mstayner 11/30/2011

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. 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. See Appendix A for subbasin input parameters used in this study.

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.

3. Design StormParameters

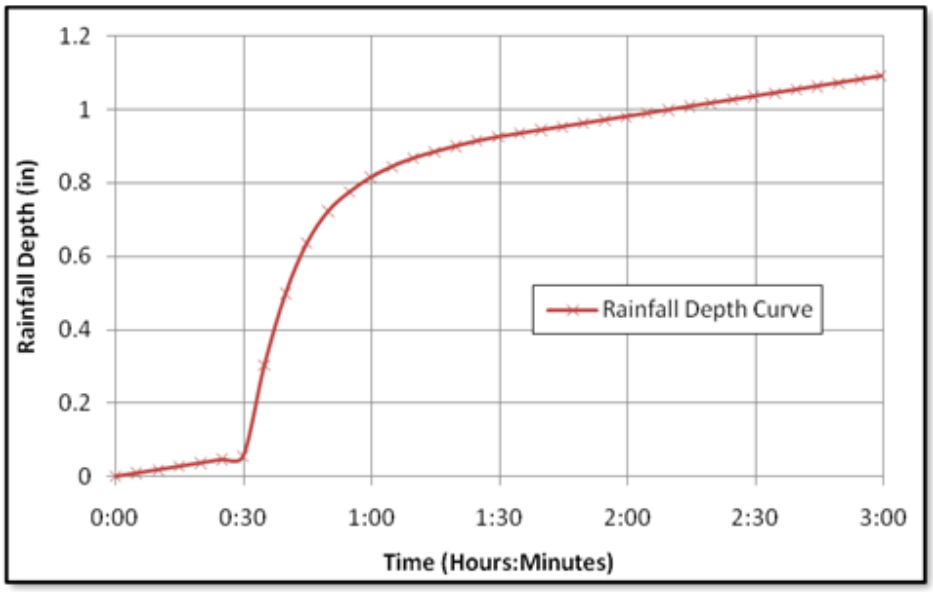
The following data was used to define the design storm for this study:

- Storm Duration: 3 Hours
- Storm Distribution: Modified Farmer and Fletcher
- Recurrence Interval:
  - Storm Drainage Pipes: 10-Year
  - Detention Basins in area of existing development: 10-Year
  - Detention Basin in area of new development: 25-Year

- Storm Depth (From NOAA Atlas 14):
  10-Year: 1.09 inches
  25-Year: 1.38 inches

The distribution of the storm used in the HEC-HMS 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 Attachment 1 – Storm Water Drainage Design Manual.

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



4. Detention Basin Modeling

Existing detention basin parameters were provided by the City. Detention facilities were analyzed as a 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. Local detention facilities were incorporated into the model using one of two methods as listed below.

1. Local detention facilities were inputted into the hydrologic computer model 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 Attachment 1 - 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. 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 has three local detention, 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).

5. 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 rainfall-runoff model generally produces peak runoff rates that range from 0.25 cfs/ac to 0.32 cfs/ac runoff for quarter-acre subdivision lots. 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 areas of the City that produce runoff below 0.25 cfs/ac tend to have less slopethan other areas of the City. As a result, the flatter areas drain more slowly, have a longer time of concentration and produce less runoff.

*CN Values.*In some instances the simulated peak runoff initially exceeded the calibration 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 pervious 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. The Lag Time was further adjusted for some subbasins during the calibration process to adjust the peak runoff to be within, or closer to, the calibration target range described above. Therefore, the calculated Lag Time does not match the Lag Time in the hydrologic model for all subbasins.

*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 intercept the runoff generated from the 10-year storm. In areas where ponding or flooding occurs, the inlet capacity should be evaluated and additional inlets should be added is necessary.

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 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 where it could limit the use of maintenance equipment and personnel and 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 StructureWith 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 in the 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 have solid foam cores and are typically 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. Floating booms can have a screen attached to the bottom of the floating booms to more effectively remove 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 secondto 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)

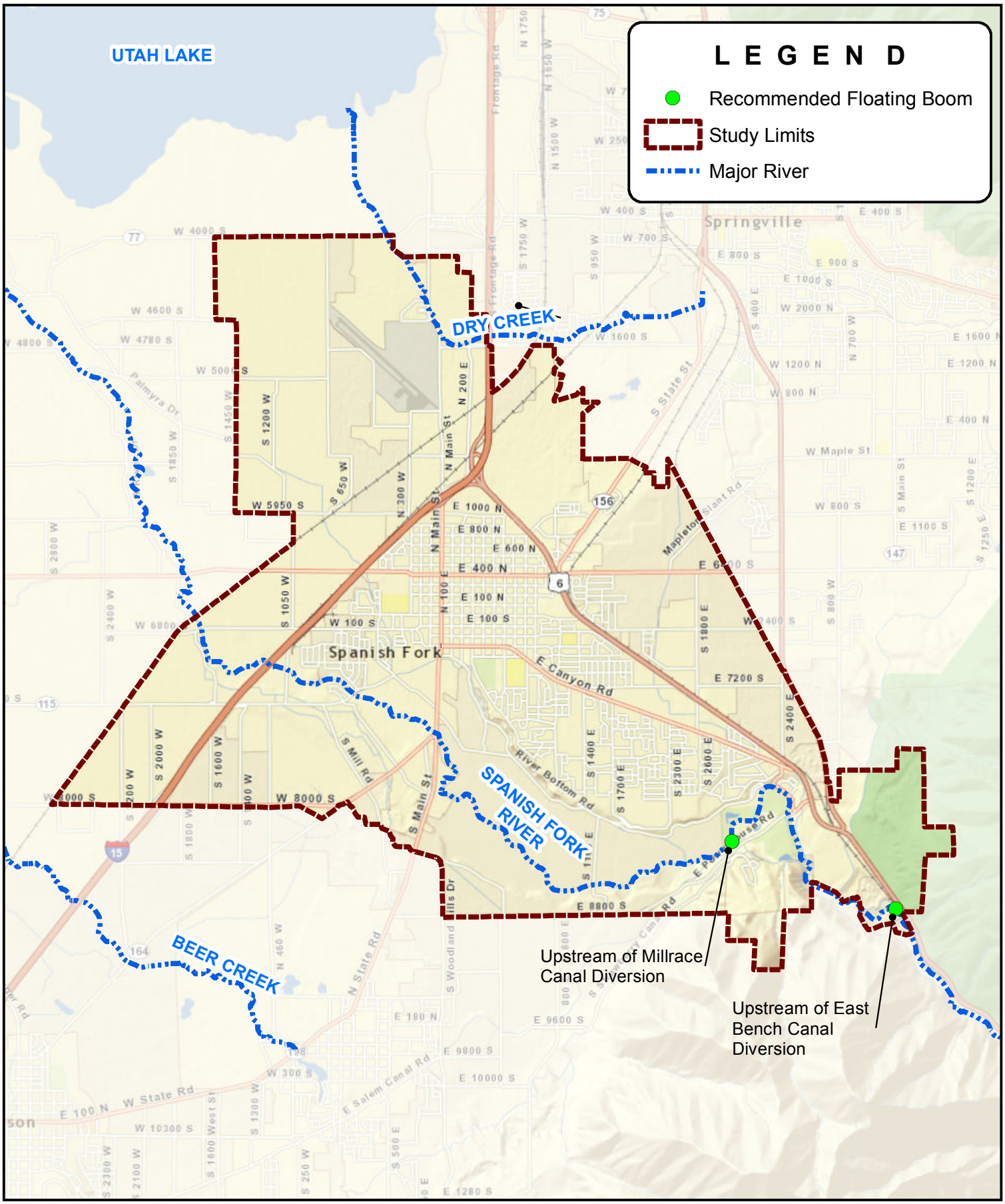
LOCATION ANALYSIS

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 this 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 would 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 boomsdo not function well or if issues like large rock collection and removal that the booms do not addressan 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\Task 2 - Flood Consulting\SDMP\Report\Figures\Figure 4-3 Boom Location.mxd mstayner 10/31/2011

CHAPTER 5
RECOMMENDED STORM DRAINAGE SYSTEM CAPITAL IMPROVEMENTS PLAN

GENERAL APPROACH

The following major tasks were completed to accomplish the objectives of this study:

- Peak discharge rates and runoff volumes produced by design storms were estimated for the drainage basins and subbasins within the study area.
- Estimates of hydraulic capacities of existing storm drainage facilities in the study area were provided by Spanish Fork City.
- The results of the hydrologic and hydraulic analyses were used to identify deficiencies in storm drainagetrunklines and storm water detention basins.
- Improvements were recommended to resolve storm drainage system deficiencies under projected future development conditions.

GENERAL RECOMMENDATIONS

Spanish Fork City has a Storm Water Drainage Design Manual that provides design detail requirements for designing new storm drain facilities. The analyses used to identify recommended improvements is based on future development conditions and the design criteria defined in the Storm Water Drainage Design Manual (see Attachment 1), including post-construction peak discharge requirements.

Post-construction peak design storm discharge shall not be greater than 0.15 cfs per acre for industrial, commercial and high density residential areas, or a net peak discharge, including public right-of-ways, of 0.2 cfs per acre (see Section 3.2 of the Storm Water Drainage Design Manual). Future residential development areas were model assuming there would be no local detention constructed.The discharge from future residential areas was calculated based on unit densities from the Spanish Fork General Plan (see Appendix C). If development is approved for higher densities than what is on the current General Plan, additional detention will be required.

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 high intensity cloudburst design storm event. A detailed list of recommended projects for trunk lines and regional detention basins is presented in Table 5-1 and are shown in Figure 5-1. The back-up cost estimate calculations for the recommended projects are included in Appendix D.

The projects are not listed by priority or construction order. Spanish Fork City personnel will prepare a separate Impact Fee Facility Plan where the proposed projects will be prioritized. The trunk lines are numbered by subfigure as indicated in Table 5-1.

Recommended Pipe Sizes

ID	Existing Flow (cfs)	Design Flow[1] (cfs)	Existing Diameter (in)	Estimated Pipe Slope (ft/ft)	Manning's n	Estimated Existing Full Pipe Capacity (cfs)	Existing Deficient	Future Deficient	Recommended Future Diameter[2] (in)	Estimated Future Pipe Capacity (cfs)
R100	0.0	15.2	24	0.003	0.013	15.0	NO	NO	24	12.4
R101	24.1	27.3	30	0.008	0.013	22.5	NO	NO	30	36.8
R102	3.6	11.0	24	0.004	0.013	10.0	NO	NO	24	14.3
R103	4.6	12.0	24	0.007	0.013	20.0	NO	NO	24	19.0
R104	2.7	14.3		0.004	0.013		FUT	FUT	24	14.3
R105	2.7	14.3		0.009	0.013		FUT	FUT	24	21.5
R106	6.0	15.5		0.005	0.013		FUT	FUT	24	16.0
R107	0.4	0.4		0.002	0.013		FUT	FUT	18	4.7
R108	0.0	14.6		0.003	0.013		FUT	FUT	30	22.5
R109	0.0	18.1		0.003	0.013		FUT	FUT	30	22.5
R110	0.0	14.1		0.003	0.013		FUT	FUT	30	22.5
R111	0.0	61.8		0.0026	0.013		FUT	FUT	42	59.7
R112	0.0	85.7		0.003	0.013		FUT	FUT	48	78.9
R113	0.0	118.3		0.006	0.013		FUT	FUT	48	111.6
R114	14.8	14.8		0.006	0.013		FUT	FUT	24	17.6
R115	31.9	31.9		0.012	0.013		FUT	FUT	30	45.1
R116	39.9	39.9		0.014	0.013		FUT	FUT	30	48.7
R117	39.9	2.5	36	0.007	0.013	2.5	NO	NO	36	19.3
R118	20.0	20.0		0.01	0.013		FUT	FUT	24	22.7
R119	50.8	50.8		0.02	0.013		FUT	FUT	30	56.2
R120	14.9	14.9		0.008	0.013		FUT	FUT	24	20.3
R121	35.9	35.9		0.008	0.013		FUT	FUT	30	36.8
R122	14.8	14.8		0.008	0.013		FUT	FUT	24	20.3
R123	77.1	79.7	48	0.0002	0.013	79.9	NO	NO	54	80.0
R124	175.7	66.6	54	0.002	0.013	66.6	YES	NO	78	73.6
R125	296.1	138.1	36	0.002	0.013	138.1	YES	NO	36	126.1
R126	31.1	31.1	30	0.0045	0.012	29.9	NO	NO	30	29.9
R127	51.8	51.8	36	0.005	0.012	52.4	NO	NO	36	51.2
R128	67.3	37.5	36	0.004	0.012	37.5	YES	NO	42	69.1
R129	21.5	21.5		0.008	0.013		FUT	FUT	24	20.3
R130	39.5	39.5		0.013	0.013		FUT	FUT	30	46.9
R131	71.8	71.8		0.01	0.013		FUT	FUT	36	66.9
R132	71.8	2.6	24	0.002	0.013	26.0	YES	NO	24	10.1
R133	12.3	12.3	18	0.016	0.013	14.5	NO	NO	18	13.3
R134	20.5	20.5	24	0.008	0.013	22.5	NO	NO	24	20.3
R135	9.1	9.1		0.005	0.013		FUT	FUT	24	16.0
R136	9.1	7.9	24	0.009	0.013	7.9	NO	NO	24	12.8
R137	25.7	25.0	24	0.011	0.013	25.0	YES	NO	24	23.8
R138	25.7	31.7	30	0.008	0.013	31.7	NO	NO	30	36.2
R139	25.7	107.8		0.009	0.013		FUT	FUT	48	136.6
R140	27.3	94.9	48	0.009	0.021	94.9	NO	NO	48	65.8
R141	19.1	101.2		0.005	0.013		OCF	FUT	48	101.8
R142	81.1	42.6		0.02	0.013		FUT	FUT	30	56.2
R143	81.1	69.5	15	0.02	0.012	10.2	YES	YES	36	102.5
R144	81.1	73.3	36	0.004	0.012	45.0	YES	YES	42	69.1
R145	81.1	73.3	24	0.01	0.012	25.0	YES	YES	36	72.5
R146	11.6	11.6	24	0.024	0.012	38.3	NO	NO	18	17.7
R147	15.6	19.8	24	0.014	0.013	19.8	NO	NO	24	26.8
R148	5.9	19.1		0.004	0.013		FUT	FUT	30	26.0
R149	2.9	9.6	36	0.004	0.013	40.0	NO	NO	36	42.3
R150	5.9	19.1		0.004	0.013		FUT	FUT	30	26.0
R151	0.0	39.8		0.004	0.013		FUT	FUT	36	42.3
R152	0.0	92.1		0.003	0.013		FUT	FUT	54	108.0
R153	0.0	24.1		0.004	0.013		FUT	FUT	30	26.0
R157	0.0	23.5		0.004	0.013		FUT	FUT	30	26.0
R158	0.0	10.6		0.002	0.013		FUT	FUT	24	10.1
R159	0.0	27.1		0.008	0.013		FUT	FUT	30	36.8
R160	33.2	54.1		0.008	0.013		FUT	FUT	36	59.8
R161	35.1	74.1		0.008	0.013		FUT	FUT	42	90.2
R162	11.3	11.3		0.004	0.013		OCF	FUT	24	14.3
R163	61.1	102.5		0.004	0.013		FUT	FUT	54	124.7
R164	73.1	127.9		0.004	0.013		FUT	FUT	54	124.7
R165	73.9	129.4		0.004	0.013		FUT	FUT	54	124.7
R166	7.3	7.3	18	0.002	0.013	8.0	NO	NO	18	4.7
R167	15.0	15.0	36	0.0025	0.013	33.4	NO	NO	36	33.4
R177	67.5	67.5	54	0.005	0.013	87.5	NO	NO	54	111.2
R178	26.9	26.9	18	0.021	0.013	26.9	YES	YES	30	59.3
R179	12.1	12.1	18	0.013	0.013	21.1	No	No	18	12.2
R180	14.7	14.7	18	0.022	0.013	14.7	NO	NO	18	15.6
R181	9.1	9.1	15	0.015	0.022	9.1	NO	NO	15	4.6
R182	9.3	9.3	18	0.011	0.013	9.3	NO	NO	18	11.0
R183	29.3	29.3	30	0.31	0.013	29.3	NO	NO	30	71.7
R184	15.6	15.6	24	0.019	0.013	15.6	NO	NO	24	18.3
R185	13.3	13.3	24	0.022	0.013	13.3	NO	NO	24	34.0
R186	8.4	8.4	30	0.007	0.012	8.4	NO	NO	30	38.0
R187	36.2	36.2	36	0.01	0.013	36.2	NO	NO	36	65.7
R188	39.9	39.9		0.005	0.013	39.9	FUT	FUT	36	47.3
R189	9.1	9.1		0.015	0.013	9.1	FUT	FUT	18	12.9
R190	31.8	31.8	36	0.003	0.013	31.8	FUT	FUT	36	36.5
R191	9.3	9.3		0.007	0.013	9.3	NO	NO	18	9.0
R192	24.7	24.7		0.013	0.013	24.7	FUT	FUT	36	46.8
R193	53.6	53.6		0.011	0.013	53.6	FUT	FUT	36	69.3
R194	35.3	35.3		0.015	0.013	35.3	FUT	FUT	30	49.9
R195	67.0	67.0		0.007	0.013	67.0	FUT	FUT	42	86.0
R196	49.3	49.3		0.011	0.013	49.3	FUT	FUT	36	71.5
R197	15.0	15.0	24	0.017	0.013	15.0	NO	NO	24	30.0
R198	44.9	44.9		0.011	0.013	44.9	FUT	FUT	30	43.2
R199-A	15.9	15.9		0.01	0.013		FUT	FUT	24	22.7
R199-B	63.5	63.5		0.003	0.013		FUT	FUT	48	88.5
R199-C	93.5	93.5		0.003	0.013		FUT	FUT	54	102.2
R199-D	37.5	37.5		0.005	0.013		FUT	FUT	36	47.3
R199-E	3.9	3.9	15	0.0021	0.013	3.0	FUT	No	15	3.0

FUT = Future Pipe

[1] Pipe diameter is based on estimated slope. Pipe diameter and slope should be designed to convey the estimated design flow.

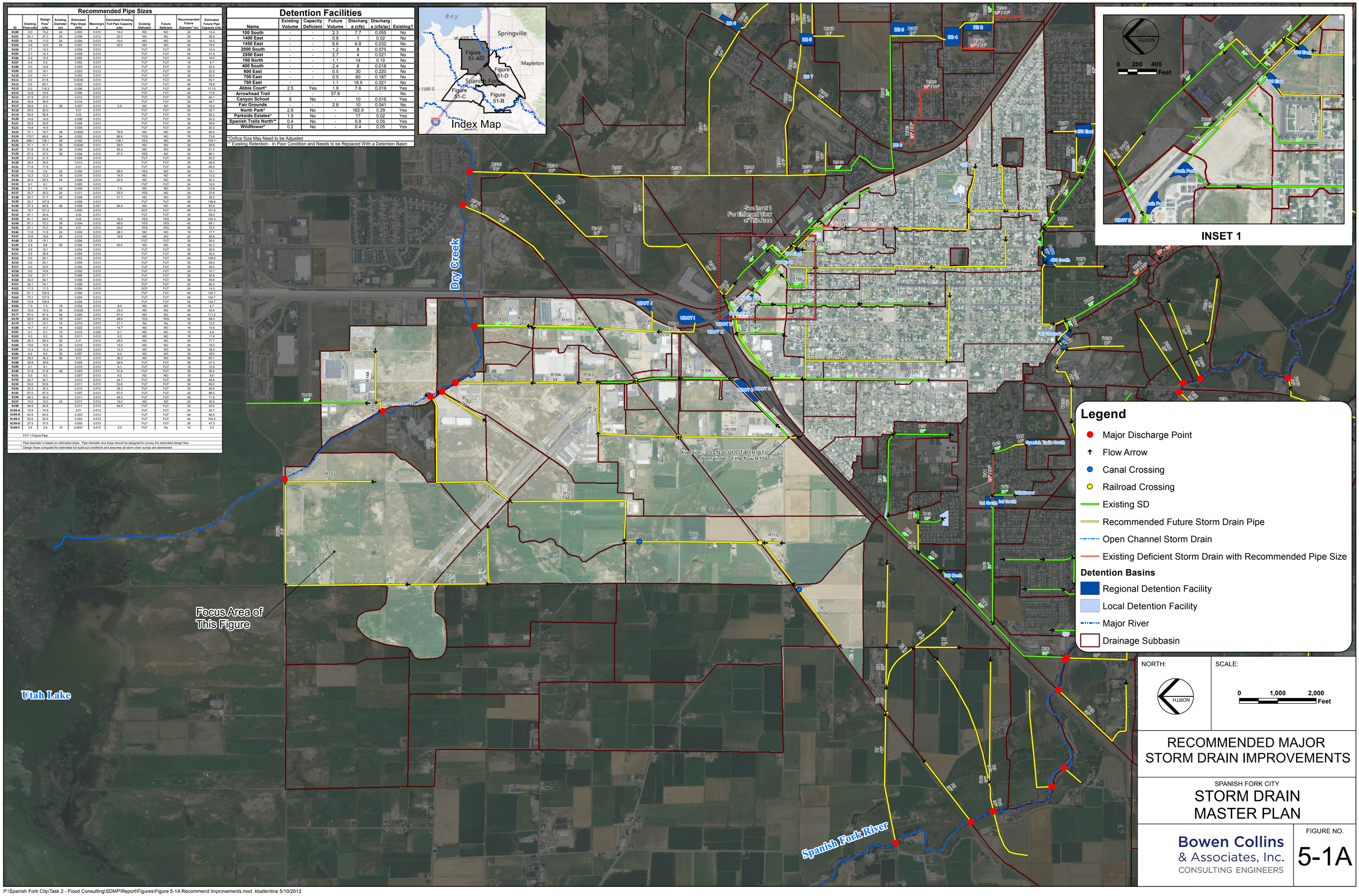
[2] Design flows computed for estimated full build-out conditions and assumes all storm drain sumps are abandoned.

Detention Facilities

Name	Existing Volume	Capacity Deficient	Future Volume	Discharge (cfs)	Discharge (cfs/ac)	Existing?
100 South	-	-	2.3	7.7	0.055	No
1400 East	-	-	0.8	1	0.02	No
1450 East	-	-	6.6	6.8	0.032	No
2000 South	-	-	1.2	8	0.075	No
2550 East	-	-	2.7	4	0.021	No
100 North	-	-	1.1	14	0.10	No
400 South	-	-	2.4	8	0.018	No
600 East	-	-	0.5	30	0.220	No
700 East	-	-	0.5	60	0.187	No
750 East	-	-	1.1	18.5	0.021	No
Abbie Court*	2.5	Yes	1.9	7.6	0.019	Yes
Arrowhead Trail	-	-	57.9	-	-	No
Canyon School	5	No	-	10	0.016	Yes
Fair Grounds	-	-	2.8	10	0.041	No
North Park*	2.8	No	-	162.9	0.29	Yes
Parkside Estates*	1.9	No	-	17	0.02	Yes
Spanish Trails North**	0.4	No	-	0.8	0.05	Yes
Wildflower*	0.2	No	-	0.4	0.05	Yes

*Orifice Size May Need to be Adjusted

** Existing Retention - In Poor Condition and Needs to be Replaced With a Detention Basin



RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.

5-1A

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ID	Existing Flow (cfs)	Design Flow[1] (cfs)	Existing Diameter (in)	Estimated Pipe Slope (ft/ft)	Manning's n	Estimated Existing Full Pipe Capacity	Existing Deficient	Future Deficient	Diameter Required (in)	Recommended Future Diameter[2] (in)	Estimated Future Pipe Capacity (cfs)
R200	0.0	28.7		0.006	0.013		FUT	FUT	28.8	30	31.9
R201	0.0	8.0		0.06	0.013		FUT	FUT	11.6	18	25.8
R202	0.0	8.0		0.006	0.013		FUT	FUT	17.9	18	8.2
R203	0.0	5.5		0.004	0.013		FUT	FUT	16.7	18	6.7
R204	2.0	20.1	18	0.006	0.013	4.5	NO	YES	27.2	30	26.0
R205	4.0	4.0	15	0.008	0.022	5	NO	NO	15.9	15	3.4
R206	4.0	4.0	18	0.008	0.013	5	NO	NO	13.1	18	9.4
R207	11.8	11.8	18	0.003	0.013	6	YES	YES	23.5	24	12.4
R208	20.7	20.7	18	0.008	0.013	5	YES	YES	24.2	24	20.3
R209	42.9	42.9	24	0.004	0.013	10	YES	YES	36.2	36	42.3
R210	7.6	7.6	18	0.0025	0.012	30.5	NO	NO	20.0	18	5.7
R211	8.7	8.7	18	0.005	0.012	7.8	NO	NO	18.5	18	8.1
R212	20.1	20.1	18	0.002	0.013	4.3	YES	YES	31.0	30	18.4
R213	4.5	4.5	15	0.002	0.012	4	NO	NO	17.2	15	3.1
R214	28.0	28.0	18	0.005	0.013	7.5	YES	YES	29.6	30	29.1
R215	5.7	7.5	21	0.004	0.022	6.5	NO	NO	22.9	21	5.9
R216	11.4	15.0	18	0.004	0.012	8	YES	YES	23.7	24	15.5
R217	13.2	13.2	24	0.004	0.012	15	NO	NO	22.6	24	15.5
R218	1.6	1.6	15	0.001	0.012	3	NO	NO	13.3	15	2.2
R219	16.4	16.4	24	0.002	0.013	3	YES	YES	28.8	30	18.4
R220	12.8	12.8	18	0.004	0.013	6	YES	YES	23.0	24	14.3
R221	38.3	38.3	24	0.005	0.013	5.1	YES	YES	33.3	36	47.3
R222	1.6	1.6	15	0.001	0.012	2	NO	NO	13.3	15	2.2
R223	11.0	11.0	24	0.005	0.012	13.7	NO	NO	20.2	24	17.4
R224	10.0	10.0		0.005	0.013		FUT	FUT	20.1	24	16.0
R225	36.9	36.9	24	0.006	0.012	6.7	YES	YES	30.8	30	34.5
R226	36.9	36.9	24	0.3	0.012	135	NO	NO	14.8	24	134.6
R227	18.5	18.5		0.002	0.013		FUT	FUT	30.1	30	18.4
R231	18.5	26.5		0.002	0.013		FUT	FUT	34.4	36	20.9
R232	1.9	3.0		0.002	0.013		OCF	FUT	15.2	18	4.7
R233	1.9	3.0		0.002	0.013		OCF	FUT	15.2	18	4.7
R234	0.0	6.0		0.003	0.013		FUT	FUT	18.3	18	5.8
R237	0.0	9.6		0.004	0.013		FUT	FUT	20.6	24	14.3
R238	0.0	24.0		0.004	0.013		FUT	FUT	29.1	30	26.0
R242	13.0	13.0	24	0.005	0.013	16	NO	NO	22.1	24	16.0
R243	37.0	37.0	30	0.25	0.013	200	NO	NO	15.8	30	205.6
R244	37.0	37.0		0.002	0.013		FUT	FUT	39.0	42	45.1
R245	19.6	25.9	18	0.005	0.013	12.4	YES	YES	28.7	30	29.1
R246	19.6	20.8	24	0.005	0.013	4.2	YES	YES	26.5	30	29.1
R247	38.5	45.9	24	0.01	0.013	13.5	YES	YES	30.8	30	41.1
R249	39.5	53.1		0.015	0.013		YES	YES	30.6	30	50.4
R250	0.0	45.2		0.003	0.013		FUT	FUT	39.0	42	55.3
R251	0.0	11.0		0.003	0.013		FUT	FUT	22.9	24	12.4
R252	0.0	11.0		0.003	0.013		FUT	FUT	22.9	24	12.4
R253	0.0	22.0		0.002	0.013		FUT	FUT	32.1	36	29.9
R254	0.0	22.8		0.003	0.013		FUT	FUT	30.1	30	22.5
R255	32.6	38.0		0.0014	0.013		FUT	FUT	42.1	42	37.7
R256	3.1	6.9		0.004	0.013		FUT	FUT	18.2	18	6.7
R257	66.5	93.0	54	0.006	0.012	166.9	NO	NO	43.5	54	165.5
R258	67.5	93.5		0.003	0.013		OCF	FUT	51.2	54	108.0
R259	51.0	62.9		0.0023	0.013		FUT	FUT	46.3	48	69.1
R260	67.5	93.2		0.0023	0.013		FUT	FUT	53.7	54	94.6
R261	0.0	7.1		0.004	0.013		FUT	FUT	18.4	18	6.7
R262	8.0	8.0		0.015	0.013		FUT	FUT	15.0	18	12.9
R263	38.4	45.6	36	0.013	0.022	44.8	NO	NO	36.2	36	45.1
R264	8.0	8.0	36	0.3	0.013	300	NO	NO	8.6	36	366.3
R265	10.0	10.0		0.0017	0.013		FUT	FUT	24.6	24	9.4
R266	20.6	24.3		0.0014	0.013		FUT	FUT	35.6	36	25.0
R267	8.0	8.0		0.005	0.013		FUT	FUT	18.5	18	7.4
R268	3.7	3.6		0.008	0.013		FUT	FUT	12.5	18	9.4
R269	18.3	28.6	24	0.011	0.013	34.5	NO	NO	22.3	36	70.1
R270	20.4	29.9		0.01	0.012		FUT	FUT	23.0	36	72.5
R271	8.2	5.9		0.01	0.013		FUT	FUT	14.5	18	10.5
R272	7.7	7.7	24	0.0012	0.012	7.7	NO	NO	23.1	24	8.5
R273	11.9	20.8	30	0.014	0.012	52.9	NO	NO	17.5	30	52.7
R274	6.8	6.8		0.003	0.012		OCF	FUT	18.6	18	6.2
R275	8.6	25.5		0.004	0.013		FUT	FUT	29.8	30	26.0
R276	1.1	1.2	24	0.003	0.012	10	NO	NO	9.6	24	13.5
R277	22.1	28.1		0.006	0.013		FUT	FUT	29.6	30	29.1
R278	2.61	2.61		0.006	0.013		FUT	FUT	11.7	18	8.2

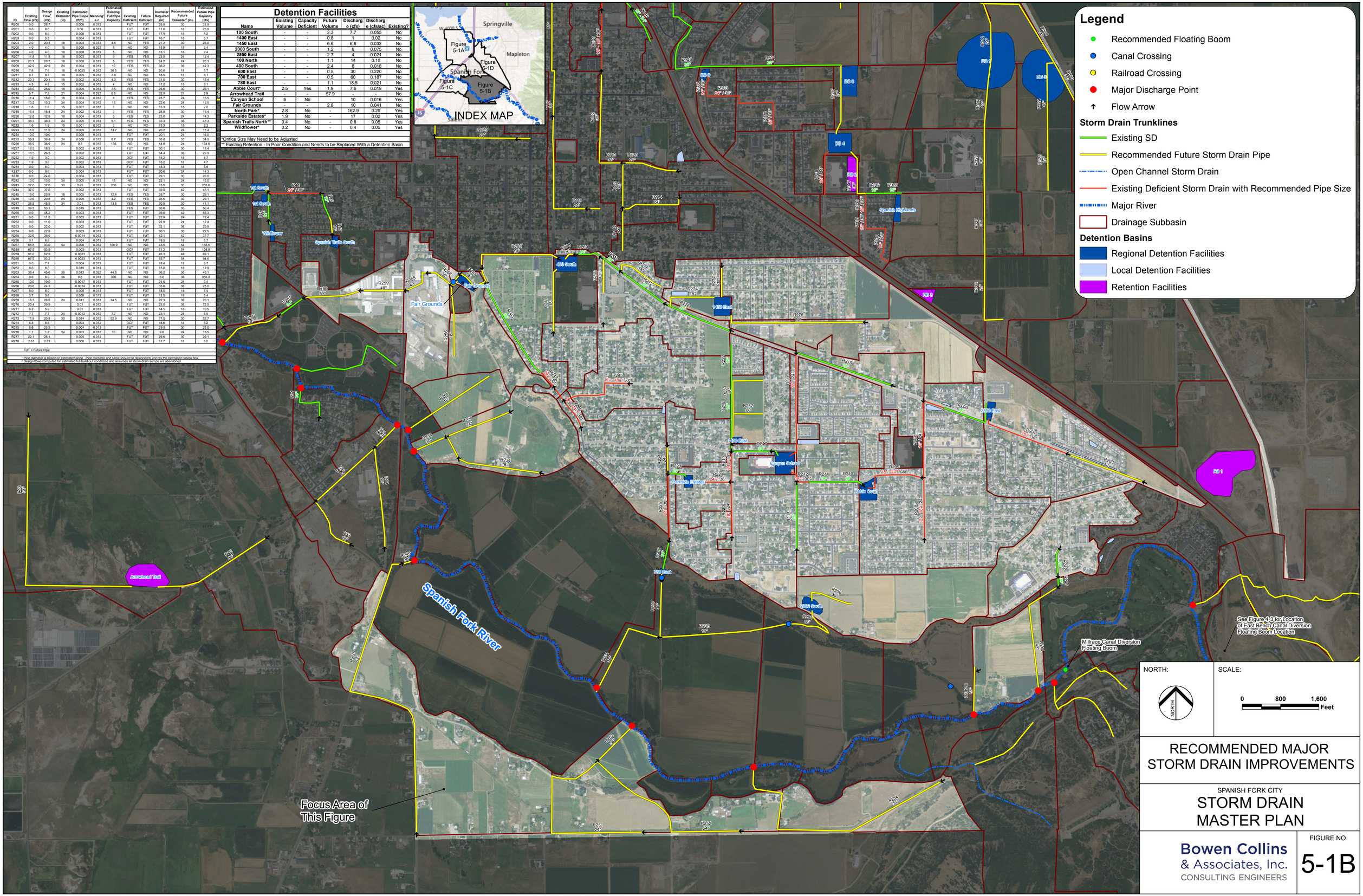
FUT = Future Pipe

[1] Pipe diameter is based on estimated slope. Pipe diameter and slope should be designed to convey the estimated design flow.
[2] Design flows computed for estimated full build-out conditions and assumes all storm drain sumps are abandoned.

Detention Facilities

Name	Existing Volume	Capacity Deficient	Future Volume	Discharge (cfs)	Discharge (cfs/ac)	Existing?
100 South	-	-	2.3	7.7	0.055	No
1400 East	-	-	0.8	1	0.02	No
1450 East	-	-	6.6	6.8	0.032	No
2000 South	-	-	1.2	8	0.075	No
2550 East	-	-	2.7	4	0.021	No
100 North	-	-	1.1	14	0.10	No
400 South	-	-	2.4	8	0.018	No
600 East	-	-	0.5	30	0.220	No
700 East	-	-	0.5	60	0.187	No
750 East	-	-	1.1	18.5	0.021	No
Abbie Court*	2.5	Yes	1.9	7.6	0.019	Yes
Arrowhead Trail	-	-	57.9	-	-	No
Canyon School	5	No	-	10	0.016	Yes
Fair Grounds	-	-	2.8	10	0.041	No
North Park*	2.8	No	-	162.9	0.29	Yes
Parkside Estates*	1.9	No	-	17	0.02	Yes
Spanish Trails North**	0.4	No	-	0.8	0.05	Yes
Wildflower*	0.2	No	-	0.4	0.05	Yes

*Orifice Size May Need to be Adjusted
** Existing Retention - In Poor Condition and Needs to be Replaced With a Detention Basin



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Recommended Pipe Sizes

ID	Existing Flow (cfs)	Design Flow[1] (cfs)	Existing Diameter	Existing Pipe Slope (ft/ft)	Manning's n	Estimated Existing Full Pipe Capacity (cfs)	Existing Deficient	Future Deficient	Diameter Required (in)	Recommended Future Diameter[2] (in)	Estimated Future Pipe Capacity (cfs)
R1	0	3.2		0.003	0.013		FUT	FUT	14.4	18	5.8
R2	0	12.8		0.003	0.013		FUT	FUT	24.2	24	12.4
R3	0	12.8		0.003	0.013		FUT	FUT	24.2	24	12.4
R4	0	22.5		0.003	0.013		FUT	FUT	30.0	30	22.5
R5	0	23.3		0.003	0.013		FUT	FUT	30.4	30	22.5
R6	0	45.8		0.003	0.013		FUT	FUT	39.1	42	55.3
R7	0	45.8		0.003	0.013		FUT	FUT	39.1	42	55.3
R8	0	23.3		0.003	0.013		FUT	FUT	30.4	30	22.5
R9	0	17.1		0.002	0.013		FUT	FUT	29.2	30	18.4
R10	0	10.0		0.002	0.013		FUT	FUT	23.8	24	10.1
R11	0	28.5		0.005	0.013		FUT	FUT	29.8	30	29.1
R12	0	55.9		0.03	0.013		FUT	FUT	27.4	30	71.2
R13	0	121.1		0.004	0.013		FUT	FUT	53.4	54	124.7
R14	0	40.4		0.004	0.013		FUT	FUT	35.4	36	42.3
R19	0	19.1		0.003	0.013		FUT	FUT	26.2	30	22.5
R20	0	224.9		0.006	0.013		FUT	FUT	62.4	66	260.8
R21	0	37.8		0.003	0.013		FUT	FUT	36.4	36	36.6
R22	0	23.9		0.003	0.013		FUT	FUT	30.7	30	22.5
R23	0	113.2		0.003	0.013		FUT	FUT	55.0	60	143.0
R24	0	18.6		0.003	0.013		FUT	FUT	26.0	30	22.5
R25	0	155.3		0.003	0.013		FUT	FUT	61.9	66	184.4
R26	0	13.3		0.004	0.013		FUT	FUT	23.3	24	14.3
R28	4	21.0		0.004	0.013		FUT	FUT	27.7	30	26.0
R29	4.2	18.6		0.005	0.013		FUT	FUT	25.4	30	29.1
R30	11.1	23.4	24	0.01	0.012	25.6	NO	NO	23.6	24	24.6
R31	18	18.0	24	0.005	0.012	17.1	NO	NO	24.3	24	17.4
R32	4.2	14.2		0.02	0.013		FUT	FUT	17.7	18	14.9
R33	9.45	32.0		0.017	0.013		FUT	FUT	24.7	24	29.6
R34	9.45	32.0		0.01	0.013		FUT	FUT	27.3	30	41.1
R35	21	71.1		0.025	0.013		FUT	FUT	31.0	30	65.0
R36	27.6	31.0	54	0.0007	0.013	30.0	NO	NO	44.4	48	38.1
R37	4.69	4.7	18	0.003	0.013	10.9	NO	NO	16.7	18	5.8
R38	13.4	13.4	24	0.003	0.013	12.0	NO	NO	24.7	24	12.4
R39	17.4	17.4	48	0.0006	0.013	35.3	FUT	NO	36.8	48	35.3
R40	9.5	8.2	21	0.002	0.013	8.0	NO	NO	22.2	24	10.1
R41	15.4	15.5	30	0.0005	0.013	14.0	NO	NO	36.5	30	9.2
R42	6.3	6.3	12	0.002	0.013	6.0	NO	NO	20.1	12	1.6
R43	10.5	10.5		0.002	0.013		FUT	FUT	24.3	24	10.1
R44	33.6	28.6	24	0.004	0.012	11.2	YES	YES	30.1	30	28.2
R45	0	1.6	18	0.006	0.012	2.0	NO	NO	9.4	18	8.8
R46	9.5	8.2	21	0.002	0.012	9.0	NO	NO	21.5	24	11.0
R47	0	0.6		0.003	0.013		FUT	FUT	8.6	18	5.8
R48	29.7	34.6	48	0.0006	0.013	35.3	FUT	NO	47.7	48	35.3
R49	4.2	4.2	12	0.002	0.013	3.8	NO	NO	17.2	12	1.6

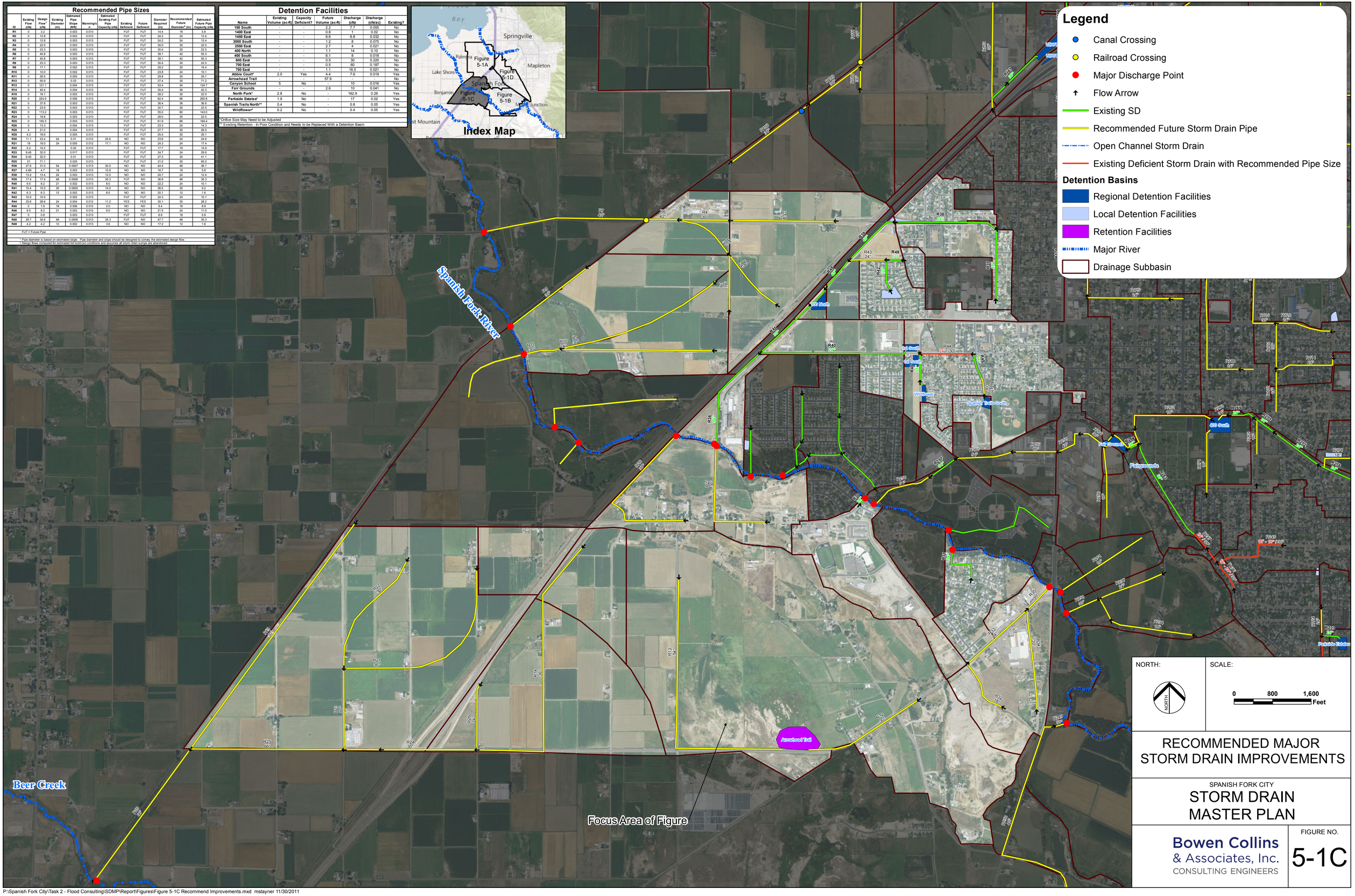
FUT = Future Pipe

[1] Pipe diameter is based on estimated slope. Pipe diameter and slope should be designed to convey the estimated design flow.
[2] Design flows computed for estimated full buildout conditions and assumes all storm drain sumps are abandoned.

Detention Facilities

Name	Existing Volume (ac-ft)	Capacity Deficient?	Future Volume (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)	Existing?
100 South	-	-	2.2	7.7	0.055	No
1400 East	-	-	0.8	1	0.02	No
1450 East	-	-	6.6	6.8	0.032	No
2000 South	-	-	1.2	8	0.075	No
2550 East	-	-	2.7	4	0.021	No
400 North	-	-	1.1	14	0.10	No
400 South	-	-	6.1	8	0.018	No
600 East	-	-	0.5	30	0.220	No
700 East	-	-	0.5	60	0.187	No
780 East	-	-	1.1	18.5	0.021	No
Abbie Court*	2.5	Yes	4.4	7.6	0.019	Yes
Arrowhead Trail	-	-	57.9	-	-	No
Canyon School	5	No	-	10	0.016	Yes
Fair Grounds	-	-	2.6	10	0.041	No
North Park*	2.8	No	-	162.9	0.29	Yes
Parkside Estates*	1.9	No	-	17	0.02	Yes
Spanish Trails North**	0.4	No	-	0.8	0.05	Yes
Wildflower*	0.2	No	-	0.4	0.05	Yes

*Orifice Size May Need to be Adjusted
** Existing Retention - In Poor Condition and Needs to be Replaced With a Detention Basin



RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY
STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
5-1C

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ID	Existing Flow (cfs)	Design Flow[1] (cfs)	Existing Diameter (in)	Estimated Pipe Slope (ft/ft)	Manning's n	Estimated Existing Full Pipe Capacity (cfs)	Existing Deficient	Future Deficient	Recommended Future Diameter[2] (in)	Estimated Future Pipe Capacity (cfs)
R300	15.0	21.0	18	0.005	0.013	7.4	YES	YES	30	29.1
R301	9.0	15.0	24	0.0042	0.013	14.7	NO	NO	24	14.7
R302	50.0	53.7	24	0.015	0.013	8.0	YES	YES	30	50.4
R303	40.0	43.1	24	0.012	0.013	13.0	YES	YES	30	45.1
R304	0	43.2		0.002	0.013		FUT	FUT	42	45.1
R305	0	31.3		0.02	0.013		FUT	FUT	24	32.1
R306	0	89.3		0.02	0.013		FUT	FUT	36	94.6
R307	9	9.0		0.003	0.013		FUT	FUT	24	12.4
R308	0	23.8		0.0044	0.013		FUT	FUT	30	27.3
R309	0	13.1		0.004	0.013		FUT	FUT	24	14.3
R310	0	48.5		0.002	0.013		FUT	FUT	42	45.1
R311	0	33.1		0.003	0.013		FUT	FUT	36	36.6
R312	0	7.9		0.003	0.013		FUT	FUT	24	12.4
R313	0	48.9		0.008	0.013		FUT	FUT	36	59.8
R314	4.7	32.6		0.02	0.013		FUT	FUT	24	32.1
R315	84.3	176.0		0.011	0.013		FUT	FUT	54	206.8
R316	4.7	20.5		0.02	0.013		FUT	FUT	24	32.1
R317	0	54.6		0.004	0.013		FUT	FUT	42	63.8
R318	0	10.0		0.004	0.013		FUT	FUT	24	14.3
R319	0	19.9		0.004	0.013		FUT	FUT	30	20.0
R320	15.6	103.4		0.02	0.013		FUT	FUT	42	142.7
R321	3.8	5.3		0.01	0.013		FUT	FUT	18	10.5
R322	0	10.4		0.005	0.013		FUT	FUT	24	16.0
R323	0	17.2		0.003	0.013		FUT	FUT	30	22.5
R324	0	28.9		0.0046	0.013		FUT	FUT	30	27.9
R325	0	9.5		0.0046	0.013		FUT	FUT	24	15.4
R326	0	27.8		0.0035	0.013		FUT	FUT	36	39.6
R327	0	20.7		0.003	0.013		FUT	FUT	30	22.5
R328	0.4	1.0	15	0.003	0.013	3.5	NO	NO	15	3.5
R329	0.4	1.0	15	0.004	0.013	4.1	NO	NO	15	4.1
R330	16.6	21.3	15	0.004	0.013	4.1	YES	YES	30	26.0
R331	14.1	18.8	15	0.004	0.013	4.1	YES	YES	30	26.0
R332	11.6	16.3	15	0.004	0.013	4.1	YES	YES	24	14.3
R333	0	25.9		0.02	0.013		FUT	FUT	24	32.1
R334	419.4	580.1		0.005	0.013		FUT	FUT	90	544.4
R335	414.4	608.5		0.005	0.013		FUT	FUT	96	646.7
R336	89.7	220.8		0.01	0.013		FUT	FUT	60	261.1
R337	411.9	579.9		0.005	0.013		FUT	FUT	90	544.4
R338	48.5	58.8		0.01	0.013		FUT	FUT	36	66.9
R339	20.1	119.24		0.005	0.013		FUT	FUT	54	139.4
R340	28.7	42.4	36	0.005	0.013	47.3	NO	NO	36	47.3
R341	0	9.6		0.006	0.013		FUT	FUT	24	17.6
R342	0	19.2		0.006	0.013		FUT	FUT	24	17.6
R343	336.7	362.9		0.003	0.013		FUT	FUT	84	350.8
R344	0	361.2		0.003	0.013		FUT	FUT	84	350.8
R345	10.4	14.2		0.01	0.013		FUT	FUT	24	22.7
R346	10.4	28.4		0.01	0.013		FUT	FUT	30	41.1
R347	19.3	23.3		0.005	0.013		FUT	FUT	30	29.1
R348	13.3	23.0	24	0.005	0.013	16.0	NO	NO	24	16.0
R349	15.6	15.6		0.0067	0.013		FUT	FUT	24	18.6

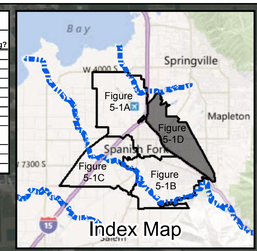
FUT = Future Pipe

[1] Pipe diameter is based on estimated slope. Pipe diameter and slope should be designed to convey the estimated design flow.

[2] Design flows computed for estimated full build-out conditions and assumes all storm drain sumps are abandoned.

Detention Facilities

Name	Existing Volume (ac-ft)	Capacity Deficient?	Future Volume (ac-ft)	Discharge (cfs)	Discharge (cfs/ac)	Existing?
DB1	-	-	8.5	7.9	0.04	No
DB3	-	-	4.5	13.1	0.08	No
DB4	-	-	4.9	12.2	0.05	No
DB5	-	-	3.1	89.3	0.11	No
DB6	-	-	2.6	20.5	0.15	No
DB7	-	-	1	5.7	0.15	No
DB8	-	-	2	2.8	0.05	No
DB9	1.7	No	1.7	47.1	0.32	Yes
Spanish Highlands	3.7	No	3.7	2.5	0.04	Yes
RB1	-	-	22.7	0	-	No
RB2	-	-	2.3	0	-	Yes
RB3	-	-	2.6	0	-	No



Legend

- Major Discharge Point
- Flow Arrow
- Canal Crossing
- Railroad Crossing

Storm Drain Trunklines

- Existing SD
- Recommended Future Storm Drain Pipe
- Open Channel Storm Drain
- Existing Deficient Storm Drain with Recommended Pipe Size

Detention Basins

- Regional Detention Facilities
- Local Detention Facilities
- Retention Facilities
- Major Rivers
- Drainage Subbasin

NORTH:

SCALE: 0 800 1,600 Feet

RECOMMENDED MAJOR STORM DRAIN IMPROVEMENTS

SPANISH FORK CITY

STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
5-1D

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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 G.

COORDINATION WITH THE UDOT I-CORE PROJECT

The Utah Department of Transportation (UDOT) is currently expanding Interstate 15 through Spanish Fork under the Utah County Corridor Expansion Project (I-CORE). Spanish Fork City and UDOT developed and entered into a Storm Drain System Maintenance and Cooperative Agreement in conjunction with the I-CORE Project (see Appendix E).

Representatives from the I-CORE design team, Spanish Fork City and BC&A met multiple times during the I-CORE design process to coordinate the discharge of storm water from UDOT facilities. Several recently constructed storm drainage projects in Spanish Fork City resulted from the I-CORE project. See Appendix F for the I-CORE Drainage Report.

MODEL ACCURACY

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, and information from other drainage studies completed for the study area. BC&A and Spanish Fork City are not responsible for the results or accuracy of these models when used or modified by others.

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	$ 273,943	0%	100%	$ -	$ 273,943
R2	$ 243,985	0%	100%	$ -	$ 243,985
R3	$ 532,853	0%	100%	$ -	$ 532,853
R4	$ 288,943	0%	100%	$ -	$ 288,943
R5	$ 265,357	0%	100%	$ -	$ 265,357
R6	$ 250,851	0%	100%	$ -	$ 250,851
R7	$ 1,267,970	0%	100%	$ -	$ 1,267,970
R8	$ 409,646	0%	100%	$ -	$ 409,646
R9	$ 736,340	0%	100%	$ -	$ 736,340
R10	$ 809,279	0%	100%	$ -	$ 809,279
R11	$ 177,404	0%	100%	$ -	$ 177,404
R12	$ 621,388	0%	100%	$ -	$ 621,388
R13	$ 2,243,057	0%	100%	$ -	$ 2,243,057
R14	$ 1,499,734	0%	100%	$ -	$ 1,499,734
R19	$ 1,171,277	0%	100%	$ -	$ 1,171,277
R20	$ 1,660,388	0%	100%	$ -	$ 1,660,388
R21	$ 1,003,331	0%	100%	$ -	$ 1,003,331
R22	$ 548,854	0%	100%	$ -	$ 548,854
R23	$ 733,486	0%	100%	$ -	$ 733,486
R24	$ 758,491	0%	100%	$ -	$ 758,491
R25	$ 1,554,115	0%	100%	$ -	$ 1,554,115
R26	$ 233,996	0%	100%	$ -	$ 233,996
R28	$ 1,017,360	19%	81%	$ 193,783	$ 823,577
R29	$ 734,286	23%	77%	$ 165,807	$ 568,480
R32	$ 279,606	30%	70%	$ 82,584	$ 197,022
R33	$ 402,460	30%	70%	$ 118,870	$ 283,590
R34	$ 586,254	30%	70%	$ 173,155	$ 413,099
R35	$ 181,788	30%	70%	$ 53,693	$ 128,095
R43	$ 181,666	85%	15%	$ 155,081	$ 26,585
R44	$ 340,029	85%	15%	$ 288,974	$ 51,055
R47	$ 82,958	100%	0%	$ 82,958	$ -
R104	$ 640,163	19%	81%	$ 120,870	$ 519,293
R105	$ 376,174	0%	100%	$ -	$ 376,174
R106	$ 376,121	0%	100%	$ -	$ 376,121
R107	$ 115,537	100%	0%	$ 115,537	$ -
R108	$ 403,403	0%	100%	$ -	$ 403,403
R109	$ 272,571	0%	100%	$ -	$ 272,571
R110	$ 98,199	0%	100%	$ -	$ 98,199
R111	$ 1,165,927	0%	100%	$ -	$ 1,165,927
R112	$ 1,544,843	0%	100%	$ -	$ 1,544,843
R113	$ 1,670,508	0%	100%	$ -	$ 1,670,508

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**
R114	$ 326,289	100%	0%	$ 326,289	$ -
R115	$ 530,432	100%	0%	$ 530,432	$ -
R116	$ 506,534	100%	0%	$ 506,534	$ -
R118	$ 592,491	100%	0%	$ 592,491	$ -
R119	$ 130,895	100%	0%	$ 130,895	$ -
R120	$ 292,764	100%	0%	$ 292,764	$ -
R121	$ 263,526	100%	0%	$ 263,526	$ -
R122	$ 208,935	100%	0%	$ 208,935	$ -
R129	$ 478,257	100%	0%	$ 478,257	$ -
R130	$ 509,326	100%	0%	$ 509,326	$ -
R131	$ 592,079	100%	0%	$ 592,079	$ -
R141	$ 151,842	93%	7%	$ 141,100	$ 10,742
R142	$ 522,847	100%	0%	$ 522,847	$ -
R143	$ 406,742	100%	0%	$ 406,742	$ -
R144	$ 110,415	100%	0%	$ 110,415	$ -
R145	$ 122,159	100%	0%	$ 122,159	$ -
R148	$ 271,666	31%	69%	$ 83,458	$ 188,207
R150	$ 59,981	31%	69%	$ 18,427	$ 41,554
R151	$ 1,010,122	0%	100%	$ -	$ 1,010,122
R152	$ 1,359,130	0%	100%	$ -	$ 1,359,130
R153	$ 461,822	0%	100%	$ -	$ 461,822
R157	$ 580,632	0%	100%	$ -	$ 580,632
R158	$ 362,387	0%	100%	$ -	$ 362,387
R159	$ 855,039	92%	8%	$ 790,432	$ 64,607
R160	$ 674,537	55%	45%	$ 370,159	$ 304,378
R161	$ 504,413	44%	56%	$ 220,210	$ 284,203
R162	$ 240,040	100%	0%	$ 240,040	$ -
R163	$ 234,892	56%	44%	$ 131,307	$ 103,584
R164	$ 578,472	54%	46%	$ 313,697	$ 264,775
R165	$ 978,032	54%	46%	$ 531,055	$ 446,977
R178	$ 48,476	89%	11%	$ 43,178	$ 5,298
R188	$ 301,111	100%	0%	$ 301,111	$ -
R189	$ 81,142	100%	0%	$ 81,142	$ -
R190	$ 126,889	91%	9%	$ 115,158	$ 11,731
R192	$ 110,846	100%	0%	$ 110,846	$ -
R193	$ 134,007	87%	13%	$ 116,356	$ 17,651
R194	$ 51,870	80%	20%	$ 41,496	$ 10,374
R195	$ 350,448	100%	0%	$ 350,448	$ -
R196	$ 51,414	86%	14%	$ 44,052	$ 7,363
R198	$ 88,562	84%	16%	$ 74,637	$ 13,925
R199-A	$ 229,826	100%	0%	$ 229,826	$ -

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**
R199-B	$ 188,257	100%	0%	$ 188,257	$ -
R199-C	$ 1,354,367	100%	0%	$ 1,354,367	$ -
R199-D	$ 337,980	0%	100%	$ -	$ 337,980
R200	$ 227,158	0%	100%	$ -	$ 227,158
R201	$ 220,361	0%	100%	$ -	$ 220,361
R202	$ 434,524	0%	100%	$ -	$ 434,524
R203	$ 378,796	0%	100%	$ -	$ 378,796
R204	$ 541,790	91%	9%	$ 491,322	$ 50,468
R207	$ 511,304	95%	5%	$ 485,561	$ 25,743
R208	$ 306,990	100%	0%	$ 306,990	$ -
R209	$ 473,559	99%	1%	$ 467,010	$ 6,549
R212	$ 70,864	100%	0%	$ 70,864	$ -
R214	$ 90,226	100%	0%	$ 90,226	$ -
R216	$ 563,787	100%	0%	$ 563,787	$ -
R219	$ 177,144	97%	3%	$ 172,606	$ 4,538
R220	$ 278,808	100%	0%	$ 278,808	$ -
R221	$ 280,685	99%	1%	$ 277,752	$ 2,933
R224	$ 144,048	100%	0%	$ 144,048	$ -
R225	$ 381,634	100%	0%	$ 381,634	$ -
R227	$ 265,613	100%	0%	$ 265,613	$ -
R231	$ 514,171	70%	30%	$ 358,949	$ 155,221
R232	$ 182,486	63%	37%	$ 115,012	$ 67,474
R233	$ 330,598	63%	37%	$ 208,360	$ 122,238
R234	$ 510,597	0%	100%	$ -	$ 510,597
R237	$ 241,473	0%	100%	$ -	$ 241,473
R238	$ 146,453	0%	100%	$ -	$ 146,453
R244	$ 771,695	100%	0%	$ 771,695	$ -
R245	$ 457,661	82%	18%	$ 374,610	$ 83,050
R246	$ 183,231	94%	6%	$ 172,660	$ 10,571
R247	$ 197,836	87%	13%	$ 172,837	$ 24,999
R249	$ 69,668	0%	100%	$ -	$ 69,668
R250	$ 2,591,131	0%	100%	$ -	$ 2,591,131
R251	$ 937,870	0%	100%	$ -	$ 937,870
R252	$ 636,322	0%	100%	$ -	$ 636,322
R253	$ 238,998	0%	100%	$ -	$ 238,998
R254	$ 1,520,964	0%	100%	$ -	$ 1,520,964
R255	$ 274,056	76%	24%	$ 208,564	$ 65,492
R256	$ 227,461	45%	55%	$ 102,193	$ 125,268
R258	$ 518,625	71%	29%	$ 367,114	$ 151,511
R259	$ 403,283	80%	20%	$ 322,170	$ 81,114
R260	$ 456,388	72%	28%	$ 327,261	$ 129,128

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**
R261	$ 318,044	0%	100%	$ -	$ 318,044
R262	$ 514,097	79%	21%	$ 406,993	$ 107,104
R265	$ 25,198	82%	18%	$ 20,698	$ 4,500
R266	$ 164,338	71%	29%	$ 116,473	$ 47,865
R267	$ 108,724	79%	21%	$ 86,073	$ 22,651
R268	$ 158,769	83%	17%	$ 132,003	$ 26,766
R270	$ 99,835	63%	37%	$ 63,145	$ 36,691
R271	$ 327,370	83%	17%	$ 272,181	$ 55,189
R274	$ 167,406	26%	74%	$ 43,120	$ 124,286
R275	$ 836,186	34%	66%	$ 282,008	$ 554,178
R277	$ 201,496	79%	21%	$ 158,472	$ 43,024
R300	$ 364,915	71%	29%	$ 260,902	$ 104,013
R302	$ 119,378	93%	7%	$ 111,152	$ 8,225
R303	$ 243,138	71%	29%	$ 173,836	$ 69,302
R304	$ 516,989	0%	100%	$ -	$ 516,989
R305	$ 158,601	0%	100%	$ -	$ 158,601
R306	$ 216,049	0%	100%	$ -	$ 216,049
R307	$ 371,874	43%	57%	$ 161,685	$ 210,190
R308	$ 239,499	0%	100%	$ -	$ 239,499
R309	$ 141,155	0%	100%	$ -	$ 141,155
R310	$ 456,940	0%	100%	$ -	$ 456,940
R311	$ 129,845	0%	100%	$ -	$ 129,845
R312	$ 217,163	0%	100%	$ -	$ 217,163
R313	$ 373,485	0%	100%	$ -	$ 373,485
R314	$ 430,382	21%	79%	$ 89,580	$ 340,801
R315	$ 814,053	20%	80%	$ 165,337	$ 648,716
R316	$ 249,125	23%	77%	$ 57,165	$ 191,960
R317	$ 410,561	0%	100%	$ -	$ 410,561
R318	$ 390,046	0%	100%	$ -	$ 390,046
R319	$ 174,408	0%	100%	$ -	$ 174,408
R320	$ 195,505	15%	85%	$ 29,496	$ 166,009
R321	$ 244,199	71%	29%	$ 174,130	$ 70,068
R322	$ 297,304	0%	100%	$ -	$ 297,304
R323	$ 82,506	0%	100%	$ -	$ 82,506
R324	$ 324,370	0%	100%	$ -	$ 324,370
R325	$ 222,302	0%	100%	$ -	$ 222,302
R326	$ 310,452	0%	100%	$ -	$ 310,452
R327	$ 262,685	0%	100%	$ -	$ 262,685
R330	$ 88,520	78%	22%	$ 68,987	$ 19,532
R331	$ 60,810	75%	25%	$ 45,587	$ 15,223
R332	$ 197,344	71%	29%	$ 140,266	$ 57,078

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**
R333	$ 356,013	0%	100%	$ -	$ 356,013
R334	$ 1,165,528	57%	43%	$ 668,974	$ 496,554
R335	$ 1,168,811	56%	44%	$ 658,416	$ 510,395
R336	$ 753,101	18%	82%	$ 137,232	$ 615,869
R337	$ 1,260,651	57%	43%	$ 723,572	$ 537,080
R338	$ 475,408	82%	18%	$ 392,131	$ 83,277
R339	$ 659,830	17%	83%	$ 111,115	$ 548,715
R341	$ 347,924	0%	100%	$ -	$ 347,924
R342	$ 86,545	0%	100%	$ -	$ 86,545
R343	$ 1,181,697	74%	26%	$ 873,553	$ 308,145
R344	$ 2,037,062	74%	26%	$ 1,513,124	$ 523,938
R345	$ 89,513	73%	27%	$ 65,559	$ 23,954
R346	$ 460,080	37%	63%	$ 168,480	$ 291,600
R347	$ 237,232	83%	17%	$ 195,996	$ 41,236
R348	$ 212,463	57%	43%	$ 120,821	$ 91,642
R349	$ 167,600	100%	0%	$ 167,600	$ -
Total	**$ 73,465,765**	**44%**	**56%**	**$ 32,615,716**	**$ 40,850,048**

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

		Percentage of Cost Attributable to:		Cost Attributable to:	
Name	**Total Estimated Cost**	**Existing Development**	**Future Development**	**Existing Development**	**Future Development**
100 North	$ 152,100	71%	29%	$ 108,643	$ 43,457
100 South	$ 431,300	65%	35%	$ 281,283	$ 150,017
1400 East	$ 118,100	50%	50%	$ 59,050	$ 59,050
1450 East	$ 689,700	26%	74%	$ 177,650	$ 512,050
2000 South	$ 231,300	0%	100%	$ -	$ 231,300
2550 East	$ 350,100	85%	15%	$ 298,233	$ 51,867
400 South	$ 155,000	79%	21%	$ 122,708	$ 32,292
600 East	$ 89,200	80%	20%	$ 71,360	$ 17,840
700 East	$ 89,200	80%	20%	$ 71,360	$ 17,840
780 East	$ 152,100	100%	0%	$ 152,100	$ -
Abbie Court	$ 151,300	100%	0%	$ 151,300	$ -
Arrowhead Trail	$ 4,740,100	0%	100%	$ -	$ 4,740,100
DB1	$ 743,600	0%	100%	$ -	$ 743,600
DB3	$ 401,200	0%	100%	$ -	$ 401,200
DB4	$ 443,100	43%	57%	$ 192,652	$ 250,448
DB5	$ 361,500	0%	100%	$ -	$ 361,500
DB6	$ 316,700	0%	100%	$ -	$ 316,700
DB7	$ 149,300	0%	100%	$ -	$ 149,300
DB8	$ 253,900	0%	100%	$ -	$ 253,900
Fair Grounds	$ 352,900	82%	18%	$ 289,882	$ 63,018
RB1	$ 1,879,200	0%	100%	$ -	$ 1,879,200
RB3	$ 316,700	0%	100%	$ -	$ 316,700
Total	**$ 12,567,600**	**16%**	**84%**	**$ 1,976,221**	**$ 10,591,379**

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

		Percentage of Cost Attributable to:		Cost Attributable to:	
Name	**Total Estimated Cost**	**Existing Development**	**Future Development**	**Existing Development**	**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**	**$ -**

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 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 storagepractices 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. This will 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 $54 million based on 2011 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 $540,000/year in 2011 dollars.

CFP-A - MASTER PLAN UPDATES

This report, the associated recommendations, and the Capital Facilities Plan should be updated about every 5 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. For finical years 2010, 2011, and 2012, Spanish Fork City spent $95,048 on this storm drain master plan, and its associated studies. 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
HYDROLOGIC INPUT DATA

Table A-1
Hydrologic Input Parameters
Existing Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc (minutes)
11E1		0.294	67.9	19.5	35
11E2		0.339	69.4	25.4	33
11E3		0.13	69.7	23.6	24
11E4		0.101	69	35	32
11E5		0.207	69.7	23.6	29
11E6		0.109	60	24.2	23
11E8		0.093	63.9	18.6	29
11E9		0.078	69.8	13.8	26
1600N1		0.001093	69	90	16
1600N2		0.001875	69	90	20
1900N		0.00146	72.1	90	11
2W2		0.058	60	11.1	14
2W3		0.075	60	49.1	17
2W4		0.107	60	14.2	21
3W-1		0.031	60	40	20
3W-2		0.027	60	35	23
3W-3		0.125	77.7	52.5	37
858+65		0.0017	60	90	6.1
862+75		0.0035	60	98	6.1
873+00		0.0097	80	92	6
876+75		0.00245	80	77	5.87
882+00		0.0057	80	100	5.67
890+85		0.00844	80	90	5.6
CC-1		0.026	60	59	20
CC-10		0.213	60	30.6	32
CC-11		0.039	60	24	25
CC-12		0.098	60	27.2	21
CC-2		0.047	73	45.7	23
CC-3		0.0598	76.3	85	21
CC-3A		0.044	60	90	7
CC-4		0.147	64.8	46.6	23
CC-5		0.392	70.5	31.9	35
CC-6		0.102	60	30	28
CC-7		0.042	60	30	25
CC-8		0.184	70	32.6	30
CC-9		0.024	60	49.4	14
DC1		0.249	60	72	23
MRS1		0.00484	77	90	27

* Percent of the Impervious Area Directly Connected to the Storm Drain System

** Time of Concentration

Table A-1
Hydrologic Input Parameters
Existing Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc (minutes)
MRS2		0.00265	74	90	15
MS1		0.03296	73	72	11
MS2		0.218	60	10	23
MSL-1		0.118	60	72	16
MSL2		0.228	60	24	20
MSL3		0.039	60	72	13
MSL4		0.033	60	56.8	13
MSL5		0.025	60	35.6	13
MSR1		0.0039	76	90	24
MSU1		0.0136	83	56.2	21
MSU2		0.0485	74.9	47.2	21
MSU3		0.0345	68.5	61.2	20
MSU4		0.03875	60	36	19
MSU5		0.0134	64.8	16.7	10
NB - 17		0.055	68.5	28	13
NB - 24		0.063	63	7	16
NB - 31		0.296	80.8	23.5	24
NB - 34		0.183	74	16.5	20
NB - 36		0.203	73	5	20
NB - 6		0.046	70.7	16.2	17
NB-1		0.074	71.4	24	14
NB-2		0.028	53.3	38.7	19
NB-26		0.037	66.5	28	14
NB-3		0.093	70.9	10.5	20
NB-4		0.046	58.9	8.9	15
NB-42		0.085	60	72	20
NB-5		0.045	57.9	20.1	15
SPR1		0.124	60	3.8	19
SPR13		0.178	63.2	26	21
SPR14		0.161	72.8	21.3	32
SPR15		0.122	69.9	24	28
SPR2		0.101	55.9	4.9	19
SPR3		0.15	56.9	11.2	29
SPR4		0.099	61.8	25.2	25
SPR5		0.177	57	14	19
Udot pond H		0.015	60	90	20
WC-33		0.0328	60	35	20
WC-38		0.01656	61.3	28.3	14
WC-39		0.02437	72	40	14
WF1		0.052	69	46.8	18
WF10		0.044	60	42.1	25

Table A-1
Hydrologic Input Parameters
Existing Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc (minutes)
WF2		0.069	69	27.5	20
WF3		0.065	60	45	18
WF4		0.019	60	35	22
WF5		0.013	69	40	25
WF7		0.216	71.1	23.7	29
WF8		0.027	60	12	20
WF9		0.012	60	41.3	19
WPD10		0.092	67.2	42.9	19
WPD11		0.08	66.5	4.4	17
WPD2		0.074	66.2	29	22
WPD4		0.108	66.2	9.7	20
WPD5		0.15	74.9	22	34
WPD6		0.178	60	33.1	43
WPD7		0.045	60	22.1	30
WPD8		0.173	61.2	7.6	29
WPD9		0.153	67.2	27.5	40

Table A-2
Hydrologic Input Parameters
Future Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc** (minutes)
11E1		0.294	69	21.5	35
11E2		0.339	69.4	25.4	33
11E3		0.13	69.7	23.6	24
11E4		0.101	69	35	32
11E5		0.207	69.7	23.6	29
11E6		0.109	60	24.2	23
11E8		0.093	67.4	24.5	29
11E9		0.078	71.3	21.8	26
11E10		0.168	69	26	29
1600N1		0.001093	69	90	16
1600N2		0.001875	69	90	20
1900N		0.00146	72.1	90	11
2W1		0.022	60	72	14
2W2		0.058	60	72	14
2W3		0.075	60	72	17
2W4		0.107	60	72	21
3W-1		0.031	60	40	20
3W-2		0.027	60	35	23
3W-3		0.125	77.7	52.5	37
64S1		0.249	60	72	18
64S2		0.084	60	20	20
68S1		0.19	60	20	32
68S2		0.153	60	20	16
6W1		0.112	60	67.1	22
6W2		0.138	60	72	19
6W3		0.231	60	72	23
6W4		0.244	60	72	17
6W5		0.254	60	72	20
858+65		0.0017	60	90	6
862+75		0.0035	60	98	6
873+00		0.0097	80	92	6
876+75		0.00245	80	77	6
882+00		0.0057	80	100	6
890+85		0.00844	80	90	5.6
BC1		1.161	60	28.9	37
BC2		0.576	60	24	28
BC3		0.7	60	85	50
BC4		0.347	60	85	29

* Percent of the Impervious Area Directly Connected to the Storm Drain System

** Time of Concentration

Table A-2
Hydrologic Input Parameters
Future Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc** (minutes)
CC-1		0.026	60	85	20
CC-10		0.213	60	30.6	32
CC-11		0.039	60	30	25
CC-12		0.098	60	27.2	21
CC-2		0.047	73	45.7	23
CC-3		0.125	70	59.6	21
CC-4		0.147	64.8	46.6	23
CC-5		0.392	70.5	31.9	35
CC-6		0.102	60	30	28
CC-7		0.042	60	30	25
CC-8		0.184	70	32.6	30
CC-9		0.024	60	49.4	14
DC1		0.249	60	72	23
DC2		0.627	60	72	30
DC4		0.184	60	72	28
MRS1		0.00484	77	90	27
MRS2		0.00265	74	90	15
MS1		0.03296	73	72	11
MS2		0.218	60	70	23
MS3		0.288	60	70	23
MSL-1		0.118	60	72	16
MSL2		0.228	60	72	20
MSL3		0.039	60	72	13
MSL4		0.033	60	72	13
MSL5		0.025	60	72	13
MSR1		0.0039	76	90	24
MSU1		0.0136	83	56.2	21
MSU2		0.0485	76.1	72	21
MSU3		0.0345	69.9	72	20
MSU4		0.03875	73.4	72	19
MSU5		0.0134	71	72	10
NB - 10		0.043	69	25	15
NB - 11		0.071	67.3	25	17
NB - 12		0.053	76.5	26.1	16
NB - 13		0.068	73.4	25	16
NB - 14		0.102	70	27	19
NB - 16		0.103	73.5	25	22
NB - 17		0.055	68.5	28	13
NB - 18		0.11	77.4	25	25
NB - 20		0.074	71.5	25	16
NB - 21		0.165	69.3	25	26

Table A-2
Hydrologic Input Parameters
Future Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc** (minutes)
NB - 22		0.071	72.5	25	21
NB - 23		0.168	69	85	27
NB - 24		0.063	69	28	16
NB - 25		0.09	81	33.7	19
NB - 27		0.034	74.7	28	14
NB - 28		0.099	74.7	28	16
NB - 30		0.06	73.2	28	19
NB - 31		0.296	80.8	85	24
NB - 32		0.258	83.4	84	28
NB - 33		0.143	81	75	26
NB - 34		0.183	81.3	74.9	20
NB - 35		0.2	80.6	85	20
NB - 36		0.203	81	80.1	20
NB - 37		0.131	83.7	85	22
NB - 6		0.046	74.1	28	17
NB - 7		0.132	73	28	19
NB - 8		0.081	79.1	28	22
NB - 9		0.047	77.6	25	16
NB-1		0.074	74.4	28	20
NB-2		0.028	59	55	19
NB-26		0.037	66.5	28	14
NB-3		0.093	72.9	25.9	20
NB-4		0.046	63.7	28	18
NB-40		0.021	74	60.2	12
NB-42		0.085	60	72	20
NB-5		0.045	58.6	28	15
SPR1		0.124	60	20	19
SPR10		0.148	67.4	23.2	26
SPR12		0.231	70.6	26	31
SPR13		0.178	63.2	26	21
SPR14		0.161	73.6	26	32
SPR15		0.122	69.9	25.4	28
SPR2		0.101	61.9	21.8	19
SPR3		0.15	56.7	23.8	29
SPR4		0.099	61.8	25.2	25
SPR5		0.177	63.4	47.5	19
SPR6		0.413	60	2.7	15
SPR7		0.3	65.4	20.9	25
SPR8		0.199	68.8	15.3	25
SPR9		0.133	64.4	24.5	26
Udot pond H		0.015	60	90	20

Table A-2
Hydrologic Input Parameters
Future Conditions Model

Subbasin ID		Area (sq mi)	Curve Number	% Impervious*	Tc** (minutes)
WC-33		0.0328	60	35	20
WC-38		0.01656	61.3	28.3	14
WC-39		0.02437	72	40	14
WF1		0.052	69	46.8	18
WF10		0.044	60	42.1	25
WF11		0.019	60	35	22
WF2		0.069	69	27.5	20
WF3		0.065	60	45	18
WF4		0.019	60	35	22
WF5		0.013	69	40	25
WF6		0.025	60	37.5	35
WF7		0.216	72.2	30.1	29
WF8		0.027	60	30.2	20
WF9		0.012	60	41.3	19
WPD1		0.015	69	35	28
WPD10		0.092	68.2	72	19
WPD11		0.08	69.3	9.7	17
WPD2		0.074	70.4	66.7	22
WPD3		0.055	69	15	18
WPD4		0.108	66.2	9.7	20
WPD5		0.15	75.8	26	34
WPD6		0.178	60	33.1	43
WPD7		0.045	60	31.8	30

APPENDIX B
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 C
SPANISH FORK 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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Councilman Steve Leifson
Councilman Rod Dart
Councilman Richard Davis
Councilman Jens Nielson
Councilman Kier Scoubes

Appointed Officials
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Commissioner Shane Marshall
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V. Land Use Map

Adopted April 5, 2011

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)

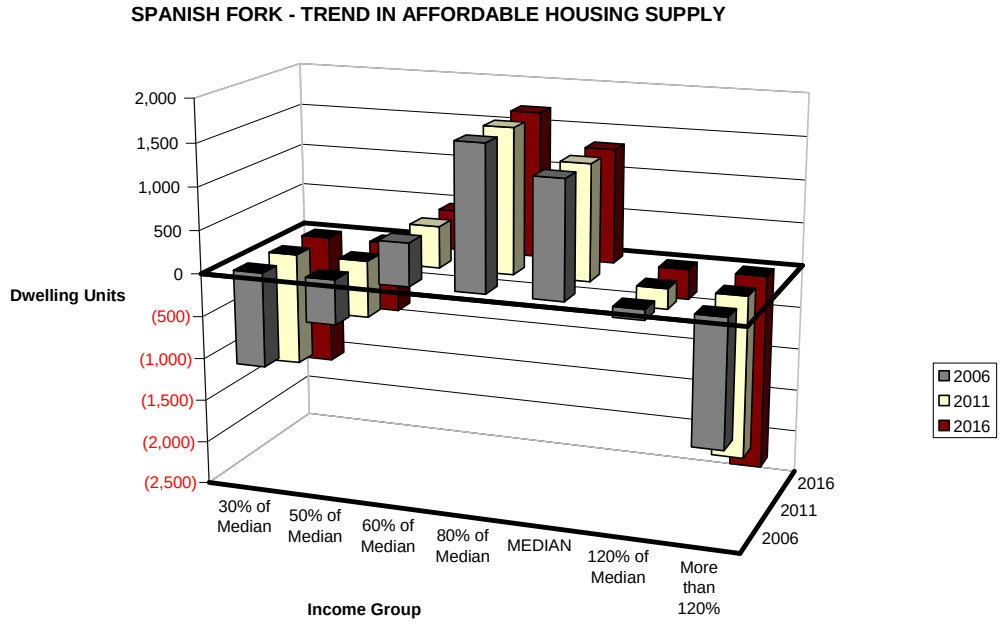
than 120%	than $78,120								
Total					7,988	8,285	297	(577)	(1,494)

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.

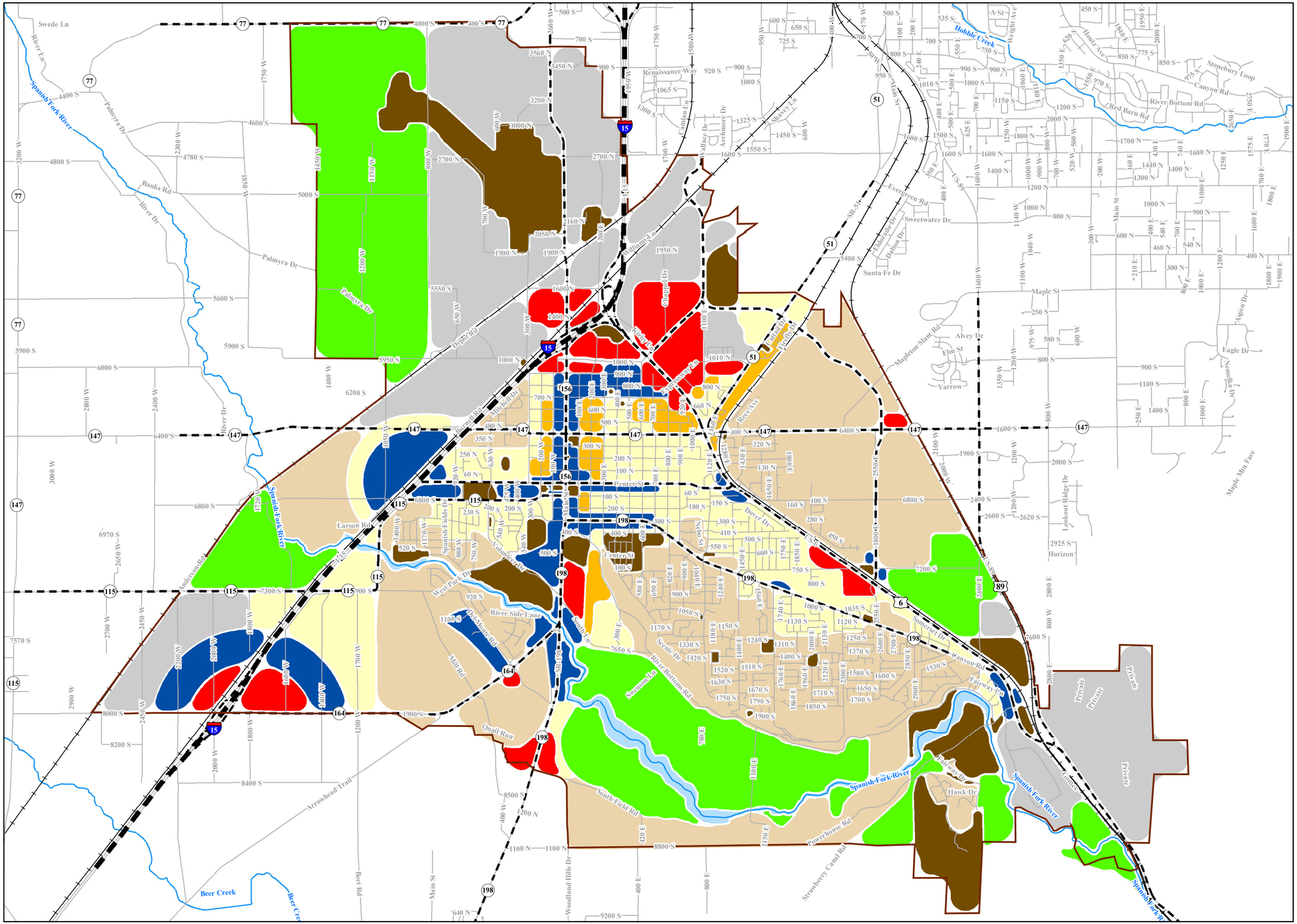
Policies:

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



Print Date: 4/18/2011

SURROUND Spanish Fork UTAH YOURSELF

GEOGRAPHIC INFORMATION SYSTEMS

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APPENDIX D
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	$13
Landscaping (Non-irrigated Native)	Square Foot	$0.30
Landscaping (Irrigated Turfgrass)	Square Foot	$2.60
Inlet Apron	Lump Sum	$12,000
Outlet Structure	Lump Sum	$16,000
Emergency Spillway	Lump Sum	$5,000
Riprap	Lump Sum	$20,000
Storm Drain Pipelines		
Permanent Easement Acquisition	Acre	$10,000
15-inch RCP	Linear Foot	$80
18-inch RCP	Linear Foot	$90
24-inch RCP	Linear Foot	$100
30-inch RCP	Linear Foot	$120
36-inch RCP (1)	Linear Foot	$145
42-inch RCP (1)	Linear Foot	$180
48-inch RCP (1)	Linear Foot	$215
54-inch RCP (1)	Linear Foot	$250
60-inch RCP (1)	Linear Foot	$285
66-inch RCP (1)	Linear Foot	$320
72-inch RCP (1)	Linear Foot	$360
78-inch RCP (1)	Linear Foot	$420
84-inch RCP (1)	Linear Foot	$470
90-inch RCP (1)	Linear Foot	$520
96-inch RCP (1)	Linear Foot	$570
Manhole (1)	Each	$4,000
Catch Basin (1)	Each	$2,800
Traffic Control	Linear Foot	$16
Channel Construction		
Excavation and Hauling	Cubic Yard	$13
Riprap	Cubic Yard	$75
Landscaping (Non-irrigated Native)	Square Foot	$0.30
Other		
Contingency	25 Percent of Construction Cost	
Engineering, Legal, and Administration	15 Percent of Construction Cost w/ Contingency	

(1) - Includes trenching, installation, backfill, and asphalt surface restoration.
(2) - Includes trenching, installation, and backfill w/out asphalt surface restoration

Table D-2
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Asphault Road Repair (sq yd)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
R1	1219	18	3	4	0	1344	$ 273,942.86
R2	1453	24	3	4	0	0	$ 243,985.44
R3	2206	24	5	7	0	2574	$ 532,853.35
R4	1065	30	2	3	0	1324	$ 288,942.73
R5	1335	30	3	4	0	0	$ 265,357.33
R6	682	42	1	2	0	974	$ 250,851.31
R7	3399	42	8	11	0	4853	$ 1,267,969.73
R8	2058	30	5	6	0	0	$ 409,645.53
R9	3659	30	9	12	0	0	$ 736,340.40
R10	3333	24	8	11	0	3888	$ 809,279.11
R11	654	30	1	2	0	813	$ 177,403.50
R12	2583	30	6	8	0	1750	$ 621,387.55
R13	5781	54	14	19	0	0	$ 2,243,057.03
R14	5966	36	14	19	0	1500	$ 1,499,733.98
R19	5830	30	14	19	0	0	$ 1,171,276.73
R20	3402	66	8	11	0	0	$ 1,660,388.40
R21	4234	36	10	14	0	0	$ 1,003,330.65
R22	2742	30	6	9	0	0	$ 548,853.60
R23	1681	60	4	5	0	0	$ 733,485.53
R24	2757	30	6	9	0	3428	$ 758,490.78
R25	3192	66	7	10	0	0	$ 1,554,114.60
R26	1384	24	3	4	0	0	$ 233,996.25
R28	3684	30	9	12	0	4581	$ 1,017,359.67
R29	2683	30	6	8	0	3336	$ 734,286.36
R32	1248	18	3	4	0	1375	$ 279,606.31
R33	1670	24	4	5	0	1948	$ 402,459.59
R34	2124	30	5	7	0	2641	$ 586,254.22
R35	672	30	1	2	0	835	$ 181,788.10
R43	776	24	1	2	0	905	$ 181,665.96
R44	1184	30	2	3	1	1473	$ 340,028.84
R47	394	18	0	1	0	434	$ 82,957.83
R104	2661	24	6	8	0	3105	$ 640,162.91
R105	1566	24	3	5	0	1827	$ 376,174.09
R106	1565	24	3	5	0	1826	$ 376,120.54
R107	540	18	1	1	0	595	$ 115,537.12
R108	2022	30	5	6	0	0	$ 403,402.75
R109	1377	30	3	4	0	0	$ 272,571.28
R110	513	30	1	1	0	0	$ 98,198.50
R111	3623	42	9	12	0	2040	$ 1,165,926.64
R112	4040	48	10	13	0	3000	$ 1,544,842.58
R113	4514	48	11	15	0	2400	$ 1,670,508.40

Table D-2
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Asphault Road Repair (sq yd)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
R114	1360	24	3	4	0	1586	$ 326,288.61
R115	1938	30	4	6	0	2410	$ 530,432.29
R116	1842	30	4	6	0	2290	$ 506,533.64
R118	2439	24	6	8	0	2845	$ 592,491.20
R119	489	30	1	1	0	608	$ 130,894.83
R120	1203	24	3	4	0	1404	$ 292,763.98
R121	962	30	2	3	0	1197	$ 263,526.43
R122	884	24	2	2	0	1032	$ 208,934.59
R129	1997	24	4	6	0	2329	$ 478,257.47
R130	1853	30	4	6	0	2304	$ 509,326.32
R131	1860	36	4	6	0	2547	$ 592,078.94
R141	460	48	1	1	0	0	$ 151,841.76
R142	1907	30	4	6	0	2372	$ 522,846.52
R143	1277	36	3	4	0	1748	$ 406,742.07
R144	303	42	0	1	0	433	$ 110,415.36
R145	400	36	0	1	0	548	$ 122,159.24
R148	1372	30	3	4	0	0	$ 271,665.65
R150	314	30	0	1	0	0	$ 59,980.55
R151	3176	36	7	10	0	4349	$ 1,010,122.19
R152	2826	54	7	9	0	4369	$ 1,359,130.13
R153	2327	30	5	7	0	0	$ 461,822.18
R157	2101	30	5	7	0	2613	$ 580,631.74
R158	1501	24	3	5	0	1752	$ 362,386.84
R159	3108	30	7	10	0	3864	$ 855,039.20
R160	2110	36	5	7	0	2889	$ 674,537.30
R161	1361	42	3	4	0	1943	$ 504,413.36
R162	1426	24	3	4	0	0	$ 240,039.50
R163	497	54	1	1	0	769	$ 234,891.78
R164	1200	54	3	4	0	1856	$ 578,471.88
R165	2040	54	5	6	0	3154	$ 978,032.07
R178	196	30	0	0	0	243	$ 48,475.66
R188	947	36	2	3	0	1297	$ 301,110.74
R189	385	18	0	1	0	424	$ 81,141.85
R190	402	36	1	1	0	551	$ 126,888.74
R192	361	36	0	1	0	494	$ 110,846.40
R193	427	36	1	1	0	584	$ 134,006.57
R194	210	30	0	0	0	261	$ 51,869.95
R195	943	42	2	3	0	1346	$ 350,448.38
R196	177	36	0	0	0	242	$ 51,414.30
R198	334	30	0	1	0	416	$ 88,562.17
R199-A	955	24	2	3	0	1114	$ 229,825.50

Table D-2
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Asphault Road Repair (sq yd)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
R199-B	447	48	1	1	0	668	$ 188,257.44
R199-C	2815	54	7	9	0	4353	$ 1,354,367.38
R199-D	1000	36	2	3	1	1369	$ 337,980.21
R200	1045	30	2	3	1	0	$ 227,157.78
R201	1432	18	3	4	0	0	$ 220,360.70
R202	2772	18	6	9	0	0	$ 434,523.62
R203	1705	18	4	5	0	1878	$ 378,795.63
R204	1897	30	4	6	1	2359	$ 541,789.65
R207	2105	24	5	7	0	2456	$ 511,303.94
R208	1270	24	3	4	0	1481	$ 306,990.32
R209	1432	36	3	4	1	1961	$ 473,558.81
R212	286	30	0	0	0	356	$ 70,864.09
R214	277	30	0	0	1	345	$ 90,225.62
R216	2250	24	5	7	1	2625	$ 563,786.55
R219	653	30	1	2	0	812	$ 177,143.55
R220	1184	24	2	3	0	1381	$ 278,808.04
R221	823	36	2	2	1	1127	$ 280,684.91
R224	600	24	1	2	0	700	$ 144,048.21
R225	1400	30	3	4	0	1741	$ 381,633.89
R227	1336	30	3	4	0	0	$ 265,612.63
R231	2177	36	5	7	0	0	$ 514,170.53
R232	1048	18	2	3	1	0	$ 182,486.31
R233	1998	18	4	6	1	0	$ 330,598.12
R234	2298	18	5	7	0	2532	$ 510,596.66
R237	1436	24	3	4	0	0	$ 241,472.69
R238	759	30	1	2	0	0	$ 146,452.50
R244	2546	42	6	8	0	710	$ 771,695.43
R245	1667	30	4	5	0	2073	$ 457,660.61
R246	677	30	1	2	0	842	$ 183,231.48
R247	736	30	1	2	0	916	$ 197,836.07
R249	281	30	0	0	0	350	$ 69,668.29
R250	6930	42	17	23	0	9894	$ 2,591,130.85
R251	4256	24	10	14	0	3400	$ 937,869.56
R252	3695	24	9	12	0	0	$ 636,322.31
R253	1025	36	2	3	0	0	$ 238,998.46
R254	5514	30	13	18	0	6857	$ 1,520,964.48
R255	749	42	1	2	0	1070	$ 274,056.24
R256	1487	18	3	4	0	0	$ 227,460.80
R258	1346	54	3	4	0	0	$ 518,624.84
R259	947	48	2	3	0	1415	$ 403,283.49
R260	1200	54	2	3	0	0	$ 456,388.28

Table D-2
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Asphault Road Repair (sq yd)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
R261	2036	18	5	6	0	0	$ 318,044.14
R262	2484	18	6	8	0	2030	$ 514,096.86
R265	175	24	0	0	0	0	$ 25,197.94
R266	531	36	1	1	0	727	$ 164,338.12
R267	720	18	1	2	0	0	$ 108,724.16
R268	731	18	1	2	0	806	$ 158,768.53
R270	269	36	0	0	1	368	$ 99,835.32
R271	1382	18	3	4	1	1523	$ 327,370.34
R274	1098	18	2	3	0	0	$ 167,405.50
R275	2968	30	7	9	1	3690	$ 836,185.90
R277	664	30	1	2	1	826	$ 201,496.24
R278	1105	18	1	2	0	1215	$ 161,280.00
R300	1332.27	30	3	4	0	1657	$ 364,914.98
R302	442.7	30	1	1	0	551	$ 119,377.53
R303	816.01	30	2	2	1	1015	$ 243,138.16
R304	1802.47	42	4	6	0	0	$ 516,989.11
R305	817.31	24	2	2	1	0	$ 158,600.81
R306	915.14	36	2	3	0	0	$ 216,049.49
R307	1471.78	24	3	4	1	1717	$ 371,874.38
R308	1422.08	24	3	4	0	0	$ 239,499.00
R309	728.29	30	1	2	0	0	$ 141,155.03
R310	1524.84	42	3	5	1	0	$ 456,939.85
R311	576.05	36	1	1	0	0	$ 129,845.42
R312	1266.7	24	3	4	0	0	$ 217,163.13
R313	1595.97	36	3	5	0	0	$ 373,485.00
R314	2505.96	24	6	8	0	0	$ 430,381.75
R315	2053.19	54	5	6	1	0	$ 814,052.66
R316	1489.04	24	3	4	0	0	$ 249,124.50
R317	1367.82	42	3	4	1	0	$ 410,560.93
R318	2293.36	24	5	7	0	0	$ 390,045.50
R319	796.06	30	1	2	1	0	$ 174,407.85
R320	844.16	36	2	2	0	0	$ 195,504.60
R321	1571.97	18	3	5	0	0	$ 244,198.62
R322	1756.2	24	4	5	0	0	$ 297,303.75
R323	421.63	30	1	1	0	0	$ 82,506.18
R324	1518.74	30	3	5	1	0	$ 324,370.15
R325	1302.45	24	3	4	0	0	$ 222,302.19
R326	1321.15	36	3	4	0	0	$ 310,452.20
R327	1319.48	30	3	4	0	0	$ 262,685.30
R330	456.49	30	1	1	0	0	$ 88,519.53
R331	319.19	30	0	1	0	0	$ 60,810.28

Table D-2
Conceptual Cost Estimate Unit Cost Summary
Spanish Fork Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Asphault Road Repair (sq yd)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
R332	1196.83	24	2	3	0	0	$ 197,344.31
R333	1974.61	24	4	6	1	0	$ 356,012.69
R334	1504.62	90	3	5	0	0	$ 1,165,528.45
R335	1383.66	96	3	4	0	0	$ 1,168,811.41
R336	1728.76	60	4	5	0	0	$ 753,101.36
R337	1626.49	90	4	5	0	0	$ 1,260,651.28
R338	2018.75	36	5	6	0	0	$ 475,408.20
R339	1711.25	54	4	5	0	0	$ 659,830.47
R341	2040.34	24	5	6	0	0	$ 347,923.88
R342	534.05	24	1	1	0	0	$ 86,544.69
R343	1682.66	84	4	5	0	0	$ 1,181,697.16
R344	2896.78	84	7	9	0	0	$ 2,037,061.99
R345	554.7	24	1	1	0	0	$ 89,513.13
R346	2317.13	30	5	7	0	0	$ 460,079.93
R347	1103.59	30	2	3	1	0	$ 237,231.78
R348	960	30	2	3	1	0	$ 212,462.50
R349	1500	24	2	3	1	0	$ 167,600.00

APPENDIX E
UDOT AGREEMENT

FINANCE NUMBER 108746

STORM DRAIN SYSTEM MAINTENANCE AND COOPERATIVE AGREEMENT

THIS AGREEMENT made and entered into this 12 day of April, 2010, by and between the UTAH DEPARTMENT OF TRANSPORTATION hereafter referred to as UDOT and SPANISH FORK CITY, a Municipal Corporation of the State of Utah, hereinafter referred to as City.

WITNESSETH:

WHEREAS, UDOT is in the process of preparing a design-build highway project identified as Project MP-I15-6(178)245; Utah County ("Project"), located in Utah County, Utah; and

WHEREAS, UDOT has awarded a design-build contract for the Project to a third party entity, hereinafter referred to as "Design-Builder", and shall require by contract that Design-Builder shall design and construct the Project; and

WHEREAS, as part of its Project UDOT shall install Storm Drain Systems to accommodate Project storm drain requirements; and

WHEREAS, the City shall be responsible for particular design, installation, operation, and maintenance of Storm Drain Systems covered by this agreement in accordance with the terms and conditions contained herein.

THIS AGREEMENT is made to set out the terms and conditions whereunder said work shall be performed.

NOW THEREFORE, it is agreed by and between the parties hereto as follows:

1. UDOT will require the Design-Builder to comply with this Storm Drain System Maintenance and Cooperative Agreement and shall incorporate it as part of its Project Contract with UDOT.

2. A Storm Drain System shall be designed and constructed for use by UDOT and City between 400 North and 100 North as follows:

   a. UDOT's Design-Builder shall design and construct a 48" storm drainpipe along the east I-15 right-of-way, beginning at the existing 30" Spanish Fork storm drainpipe located at approximately 400 North and 700 West in Spanish Fork, and ending at a manhole at approximately 100 North and 1000 West.
      i. UDOT shall discharge un-detained Project storm water to the 48" storm drainpipe at varying points between 400 North and 100 North.
      ii. City shall reserve 32cfs continuous capacity to UDOT within the 48" storm drainpipe system.
      iii. UDOT will place a manhole at 300 North I-15 to receive City flows from the east.
      iv. UDOT shall acquire necessary easements required to construct the storm drainpipe.

   b. The City, at its own expense, shall design and construct a detention pond at 100 North and I-15 to detain and treat Project and City flows, as shown in Exhibit A Pond A.
      i. UDOT shall acquire the required right-of-way for the detention pond and shall transfer title to the City.
      ii. Upon completion of construction, the City shall make the connection from the detention pond to the existing 54" Spanish Fork storm drain line.
      iii. City shall size the detention pond such that combined discharge of Project and City storm water shall not exceed capacity in the existing 54" Spanish Fork storm drain line to the Spanish Fork River. The capacity of the 54" pipe shall also include 9cfs of undetained Project flows from I-15 at 6800 South.
      iv. City shall complete all work no later than September 30, 2011.

   c. Following completion and acceptance of the facilities the City shall own, operate and maintain the 48" piped system, the 100 North detention pond and downstream systems at no additional cost to UDOT.

3. UDOT's Design-Builder, through its Project activities and expense, shall design and construct a Storm Drain System at the Main Street Interchange as follows:

   a. UDOT's Design-Builder shall design and construct a storm drain line from 300 West to a detention pond at Main Street, see Exhibit A Pond B, to accommodate Project and City storm drainage. UDOT shall reserve a minimum of 20cfs in the storm drain line and detention pond for City storm drainage. City shall operate and maintain storm drain line and pond B. UDOT shall retain ownership of property.

   b. UDOT's Design-Builder shall design and construct storm drain detention ponds in the quadrants of the Main Street Interchange to accommodate Project storm drainage, (see Exhibit A Ponds C, D, E, & F). UDOT shall operate and maintain Ponds C, D, E, and F.

   c. Storm drain detention ponds B, C, and D, and undetained area, as shown in Exhibit A, shall discharge into an existing City owned Storm Drain System in Main Street. The combined discharge shall not exceed 13cfs.

   d. Storm drain detention ponds E and F shall discharge into an existing City owned storm drain system southeast of the I-15 Main Street interchange. The combined discharge shall not exceed 2cfs.

   e. UDOT's Design-Builder may reconfigure City's storm drain systems within the Main Street Interchange to accommodate the subject Project and City storm drain requirements and connections.

4. UDOT's Design-Builder, through its Project activities and expense, shall design and construct a storm drain system at I-15 and 200 East as follows:

   a. UDOT's Design-Builder shall design and construct storm drain detention facilities located in the US-6 Interchange to accommodate Project storm drain water, see Exhibit A Ponds I and J.

   b. UDOT's Design-Builder shall construct a 24" storm drainpipe in 200 East beginning at approximately 1500 North to 2000 North. The storm drainpipe shall tie into an existing 24" storm drainpipe at 2000 North.
      i. City shall allow the new 24" storm drainpipe to be constructed within the 200 East roadway right-of-way limits.
      ii. City shall reserve 1cfs capacity to UDOT within the 24" storm drainpipe in 200 East for discharge of Ponds I and J.

c. Following completion and acceptance of the facilities the City shall own, operate, and maintain the 24" pipe in 200 East at no additional cost to UDOT.

d. UDOT shall own, operate, and maintain Ponds I and J.

5. UDOT's Design-Builder, through its Project activities and expense, shall design and construct a storm drain system at the US-6 Interchange to accommodate Project storm drain water, see Exhibit A Ponds G & H, as follows:

a. City shall accept Project storm water discharges from ponds G and H at a rate of 0.15cfs/acre based upon a 25-year 24-hr storm event.

b. City shall allow detained Project flows from Pond G to discharge into the City storm drain system north of US-6 and east of I-15. City shall own, operate, and maintain the pond at no additional cost to UDOT.

c. City shall allow detained Project flows from Pond H to discharge into the City storm drain system south of the US-6 interchange. UDOT shall own, operate and maintain the pond.

6. UDOT's Design-Builder, through its Project activities and expense agrees to pay all design and construction expenses associated with the Storm Drain Systems identified in this agreement, with the exception of the detention pond identified in section 2.b. In exchange, the City agrees to operate and maintain all Storm Drain pipes and Ponds A, B, and G with no further expense to UDOT for the life of the systems and shall allow continuous capacities and flows as stated in each section. UDOT will own, operate, and maintain Ponds C, D, E, F, H, I, and J.

7. UDOT shall maintain ownership of its properties unless otherwise stated in this agreement.

8. UDOT's Design-Builder shall obtain all applicable permits and shall comply with all current and future State and Federal storm water permits, rules, and regulations for the construction of the detention and storm drain system that it is obligated to design and construct.

9. UDOT shall maintain all applicable permits and shall comply with all current and future State and Federal storm water permits, rules, and regulations for the detention and storm drain systems it owns and operates.

10. City shall maintain all applicable permits, including but not limited to canal discharge permits, fees, and shall comply with all current and future State and Federal storm water permits, rules, and regulations for the life of the storm drain systems covered herein.

11. City and UDOT agree to indemnify, defend and save harmless the other from any and all damages, claims, suits, costs, attorneys fees and actions arising from or related to its actions or omissions or the acts or omissions of its officers, agents, employees or contractors in connection with the performance and/or subject matter of this Agreement. The obligation to indemnify is limited to the dollar amounts stated in the Governmental Immunity Act, provided the Act applies to the action or omission. This paragraph shall not construed as a waiver of the protections of the Governmental Immunity Act by City and UDOT. The indemnification in this paragraph shall survive the expiration or termination of this Agreement.

IN WITNESS WHEREOF, the parties hereto have caused these presents to be executed by their duly authorized officers as of the day and year first above written.

Spanish Fork City,
a Municipal Corporation of the State of Utah

Attest:

Title: City Recorder

Date: 4/2/10

Title: Mayor

Date: 4/2/10

(IMPRESS SEAL)

Recommended for approval:

Title: Engineering Director

Date: 4/12/2010

Utah Department of Transportation

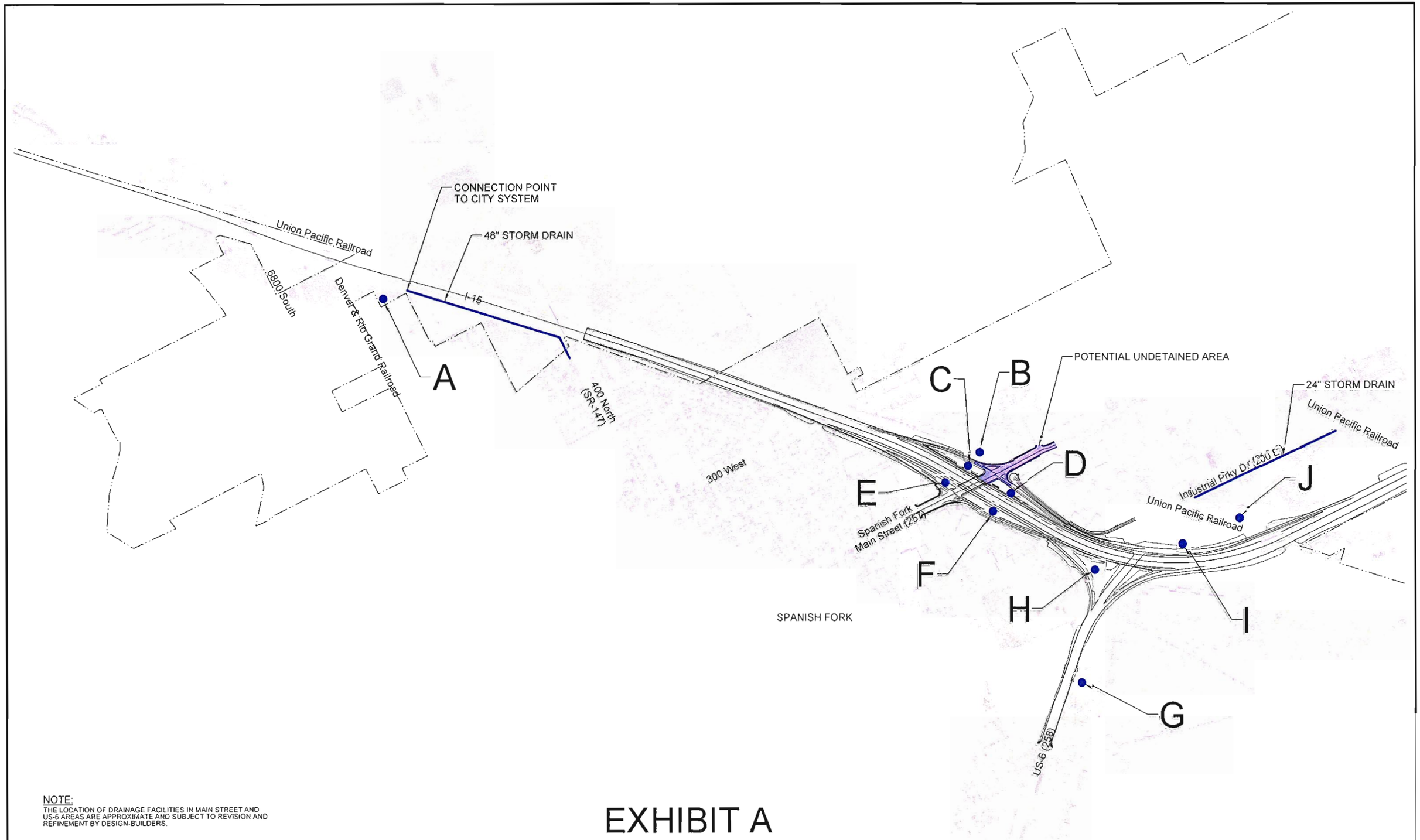
Title: Project Director

Date: 4/12/10

The Utah State Attorney General's Office has previously approved all paragraphs in this Agreement as to form.

UDOT Comptroller Office Contract Administrator

Date: Cherie Young 4/15/10



NOTE:
THE LOCATION OF DRAINAGE FACILITIES IN MAIN STREET AND US-6 AREAS ARE APPROXIMATE AND SUBJECT TO REVISION AND REFINEMENT BY DESIGN-BUILDERS.

EXHIBIT A

UTAH COUNTY
CORE 15
CORRIDOR EXPANSION

LEGEND

● PROPOSED DETENTION POND LOCATIONS

N

I-15 CORE UTAH COUNTY

SPANISH FORK CITY

SHEET NO.

1 OF 1

12736

UTAH COUNTY CORE 15 CORRIDOR EXPANSION

SPANISH FORK CITY STORM DRAIN SYSTEM MAINTENANCE AND COOPERATIVE AGREEMENT
PROJECT NO. MP-I15-6(178)245; UTAH COUNTY
I-15; UTAH COUNTY CORRIDOR EXPANSION PROJECT
CHARGE ID NO. 70963 PIN NO. 7037

UDOT Finance Number **108746**

UDOT Amendment Number _____

STORM DRAIN SYSTEM MAINTENANCE AND COOPERATIVE AGREEMENT

AMENDMENT NUMBER 1

THIS AMENDED AGREEMENT, made and entered into this 15th day of June, 2010, by and between the UTAH DEPARTMENT OF TRANSPORTATION, hereinafter referred to as "UDOT", and the **Spanish Fork City**, a Registered Municipality in the State of Utah, hereinafter referred to as the "City",

WHEREAS, the parties hereto entered into a **STORM DRAIN SYSTEM MAINTENANCE AND COOPERATIVE AGREEMENT,** hereinafter referred to as the **"Agreement"**, dated **April 12, 2010** UDOT Finance Number **108746 (Original Agreement)**; and

NOW THEREFORE, it is agreed by and between UDOT and City that the **Agreement** is amended as follows:

1. Section **3** Sub-section **a** shall be revised to reduce the reserved cfs from 20 to 10. Sub-section **a** shall read as follows:

   a. UDOT's Design-Builder shall design and construct a storm drain line from 300 West to a detention pond at Main Street, see Exhibit A Pond B, to accommodate Project and City storm drainage. UDOT shall reserve a minimum of 10cfs in the storm drain line and detention pond for City storm drainage. City shall operate and maintain storm drain line and pond B. UDOT shall retain ownership of property.

2. The final sentence of Section **3** Sub-section **c** shall be revised to read as follows:

   3.c. The combined discharge shall not exceed 4-cfs.

UTAH COUNTY CORE 15 CORRIDOR EXPANSION

SPANISH FORK CITY STORM DRAIN SYSTEM MAINTENANCE AND COOPERATIVE AGREEMENT
PROJECT NO. MP-I15-6(178)245; UTAH COUNTY
I-15; UTAH COUNTY CORRIDOR EXPANSION PROJECT
CHARGE ID NO. 70963 PIN NO. 7037

Spanish Fork City,
a Municipal Corporation of the State of Utah

Attest:

Kent R. Clark

Title: CITY RECORDER

Date: 6/16/10

(IMPRESS SEAL)

CORPORATE SEAL OF SPANISH FORK CITY UTAH

S. Wayne Condrasen

Title: MAYOR

Date: 6/16/10

Recommended for approval:

Title: Engineering Director

Date: 6/23/2010

Utah Department of Transportation

Title: Project Director

Date: 6/23/10

The Utah State Attorney General's Office has previously approved all paragraphs in this Agreement as to form.

UDOT Comptroller Office Contract Administrator

Date: Cherise Young 6/28/10

APPENDIX F
I-CORE DRAINAGE REPORT

(on CD)

APPENDIX G
COST RATIO CALCULATIONS

Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

TO: Spanish Fork City

FROM: Matthew Stayner, P.E. and Kameron Ballentine, P.E.
Bowen Collins and Associates
154 East 14000 South
Draper, UT 84020

DATE: May 10, 2012

SUBJECT: Spanish Fork Storm Drain Master Plan Cost Ratio Calculations

---

Introduction

Bowen, Collins & Associates (BC&A) was retained by Spanish Fork City (City) to update the cost ratios and the costs in Tables 5-2 and 5-3 in the storm drain master plan. The purpose of the Technical Memorandum is to describe the methodology used to estimate the cost ratios.

Cost Ratio Calculations

As part of the Storm Drain Master Plan, a cost estimate was prepared for each project listed on of the Capital Facility Projects (CFP). Also, a cost distribution, or cost ratio, was estimated for each project list in the Capital Facility Plan. The cost ratio is based on how much of the project cost is attributable to storm water runoff currently generated by the City, and how much storm water runoff is estimated to be generated by future development. The cost distribution can be used to estimate the percent of the project cost that should be paid for with impact fees, and the percentage of the project cost that should be paid for by the City's general fund.

The distribution of costs for storm drain pipes was estimated based on flow rates. For example, pipe R275 has an estimated 8.6 cubic feet per second (cfs) of storm water runoff from the existing conditions model, while 25.5 cfs is the estimated flow rate for build-out from the future conditions model. Thus, 34 percent (8.6/25.5) of the cost of the project improvement is attributable to existing users vs. 66 percent (16.9/25.5) of the cost is attributable to future development.

The distribution of costs for detention basins was estimated based on volume. For example, the 1450 East Detention Facility has an estimated required storage volume of 1.7 acre-feet from the existing conditions model, while an estimated 6.6 acre-feet of

storage will be required for build-out from the future conditions model. Thus 26 percent (1.7/6.6) of the cost of the project improvement is attributable to existing users vs. 74 percent (4.9/6.6) of the cost is attributable to future development.

The cost ratios of pipes immediately downstream of detention basins were assigned based on the cost ratio of the upstream detention facility. For example, pipe R307 is immediately downstream of Detention Facility project DB4. Project DB4 has an estimated required storage volume of 1.0 acre-feet estimated from the existing conditions model, while an estimated 2.3 acre-feet of storage will be required for build-out from the future conditions model. Thus 43 percent (1.0/2.3) of the cost of the project improvement is attributable to existing users vs. 57 percent (1.3/2.3) of the cost is attributable to future development. Because pipe R307 is immediately downstream of project DB4, and no additional storm water runoff is contributing to the flow in pipe R307 other than the flow from DB4, 43 percent of the cost of pipe R307 is attributable to existing users vs. 57 percent of the cost is attributable to future development. The cost ratios for the storm drain master plan are found on Tables 5-2 and 5-3.

ATTACHMENT 1
STORM WATER DRAINAGE DESIGN MANUAL

STORM WATER DRAINAGE DESIGN MANUAL

Prepared for:

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

Prepared by

Bowen, Collins & Associates
756 East 12200 South
Draper, UT 84020

February 2010

CITY OF SPANISH FORK STORM WATER DRAINAGE DESIGN MANUAL

February 2010

PROFESSIONAL ENGINEER
MATTHEW H.
STAYNER
5049218
2-3-10
STATE OF UTAH

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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 3 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 center line 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 3 for design criteria and Section 4 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 4 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 3 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 3 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 center line 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
DESIGN STANDARDS AND REGULATIONS FOR STORM DRAIN FACILITIES

3.1 DESIGN STORM

3.1.1 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.

3.1.2 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.

3.1.3 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.

3.2 POST-CONSTRUCTION PEAK DISCHARGE

Post-construction peak discharges for the design recurrence interval (see Section 3.1.1) 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.

3.3 STORAGE FACILITIES

All 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 volume requirements shall not be reduced based on evaporation or infiltration due to percolation.

8. The storage facility maximum depth shall be approved by the City Engineer.

3.3.1 RETENTION BASINS

1. Retained water for the design recurrence interval (see Section 3.1.1) and duration (see Section 3.1.3) must drain completely within 48 hours of the then 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.

3.3.2 DETENTION BASINS

1. The minimum area of the discharge orifice is 6 square inches.

3. Detained water for the design recurrence interval (see Section 3.1.1) and duration (see Section 3.1.3) must drain completely within 12 hours of the end of the storm event.

2. Detention basins may be constructed in landscape or parking areas.

3. 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.

3.4 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 3.1.1) 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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 3-1.

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 3-1
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

3.9 STORM WATER TREATMENT

1. Storm water treatment for oil and grease 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.

3.10 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.

3.11 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.

3.12 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).

3.13 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 4
RAINFALL-RUNOFF COMPUTATION METHODS

4.1 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 3 for design criteria.

Other methods for estimating peak runoff and runoff volume must first be approved by the City Engineer. Table 4-1 indicates the applicable total drainage area for each modelling approach.

Table 4-1
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

4.2 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

4.3 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.

4.4 RATIONAL METHOD

4.4.1 RUNOFF COEFFICIENT

Table 4-2 shall be used to estimate the runoff coefficient.

Table 4-2
Rational Method Runoff Coefficients

Type of Drainage Area	Runoff Coefficient, C*
Business:	
Downtown areas	0.70 – 0.95
Neighborhood areas	0.50 – 0.70
Residential:	
Single-family areas	0.30 - 0.50
Multi-units, detached	0.40 - 0.60
Multi-units, attached	0.60 – 0.75
Suburban	0.25 – 0.40
Apartment dwelling areas	0.50 – 0.70
Industrial:	
Light areas	0.50 – 0.80
Heavy areas	0.60 – 0.90
Parks, cemeteries	0.10 - 0.25
Playgrounds	0.20 – 0.40
Railroad yard areas	0.20 – 0.40
Unimproved areas	0.10 – 0.30
Lawns:	
Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, average, 2 – 7%	0.10 – 0.15
Sandy soil, steep, 7%	0.15 – 0.20
Heavy soil, flat, 2%	0.13 – 0.17
Heavy soil, average, 2 – 7%	0.18 – 0.22
Heavy soil, steep, 7%	0.25 – 0.65

Table 4-2
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.

4.4.2 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.

4.4.3 RAINFALL INTENSITY

The rainfall intensity shall be selected from the intensify-duration-frequency curve in Appendix A (see Section 3.1.2). The duration is assumed to equal the time of concentration. The design storm frequency can be obtained from Section 3.1.1.

4.5 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 (see Section 3.1.2)
- 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.

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

4.6 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.

4.6.1 DESIGN STORM

The design storm shall be developed in accordance with Section 3.1.

4.6.2 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.

4.6.3 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 centred 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.

4.6.4 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 4-3.

Table 4-3
Values of Manning's Coefficient (n) for Channels and Pipes

Conduit Material	Manning's n*
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

Table 4-3
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

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

4.7 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.

4.8 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 4-4.

Table 4-4
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 4-5 are only applicable to drainage basins that meet the range of values shown above.

Table 4-5
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.

SECTION 5
EROSION CONTROL

5.1 UPDES PERMIT

All new construction that disturbs one acre of land or more or more shall obtain a UPDES Storm Water General Permit for Construction Activities (Permit #UTR300000) or an alternate individual permit before construction begins. The permit requires the operator, typically the contractor, to control and eliminate storm water pollution sources through the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The permit also requires inspection of the BMP controls either:

- At least once every 7 calendar days, or
- At least once every 14 days and within 24 hours of the end of a storm event of 0.5 inches or greater.

5.2 STORM WATER POLLUTION PREVENTION PLAN

The Storm Water Pollution Prevention Plan (SWPPP) shall be prepared and submitted to the City for review before the contractor can obtain the UPDES permit.

Section 3.5 of the UPDES permit describes in detail what shall be included in the SWPPP. The plan shall include, among other things:

1. Possible sources of storm water pollutants
2. Selection of Best Management Practices (BMPs) to reduce or eliminate pollutant impacts.

A SWPPP template that addresses all of the information required in the SWPPP can be obtained from the State of Utah Division of Water Quality web site:
http://www.waterquality.utah.gov/UPDES/stormwatercon.htm.

5.3 PERMITTING PROCESS

1. The Operator prepares a SWPPP in accordance with the UPDES Permit.
2. The Operator Submits SWPPP to City for review.
3. Once the City has reviewed the SWPPP, the operator applies for the UPDES Permit by completing the Notice of Intent (NOI) form. The form can be completed online at: https://secure.utah.gov/stormwater/main.html
4. Construction may commence only after:

a. The SWPPP has been reviewed by the City
b. The NOI has been submitted
c. The Operator has attended a pre-construction meeting with designated City personnel to review and discuss the SWPPP, and
d. All other applicable permits have been obtained from the City.

5. Once construction has been completed and the site stabilized, the contractor shall complete the Notice of Termination (NOT) form and submit to the Division of Water Quality.

REFERENCES

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WRC Engineering, Inc., October 1990. Hydrologic Criteria and Drainage Design Manual, Clark County Regional Flood Control District, Las Vegas, Nevada.

ATTACHMENT 2
LEVEE OPERATION AND MAINTENANCE PROCEDURES

Standard Operation and Maintenance Procedures For the Spanish Fork River Levee

Spanish Fork City, Utah

Operated By

Spanish Fork City Corporation
Spanish Fork City, Utah

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GENERAL INFORMATION

PURPOSE AND SCOPE

The Spanish Fork River Levee has been constructed to provide flood protection of existing development adjacent to Spanish Fork River. This document establishes standards for operation and maintenance of the levee along Spanish Fork River in Spanish Fork City, Utah.

LEVEE LOCATION

The Spanish Fork River Levee is located on the north side of the river immediately upstream and downstream of the West Park Drive bridge.

ASSIGNMENT OF RESPONSIBILITY

Responsibilities of Spanish Fork City Department of Public Works

Spanish Fork City Department of Public Works operates and maintains the levee along the Spanish Fork River. The responsible official of Spanish Fork City Department of Public Works is Chris Thompson, P.E., Assistant Public Works Director. Daily operations of the levee are delegated to public works department field crews.

Spanish Fork City Assistant Public Works Director:

- Maintains and repairs the levee as needed to ensure safe operation
- Directs field crew maintenance activities
- Ensures the facility complies with applicable local, state, and federal law
- Provides necessary coordination with adjacent property owners

Public Works Field Personnel:

- Operate and maintain the levee according to approved Standard Operating Procedures
- Determine and identify conditions or triggering events that initiate or require emergency actions
- Initiate emergency actions to be taken
- Clearly communicate the emergency situation to those who need to be contacted (as specified in the communications section of this plan)
- Issue warning messages if levee failure is impending or has occurred
- Maintain operation and maintenance records
- Maintain the landscaping on and around the levee

OPERATING PERSONNEL SCHEDULED DUTIES
March, June, and November **1. Levee** Check condition of: a. Crest of embankment b. Riverside and Landside embankment faces c. Levee area (clear of sediment, debris, trash, etc.) d. Pipe Penetrations e. Rodent or woody vegetation problems
After Each Flood Event 1. Check condition of the embankment. 2. Repair areas of erosion, if needed. 3. Remove accumulated sediment in channel. 4. Inspect for erosion 5. Inspect riprap 6. Record pertinent information in Operating Log.

MAINTENANCE LOG

The maintenance log for the Spanish Fork River Levee shall be updated by the public works field personnel after each inspection visit to the site. Field personnel shall record the following information in the log: site observations; maintenance work; and any other pertinent information regarding the levee and associated facilities. The purpose of the maintenance log is to provide a chronological history of all regular and emergency occurrences at the levee site. This log is to be a bound document kept with field personnel. All entries in the log shall be made legibly with ink, dated, and signed.

Neither erasures nor ink eradicators shall be used to make corrections. Errors shall be lightly crossed out so that the incorrect item can still be read. Typical log entry information is summarized below:

Typical *Maintenance Log* Entries

1. High Water elevations and peak discharges from flood events.
2. Minor and major maintenance activities including scheduled maintenance.
3. Erosion occurrence and repair.
4. Sediment and debris accumulation and removal.
5. Levee observations.
6. Acknowledgment of emergency or unusual conditions.
7. Acts of vandalism.

8. Miscellaneous items pertinent to operation, emergency, or unusual conditions.

STANDARD OPERATING PROCEDURES

GENERAL DESCRIPTION OF SPANISH FORK RIVER LEVEE

The levee has a minimum crest width of 8 feet with the embankments having a minimum 2(H):1(V) side slope. The levee consists of three distinct segments 1) along the trail located on the east end of the "urban forest", 2) along the river between the urban forest and West Park Drive and 3) along the east side of West Park Drive. Segments 1 and 3 are situated perpidicular to the river and have native grass embankments to prevent erosion. Segment 2 is located on the landward side of a berm. The embankment on the berm is protected by riprap and the combination of the riprap and the trail protect the levee.

Levee Embankment

The Spanish Fork River levee is formed to provide a minimum of 3-feet of freeboard above the calculated 100-year water surface elevation. The embankment slopes are 2(H) minimum:1(V), and the minimum crest width is 8 feet.

The embankment shall be inspected each March, June, and November for evidence of the development of unfavorable conditions. After *a significant flood in Spanish Fork River*, the riverside and landside slopes of the embankment shall be inspected carefully for indications of:

- Impairments of slope protection
- Slides
- Sloughs
- Subsidence
- Boggy areas
- Erosion

Any modifications that could effect the levee embankment shall first be approved by the Spanish Fork City Assistant Public Works Director. No trees or undesirable plants will be allowed within 10 feet of the levees.

See the Routine Maintenance Guide section for additional maintenance guidelines.

Spanish Fork River Channel

Public Works field personnel shall inspect the channel each March, June, and November, and after each significant flood event. During those inspections, the field personnel shall determine if any significant quantities of sediment and/or debris was deposited within the channel. Sediment and debris should be removed as needed to maintain the channel geometry and capacity. Field personnel should also inspect the bank stabilization (riprap and vegetation), and repair as necessary. Field personnel should also inspect all pipe crossings below the river invert for erosion and scour (see record drawings for pipe crossings).

See the Routine Maintenance Guide section for further maintenance details.

Internal Drainage

Internal drainage includes all pipes crossing the levee and drainage facilities allowing the landside of the levee to drain.

Public Works field personnel shall inspect the storm drain inlet and conveyance facilities associated with pipes crossing the levee each March, June, and November, and after each significant flood event. During those inspections, field personnel shall clean the collection facilities to ensure proper operation. Field personnel shall also inspect pipe crossings and penetrations to determine if any piping has occurred.

See the Routine Maintenance Guide section for further maintenance details.

ROUTINE MAINTENANCE GUIDE

A. VEGETATION CONTROL

All types of woody, deep-rooted vegetation and brush growing on embankments are considered a problem and should be controlled. Some of the problems associated with excessive vegetation growth on the embankment are:

– Heavy vegetation obstructs the view of the embankment inspector and obscures any cracking, seepage and other surficial indications of a problem with the embankment.

– After trees and brush die, the root systems can decay, leaving behind a tunnel through which water can pass (piping).

– Large trees blown over during windstorms can have their root systems uprooted, leaving behind a large hole in the embankment that could lead to breaching.

– Vegetation on the embankment provides habitat for burrowing animals, whose presence further endangers the embankment.

Taking early action to remove vegetation before it becomes established is a critical part of embankment maintenance. Common types of vegetation detrimental to embankments are willows, saltcedar (tamarisk), Russian olives, cottonwoods, sagebrush, aspens, poplars, pine, spruce, fir, and juniper.

> **POLICY** – Only native grasses, which do not obscure observation of the embankment, should be allowed to grow on the embankment itself. All brush and trees should be prevented from growing: 1) on the embankment itself and within 15 feet of the embankment for deciduous trees and 10 feet for evergreens.

B. BURROWING ANIMAL CONTROL

Some of the typical burrowing animals, which damage levee embankments in Utah, are squirrels, prairie dogs, rock chucks, badgers, beaver and muskrat. Proper maintenance of levee embankments require that these animals be prevented from burrowing on the embankment and that they be eradicated if they are present on a levee. Repair of rodent burrows on levee embankments should be made by digging out the holes and recompacting clean fill into the excavation. This work can usually be done by hand.

The Utah Division of Wildlife Resources, Proclamation of the Wildlife Board of Non-game Mammals set forth rules governing certain non-game mammals. Among these is the Utah Prairie Dog, which is a protected species in some Utah

Counties. On sites where the prairie dog is present, assistance from the Division of Wildlife Resources should be requested to remove the offending animals. A certificate of registration from DWR must first be obtained before taking action against the prairie dog.

C. OTHER EMBANKMENT MAINTENANCE

Deterioration of the surfaces of a levee embankment may occur for several reasons. For example, vehicles may cause ruts in the crest or slopes, or runoff waters may leave erosion gullies on the riverside slope. Damage of this nature must be repaired on a continuing basis. The maintenance procedures described below are effective in repairing minor earthwork problems. The material selected for repairing embankments depends upon the purpose of the earthwork. Generally, earth should be free from vegetation, organic materials, trash, or large rock. Most of the earth should be fine-grained soils or earth clods which easily break down when worked with compaction equipment. The intent is to use a material which, when compacted, forms a firm, solid mass, free from excessive voids. If flow-resistant portions of an embankment are being repaired, materials which are high in clay or silt content should be used. If the area is to be free draining or highly permeable (i.e., riprap bedding, etc.) the material should have a higher percentage of sand and gravel. As a general rule, it is usually satisfactory to replace or repair damaged areas with soils similar to those originally in place.

D. CREST OF LEVEE

A levee's crest usually provides the primary access for inspection and maintenance. Because surface water will pond on a crest unless that surface is well maintained, this part of a levee usually requires periodic regrading. However, problems found on the crest should not be simply graded over or covered up. When a questionable condition is found, the Assistant Public Works Director should be notified immediately.

Surface runoff should be directed toward the riverside of the levee by having the crest graded toward the reservoir. Less erosion will result since the riverside face of the levee is armored with riprap and vegetation.

Traffic damage control –Vehicles driving across a levee can create ruts in the levee crest if the crest is not surfaced with a suitable road-base material. The ruts can then collect water and cause saturation and softening of the levee. These ruts can collect runoff and result in severe erosion. Vehicles should be banned from levee slopes and only maintenance vehicles should be allowed on the crest of the levee. Any ruts should be repaired as soon as possible.

Excessive settlement of the embankment or foundation can result in a low area in the levee crest and loss of the freeboard (vertical distance between the top of the levee and the calculated 100-year water surface elevation). The levee crest should be surveyed, the probable cause for the formation of the low spot determined by

an engineer, remedial action taken to correct the problem and then a uniform crest should be re-established by placing fill in low areas using proper construction techniques (see record drawings for elevations).

E. SIGNS OF EMBANKMENT DISTRESS

Structural problems with the embankment may be exhibited in the embankment itself, the foundation of the levee, or the abutments. Many of these types of problems become evident early in the life of the levee, often as the result of the first significant flood. Symptoms of structural problems are seepage, cracking, movement, settlement, sinkholes and erosion.

Seepage may be evidenced by water emerging in a concentrated location or wet areas. Seepage may occur through joints in the bedrock or zones of high permeability in the foundation or abutments. Seepage may also be attributed to improper construction. Any evidence of seepage will be discussed with the Assistant Public Works Director during inspections. Piping consists of the progressive erosion and removal of soil by concentrated seepage flows through the levee, its foundation, or its abutments. Seepage that is causing piping may create a sand boil where the water emerges. If new seepage areas develop, an increase in existing seepage occurs, or sand boils develop, the Assistant Public Works Director should immediately be contacted.

Cracking can occur in a variety of places on the levee. Transverse cracks, those which occur perpendicular to the crest, usually indicate that stresses in the levee are being created by unequal settlement of the fill or foundation material. Longitudinal cracks, which are parallel to the crest, can occur anywhere from the riverside toe to the landside toe of the levee. Foundation problems or an embankment weakness can be manifested by cracks. Randomly oriented, shallow cracks are usually attributable to drying of the surface soils on the embankment. Cracks of any sort should be reported to the Assistant Public Works Director.

Movement of the embankment can occur as a slough or slide. These problems are usually initiated by a period of unusually high moisture in the ground and are aggravated by seepage flows. Cracks at the top and bulging at the bottom, or toe, of the moving material frequently accompanies a slope failure. If any movement of embankment or abutment material occurs, the Assistant Public Works Director should be contacted.

Sinkholes are created by piping of material by seepage flows. They can occur directly on the levee but usually occur along the riverside face of the levee. During periods of low flow in the creek, the abutments, pipe penetrations, and the riverside face of the levee should be examined closely for sinkhole depressions. Sinkholes may indicate serious deficiencies with the levee and should be remedied quickly. Corrective action will need to be designed by a professional engineer.

Erosion of the embankment can result from inadequate protection of the levee from rain collecting and running down the embankments of the levee. Surface runoff should be directed toward the riverside face of the levee by having the crest graded toward the channel. Less erosion will result since the riverside face of the levee is armored with riprap and vegetation. Erosion of the riverside face of the levee should be corrected by placing an adequate layer of properly graded riprap, or vegetation stabilization.

F. ACCESS ROADS AND RAMPS

Access roads to and on levees, including ramps will be bladed as necessary to keep the roadway shaped properly and free of ruts, pockets and washes. Ramp embankments should be maintained to their design section and design grade. Road surfacing material will be replaced as necessary to maintain the road surface in good condition.

G. CHANNEL MAINTENANCE

Field personnel shall determine if any significant quantities of sediment and/or debris was deposited within the channel. Sediment and debris should be removed to maintain the channel geometry and channel slope (see record drawings for channel slope). Areas where riprap may have been lost or damaged during a flood event will need to be properly repaired. If the channel bank or levee embankment material above the riprap experience erosion during a large flood event, the eroded areas shall be repaired and revegetated.

H. MISCELLANEOUS LEVEE FACILITIES AND APPURTENANCES

Miscellaneous facilities and utilities which are constructed on, over or through the levee will be maintained in a good state of repair and/or in good operating condition. These facilities and appurtenances include water, sewer, and storm drain pipe crossings

EMERGENCY PROCEDURES

EARLY WARNING SYSTEM

Public Works field personnel shall monitor the NOAA Hazardous Weather Outlook at: www.weather.gov and at http://forecast.weather.gov/showsigwx.php?warnzone=UTZ004&warncounty=UTC049&firewxzone=UTZ424&local_place1=Spanish+Fork+UT&product1=Hazardous+Weather+Outlook during spring runoff events and predicted large rainfall events.

If a flood event is predicted, Public Works personnel shall contact:

Lead Forecaster
National Weather Service
801-524-4377

The Lead Forecaster is available 24-hours a day. If necessary, the Lead Forecaster can notify emergency responders, media outlets and others of flooding.

The USGS operates and maintains the stream gages that are used by the National Weather Service to predict flood events. The following person can be contacted if there are questions about the accuracy of the gage reporting:

Cory Angeroth
Flood Coordinator
US Geological Survey
801-908-5048

If damage is sustained during a flood event, Public Works personnel should contact one of the following to discuss assistance through the FEMA National Flood Insurance Program (NFIP):

John Crofts
State of Utah NFIP Coordinator
801-538-3332

Shandi Teltschik
FEMA Region VIII NFIP Branch Chief
303-235-4800

FLOOD FIGHTING

The Assistant Public Works Director/Flood Plain Manager shall direct flood fighting operations. The following is his contact information:

Chris Thompson, P.E.
Spanish Fork City, Assistant Public Works Director
40 South Main Street
Spanish Fork City, UT 84660

(801) 804-4556 (Office)
(801) 921-9882 (Mobile)
cthompson@spanishfork.org

He will have at his disposal all city heavy equipment and vehicles. This equipment is stored at the following locations:

City Shop
175 East 2160 North
Spanish Fork, UT 84660
(801) 798-5039

City Sports Park
295 West Volunteer Drive
(950 South Main Street)
Spanish Fork, UT 84660
(801) 804-4615

City Fairgrounds
475 South Main St.
Spanish Fork, Utah 84660
(801) 798-5041

Sand bagging materials are stockpiled at the City Shop. Bag filling equipment is also located at the City Shop.

In the event that city resources are not enough for the flood fighting operations the event may be declared local disaster at which point the County will be notified and the existing mutual aid agreements will be put into effect. These agreements will allow the city to utilize available equipment from all over the state of Utah.

The following is the contact information for Utah County:

Richard Nielson, P.E.
Utah County, Public Works Director
2855 South State Street
Provo, UT 84606

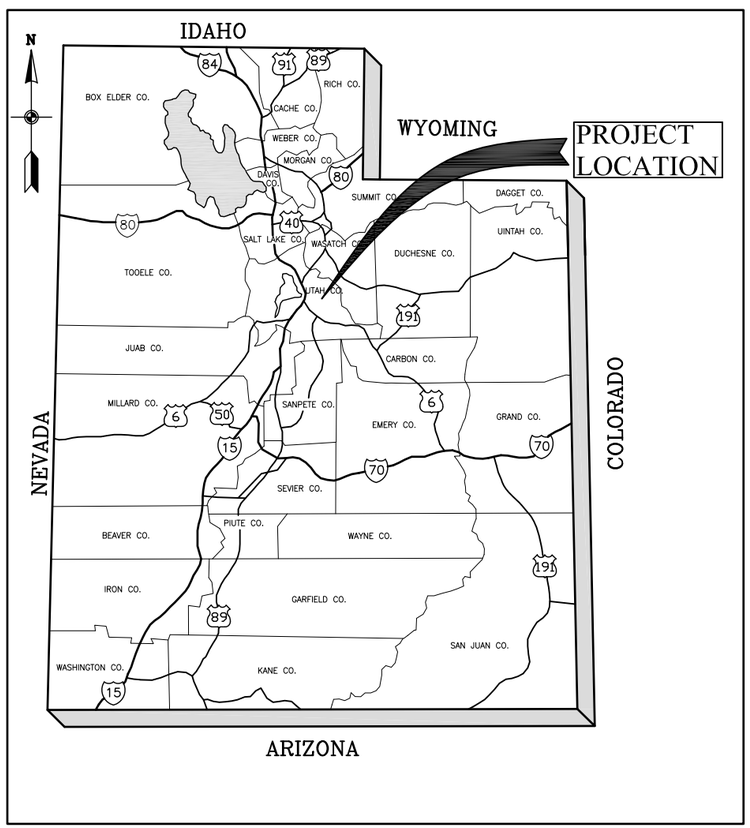
(801) 851-8601 (Office)
(801) 404-7010 (Mobile)
richardjn.ucpw@utah.gov

APPENDIX A
RECORD DRAWINGS

SPANISH FORK RIVER LEVEE PROJECT

SPANISH FORK CITY, UTAH

LEVEE, TOE DRAIN AND STORM DRAIN DESIGN



PROJECT LOCATION MAP

INDEX OF DRAWINGS			
SHT NO.	DWG NO.	DESCRIPTION	CAD FILE NAME
		GENERAL	
1	G–1	PROJECT LOCATION MAP, INDEX TO DRAWINGS AND VICINITY MAP	2040801_G–01.dwg
2	G–2	GENERAL NOTES	2040801_G–02.dwg
		CIVIL	
3	PP–1	PLAN AND PROFILE – LEVEE & TOE DRAIN STA 15+24 TO STA 25+00	2040801_PP01.dwg
4	PP–2	PLAN AND PROFILE – LEVEE & TOE DRAIN STA 25+00 TO STA 36+00	2040801_PP02.dwg
5	PP–3	PLAN AND PROFILE – LEVEE & TOE DRAIN STA 36+00 TO STA 39+95	2040801_PP03.dwg
6	PP–4	PLAN AND PROFILE – LEVEE STA 40+00 TO STA 50+95	2040801_PP04.dwg
7	PP–5	PLAN AND PROFILE – TRAIL DESIGN	2040801_PP05.dwg
8	C–1	STORM DRAIN IMPROVEMENTS	2040801_C01.dwg
9	C–2	STANDARD DETAILS 1	2040801_C02.dwg
10	C–3	STANDARD DETAILS 2	2040801_C03.dwg

PROJECT VICINITY MAP

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

BOWEN COLLINS & Associates, Inc. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION
1	6/19/09	MHS	ADDENDUM NO. 1

REVISIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY – NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

PROJECT LOCATION MAP, AND VICINITY MAP

DATE: 06/19/09

PROJECT NUMBER 204–08–01

DRAWING NO. G–1

SHEET 1 OF 10

P:\Spanish Fork City\Task 1 – Spanish Fork River FEMA Study\Levee Design\Drawings\ADDENDUM–1\SHT\ADDENDUM1_2040801_G01.dwg Jan05,2010 – 1:16pm

GENERAL NOTES

1. PRESERVING EXISTING LIVING TREES. EXISTING LARGE LIVING TREES SHALL BE PRESERVED ALONG THE CHANNEL CORRIDOR WHERE FEASIBLE. NO LIVING TREE WITH A CALIPER GREATER THAN 10 INCHES SHALL BE REMOVED WITHOUT APPROVAL OF THE ENGINEER.
2. DEWATERING AND WATER MANAGEMENT. CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS, AND EQUIPMENT NEEDED FOR DEWATERING, IF NEEDED.
3. PERMITS. CONTRACTOR SHALL OBTAIN AND COMPLY WITH ALL NECESSARY CONSTRUCTION AND ENVIRONMENTAL PERMITS.
4. SURVEY MONUMENTS. CONTRACTOR SHALL NOT DESTROY, REMOVE, OR DISTURB ANY EXISTING SURVEY OR STREET MONUMENT WITHOUT AUTHORIZATION OF CONTROLLING AGENCY.
5. UTILITY LOCATIONS. THE LOCATIONS OF EXISTING UTILITIES, DITCHES, CONDUITS, AND UNDERGROUND STRUCTURES SHOWN ON THE DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION OF, AND PRESERVING, UTILITIES AND FACILITIES IMPACTED BY CONSTRUCTION IN ACCORDANCE WITH THE SPECIFICATIONS.
6. POTHOLING. CONTRACTOR SHALL CONTACT BLUE STAKES AND UTILIZE FIELD MARKS TO VERIFY THE LOCATION AND DEPTH OF BURIED UTILITIES IN THE CONSTRUCTION AREA BY POTHOLE EXCAVATIONS. POTHOLING SHALL BE PERFORMED A MINIMUM OF 300 FEET AHEAD OF CONSTRUCTION. CONTRACTOR SHALL UTILIZE INFORMATION OBTAINED BY POTHOLING TO COORDINATE WITH THE ENGINEER TO MAKE MINOR MODIFICATIONS IN THE DESIGN TO AVOID CONFLICTS WITH EXISTING BURIED UTILITIES. ANY CHANGES TO THE DESIGN MUST BE APPROVED BY THE ENGINEER. CONTRACTOR SHALL COOPERATE WITH AND PROVIDE FIELD ASSISTANCE TO UTILITY COMPANIES TO FACILITATE RELOCATION OF BURIED UTILITIES.
7. EXCAVATION. CONTRACTOR SHALL EXCAVATE MATERIALS TO THE DEPTHS OR GRADES SHOWN ON THE DRAWINGS OR AS REQUIRED TO ACCOMPLISH THE WORK. CONTRACTOR SHALL BE RESPONSIBLE FOR DISPOSAL OF EXCESS EXCAVATED MATERIAL.
8. EXISTING FACILITIES. THE CONTRACTOR SHALL IMPLEMENT MEASURES TO PROTECT EXISTING UTILITIES AND IMPROVEMENTS, WHICH ARE TO REMAIN IN PLACE, FROM DAMAGE. ALL FACILITIES DAMAGED BY THE CONTRACTOR'S ACTIVITIES SHALL BE REPAIRED OR REPLACED TO ORIGINAL OR BETTER CONDITION BY THE CONTRACTOR AT NO COST TO THE OWNER.
9. EXCAVATION SAFETY. EXCAVATION LIMITS SHOWN ON THE DRAWINGS ARE GRAPHICAL REPRESENTATIONS ONLY, AND DO NOT REPRESENT ACTUAL EXCAVATION LIMITS REQUIRED TO COMPLETE THE WORK. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR CONFORMING TO LOCAL, STATE, AND FEDERAL CODES REGARDING EXCAVATION SAFETY.
10. STATIONING. LEVEE STATIONING AND LENGTHS CORRESPOND TO THE CENTERLINE OF THE PROPOSED LEVEE. (PEDESTRIAN PATH STATIONING CORRESPONDS TO THE CENTERLINE OF THE PEDESTRIAN PATHS.) INFORMATION ON PROFILE DRAWINGS REPRESENTS VERTICAL AND HORIZONTAL PROJECTIONS OF THE GROUND SURFACE AND OTHER FEATURES FROM THE REFERENCED CENTERLINE.
11. OVERHEAD POWER. CONTRACTOR SHALL COMPLY WITH LOCAL, STATE, AND FEDERAL SAFETY REQUIREMENTS FOR OPERATING CONSTRUCTION EQUIPMENT UNDER OR NEAR HIGH VOLTAGE POWER LINES.
12. CONTRACTOR SHALL REPLACE ALL ASPHALT THAT IS DAMAGED DURING CONSTRUCTION.
13. CLEANOUT BOXES – ALL CLEANOUT BOXES SHALL BE NYLOPLAST 2815AG OR APPROVED EQUIVALENT. ALL BOXES SHALL HAVE SOLID LIDS UNLESS OTHERWISE SPECIFIED ON DRAWINGS.
14. ADS PIPE – ALL ADS PIPE SHALL BE N–12 ST 1B (OR EQUIVALENT) PIPE. ALL ADS PIPES ARE PERFORATED WITH AASHTO CLASS II PERFORATION PATTERN UNLESS OTHERWISE SPECIFIED ON DRAWINGS.
15. LOCATIONS OF MANHOLES AND CLEANOUT BOXES ARE APPROXIMATE AND CAN BE ADJUSTED BASED ON FIELD CONDITIONS. MAINTAIN DESIGN SLOPE OF PIPES SHOWN ON PLANS.
16. CONTRACTOR CONSTRUCTING STORM DRAIN FACILITIES SHALL COORDINATE ALL WORK WITH SPANISH FORK CITY IN ORDER TO ACCOMIDATE CONSTRUCTION OF LEVEE AND TOE DRAIN.

LEGEND

C/O = CLEANOUT
FL = FLOW LINE (INVERT ELEVATION)
EXST = EXISTING
DIA = DIAMETER
LF = LINEAR FEET

ALIGNMENT TABLE

Station	Northing	Easting	Elevation
15+24	7206130.80	1591002.35	4570.43
15+50	7206131.06	1591028.33	4570.54
16+00	7206131.55	1591078.33	4570.74
16+50	7206132.04	1591128.33	4570.94
17+00	7206132.53	1591178.33	4571.14
17+50	7206133.03	1591228.32	4571.34
18+00	7206133.52	1591278.32	4571.54
18+50	7206133.68	1591328.32	4571.78
19+00	7206132.68	1591378.31	4572.12
19+50	7206129.71	1591428.20	4572.45
20+00	7206134.76	1591477.88	4572.80
20+50	7206123.25	1591525.35	4573.10
21+00	7206096.37	1591567.41	4573.39
21+50	7206064.01	1591605.53	4573.57
22+00	7206025.32	1591635.37	4573.67
22+50	7205977.27	1591646.32	4573.69
23+00	7205936.22	1591674.86	4573.75
23+50	7205897.12	1591705.67	4573.82
24+00	7205864.28	1591743.38	4573.91
24+50	7205823.04	1591770.13	4573.97
25+00	7205804.85	1591807.38	4574.05

ALIGNMENT TABLE

Station	Northing	Easting	Elevation
25+50	7205813.55	1591856.60	4574.19
26+00	7205821.31	1591905.99	4574.32
26+50	7205828.39	1591955.48	4574.47
27+00	7205831.45	1592005.37	4574.62
27+50	7205830.02	1592055.34	4574.76
28+00	7205824.71	1592105.05	4574.91
28+50	7205818.13	1592154.61	4575.06
29+00	7205809.24	1592203.81	4575.21
29+50	7205799.44	1592252.84	4575.36
30+00	7205789.23	1592301.78	4575.55
30+50	7205774.85	1592349.64	4575.76
31+00	7205755.53	1592395.73	4575.97
31+50	7205731.46	1592439.53	4576.17
32+00	7205702.93	1592480.57	4576.37
32+50	7205671.93	1592519.80	4576.59
33+00	7205640.92	1592559.02	4576.81
33+50	7205608.05	1592596.67	4577.04
34+00	7205571.59	1592630.85	4577.25
34+50	7205533.39	1592663.12	4577.42
35+00	7205495.20	1592695.38	4577.60

ALIGNMENT TABLE

Station	Northing	Easting	Elevation
35+50	7205457.00	1592727.65	4577.78
36+00	7205418.80	1592759.91	4577.96
36+50	7205380.61	1592792.18	4578.13
37+00	7205343.20	1592825.33	4578.37
37+50	7205309.12	1592861.89	4579.32
38+00	7205278.86	1592901.67	4579.58
38+50	7205252.73	1592944.27	4579.84
39+00	7205229.06	1592988.32	4580.08
39+46	7205207.34	1593028.78	4580.30

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

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BOWEN COLLINS & Associates, Inc. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY – NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

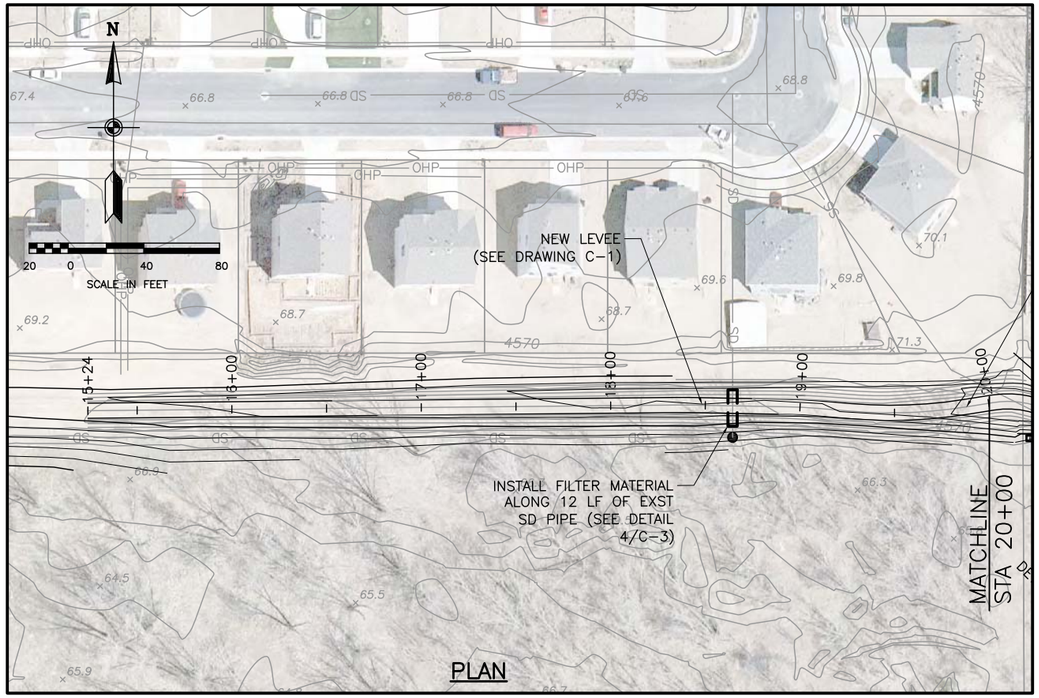
REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

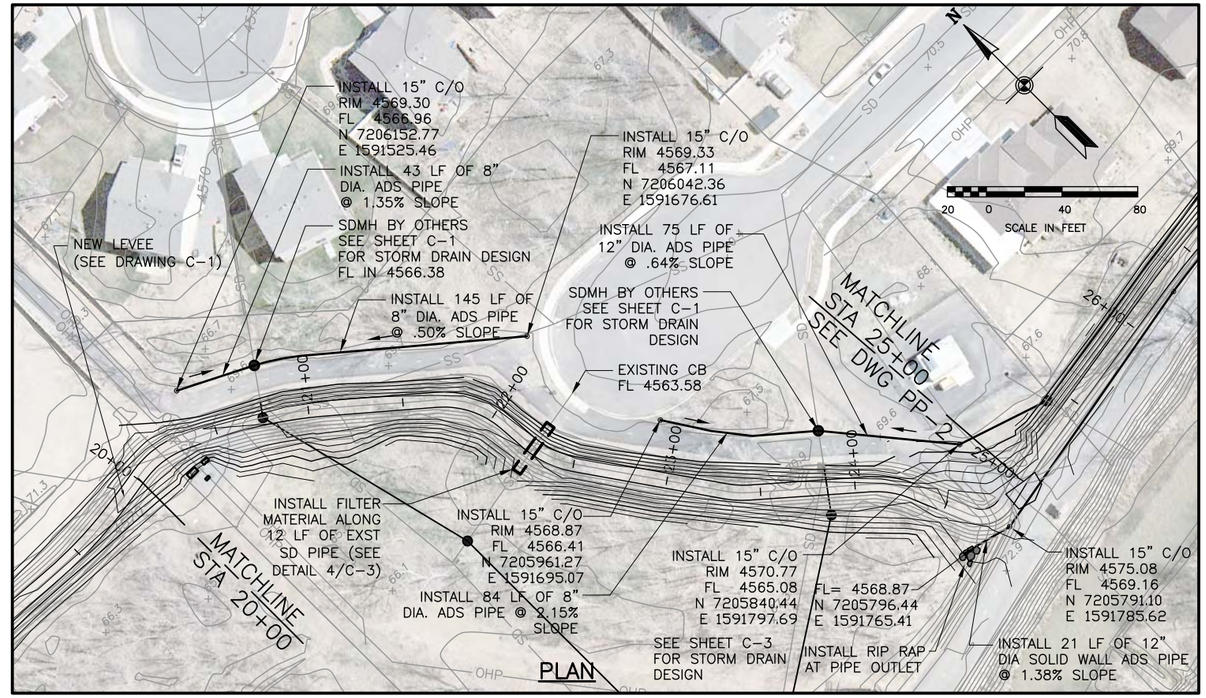
DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

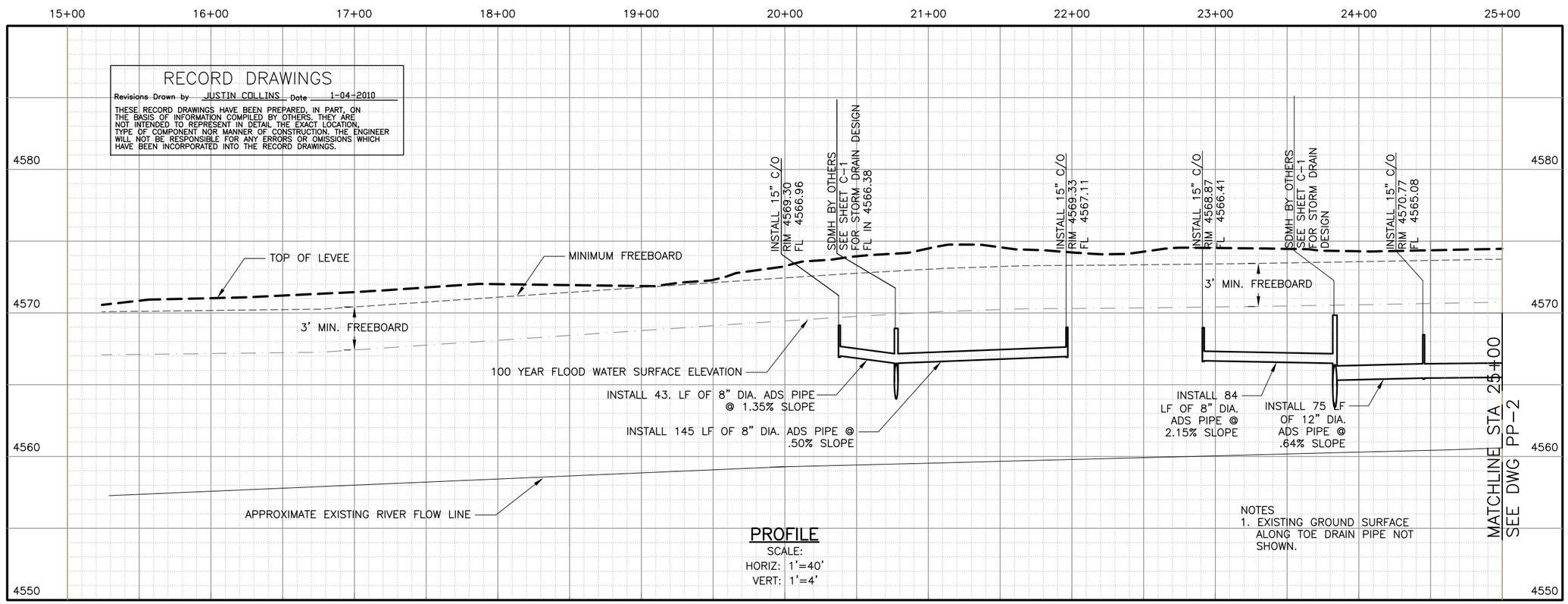
GENERAL NOTES

DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO. G–2
SHEET 2 OF 10







BOWEN COLLINS & ASSOCIATES, INC.
Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION
			REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

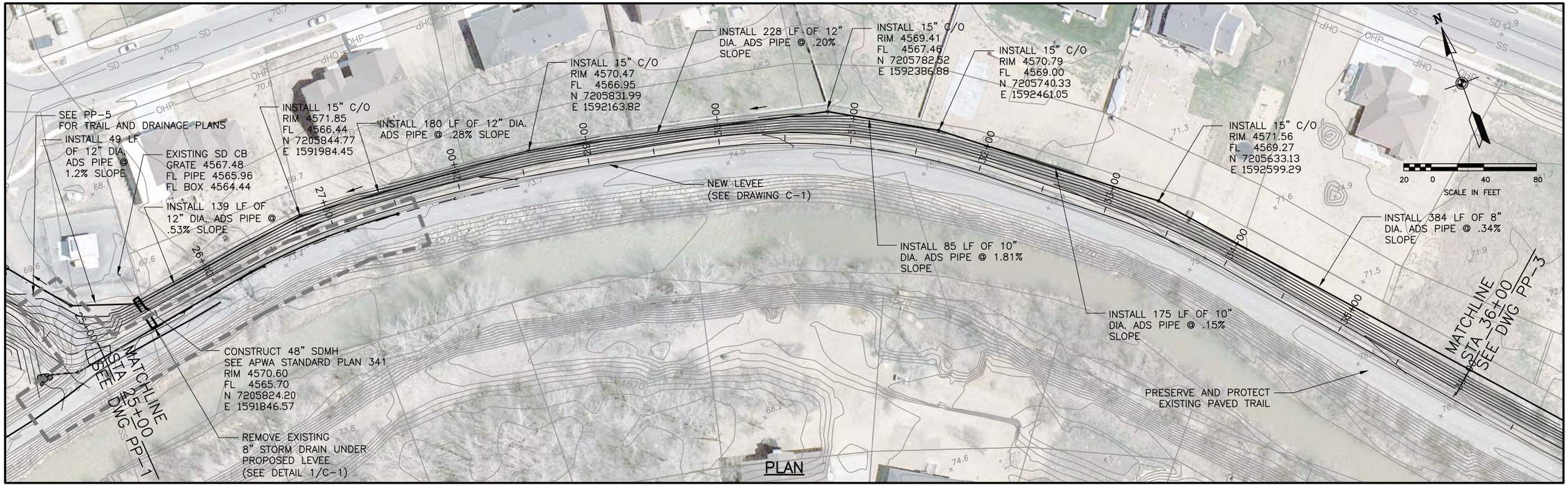
DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

CIVIL
PLAN AND PROFILE
LEVEE & TOE DRAIN
STA 15+24 TO STA 25+00

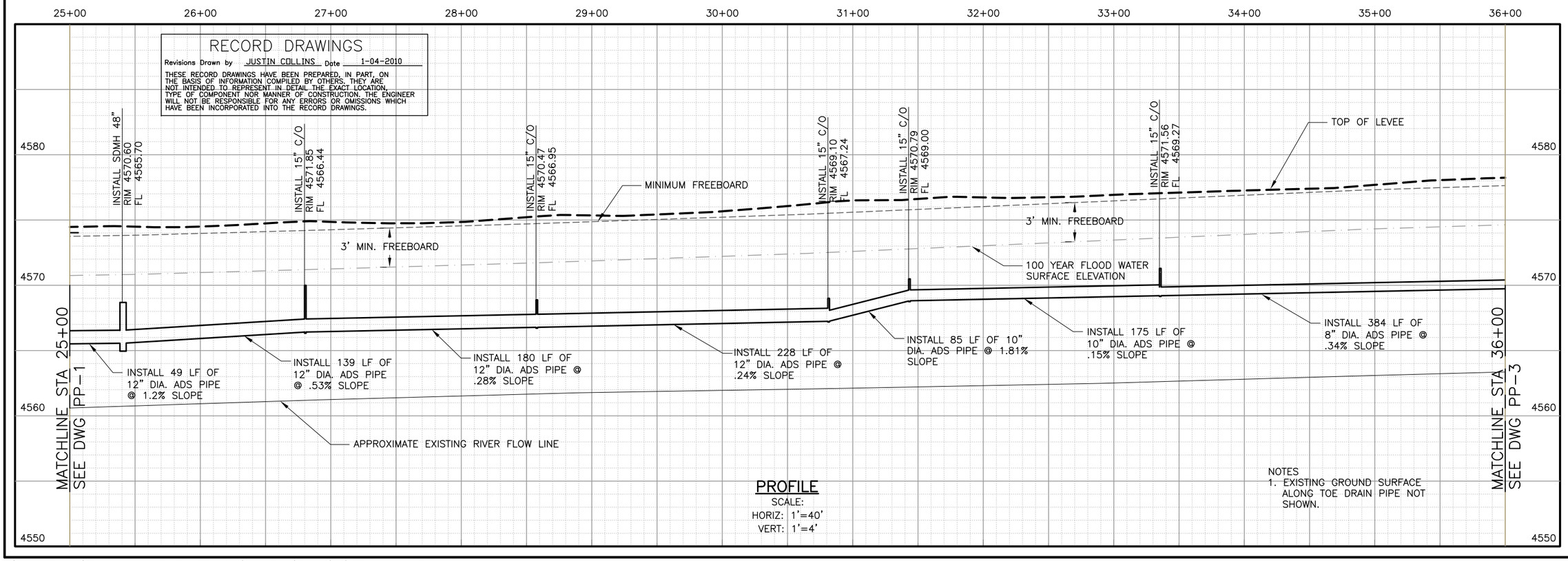
DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO.
PP-1
SHEET 3 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\sht_PP01.dwg Jan06,2010 - 9:05am



PLAN



PROFILE

SCALE:
HORIZ: 1'=40'
VERT: 1'=4'

NOTES
1. EXISTING GROUND SURFACE ALONG TOE DRAIN PIPE NOT SHOWN.

BOWEN COLLINS & ASSOCIATES, INC. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

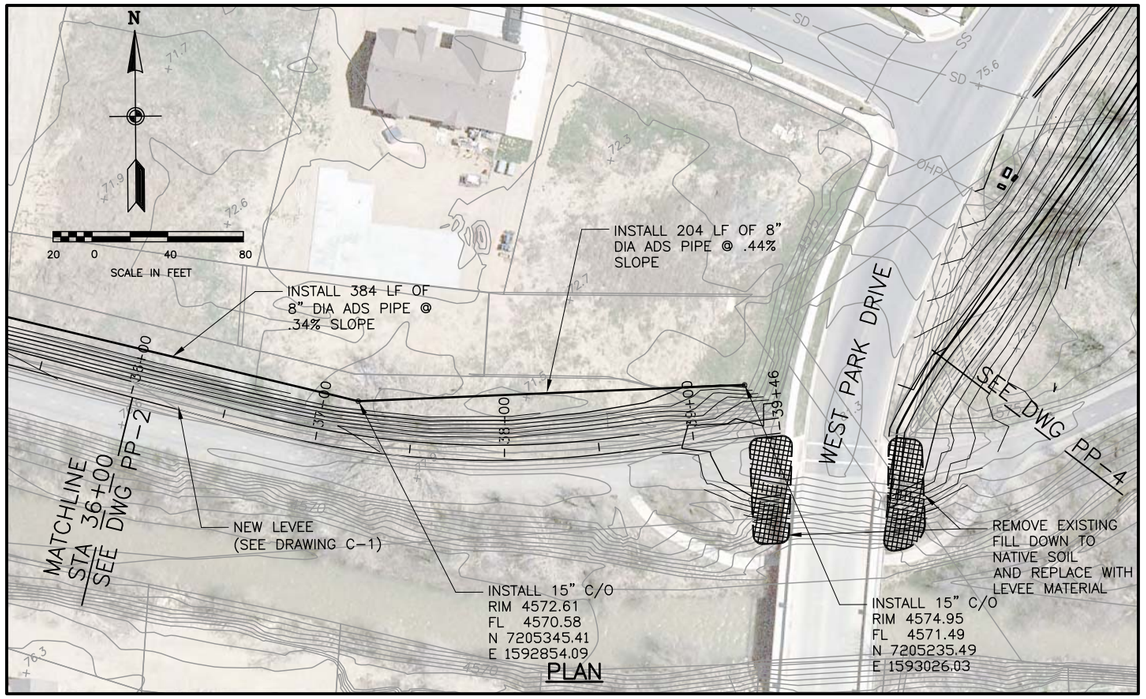
CIVIL
PLAN AND PROFILE
LEVEE & TOE DRAIN
STA 25+00 TO STA 36+00

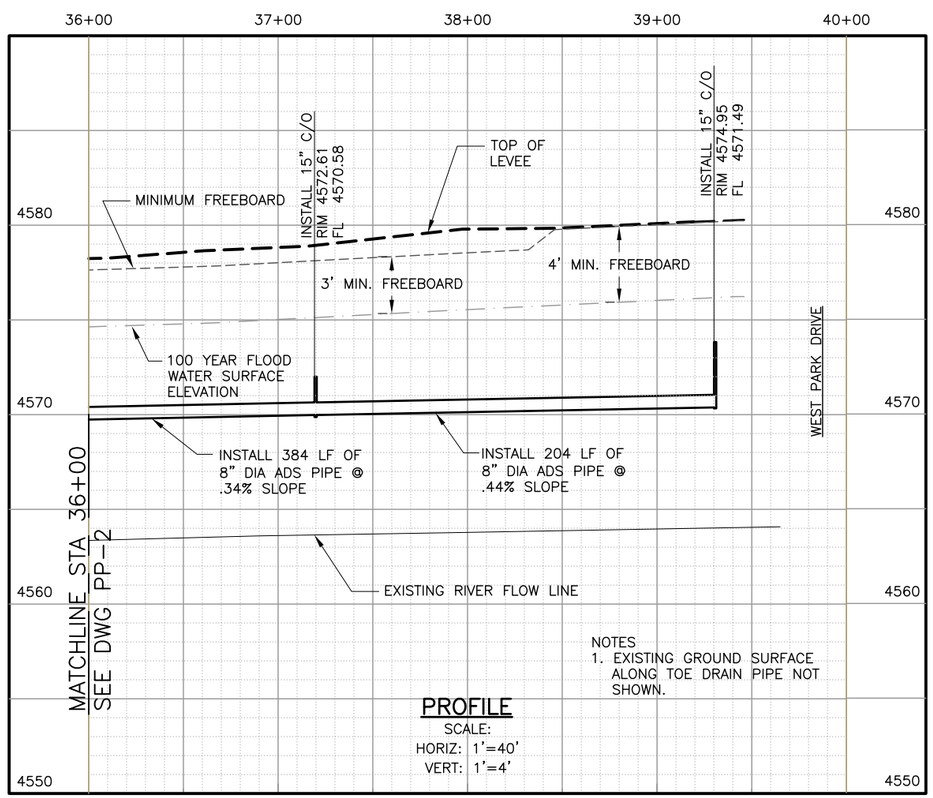
DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO.
PP-2

SHEET 4 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\sht_PP02.dwg Jan06,2010 - 9:46am





RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 1-04-2010

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BOWEN COLLINS & Associates, Inc. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

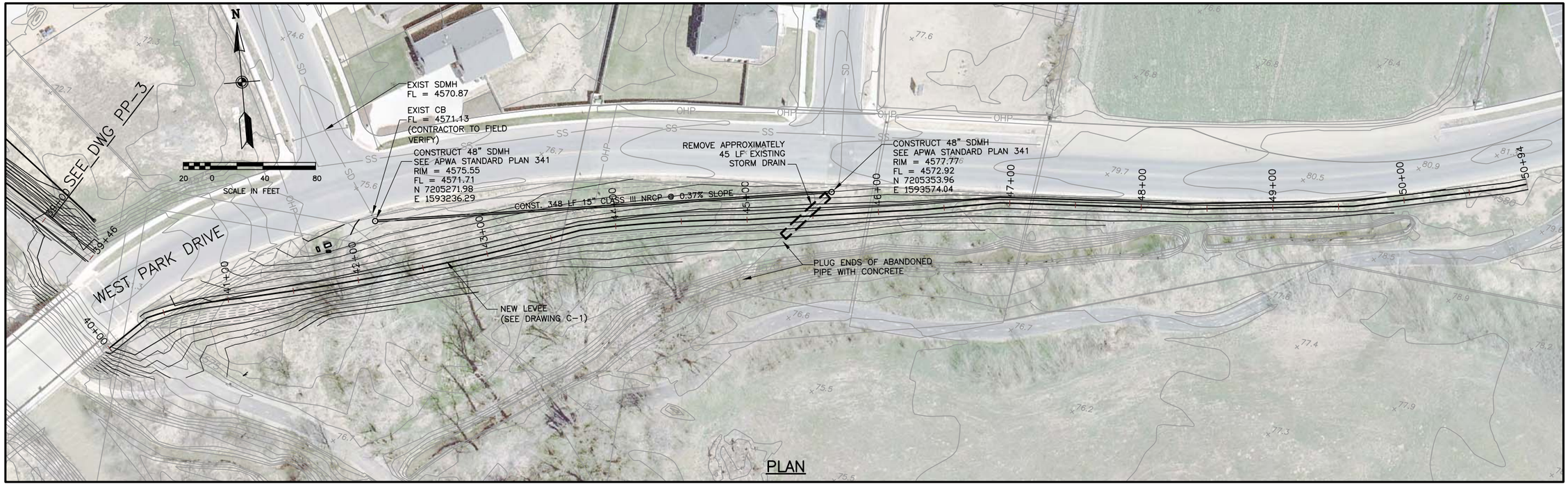
DESIGN M. STAYNER
DRAWN B. SCOTT
REVIEW C. BAGLEY
CHECKED C. BAGLEY
APPROVED C. BAGLEY

CIVIL
PLAN AND PROFILE
LEVEE & TOE DRAIN
STA 36+00 TO STA 39+46

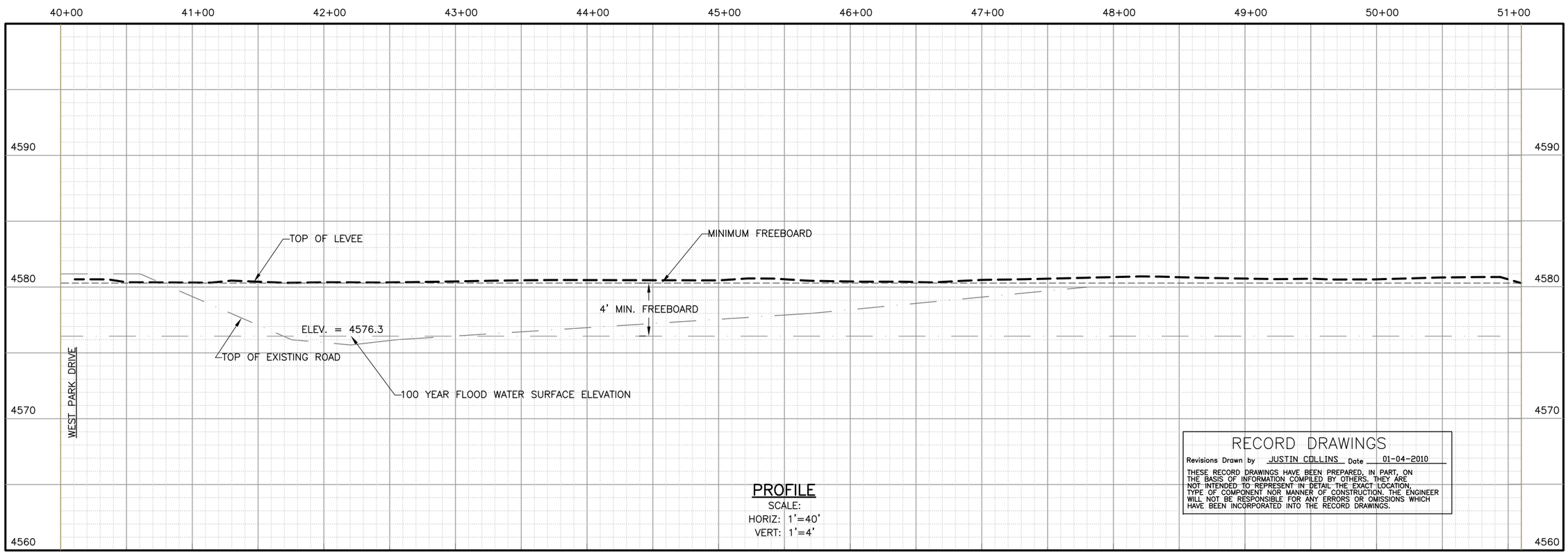
DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO. PP-3
SHEET 5 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\sht_PP03.dwg Jan06,2010 - 11:40am



PLAN



PROFILE
SCALE:
HORIZ: 1'=40'
VERT: 1'=4'

RECORD DRAWINGS
Revisions Drawn by JUSTIN COLLINS Date 01-04-2010
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Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION
1	6/19/09	MHS	ADDENDUM NO. 1

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

PLAN AND PROFILE
LEVEE
STA 40+00 TO STA 50+95

DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO. PP-4
SHEET 6 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\ADDENDUM-1\SHT\ADDENDUM1_2040801_PP04.dwg Jan06,2010 - 3:30pm

15 0 30 60
SCALE IN FEET

N

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

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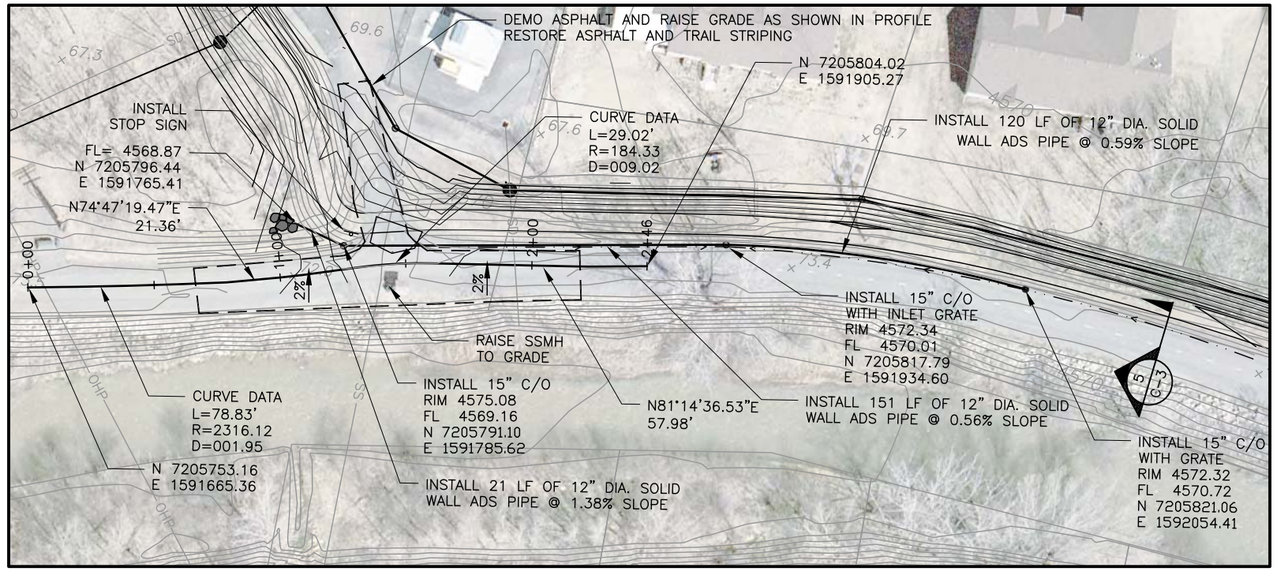
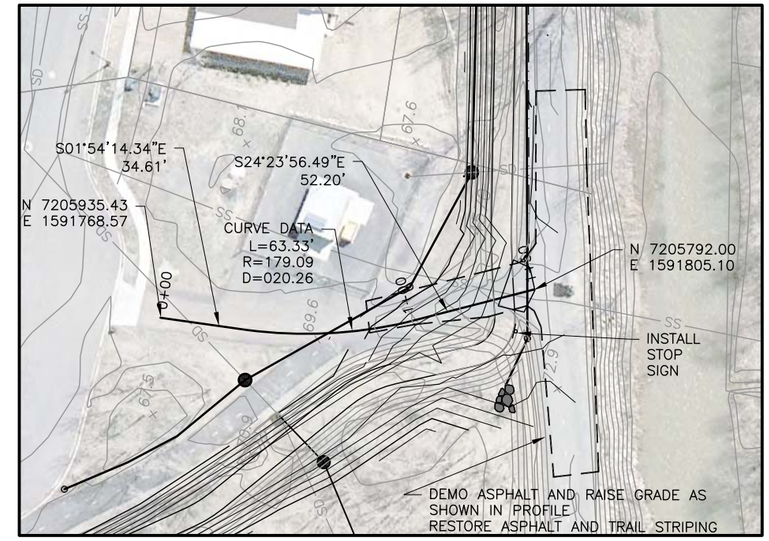
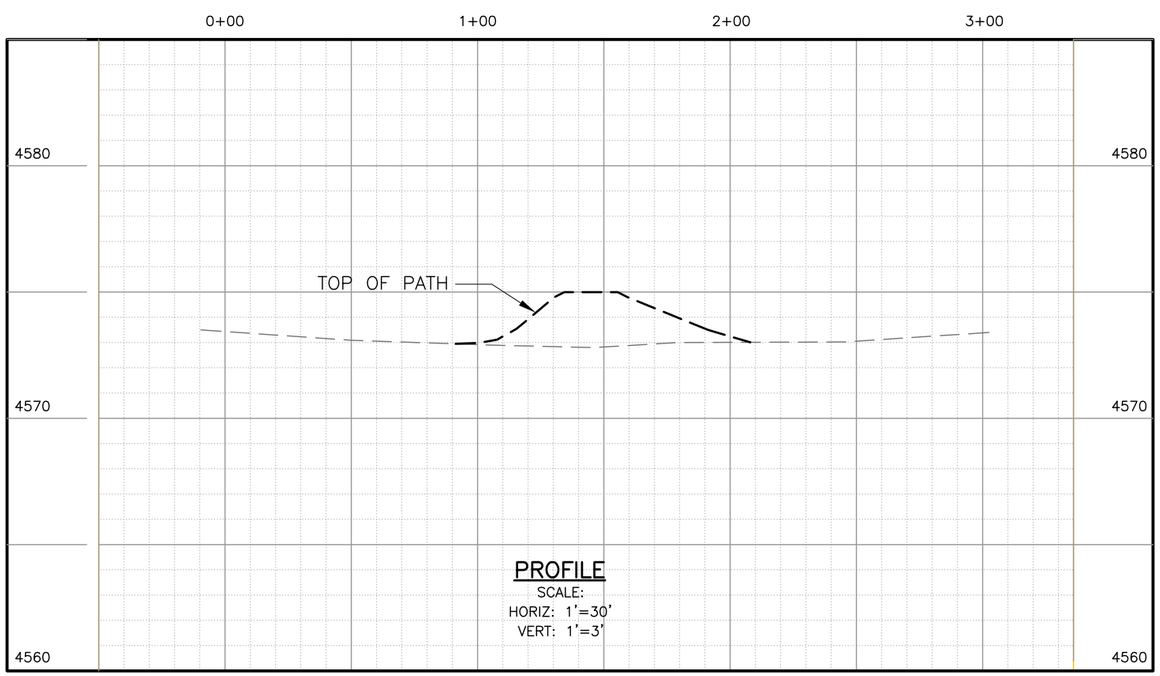
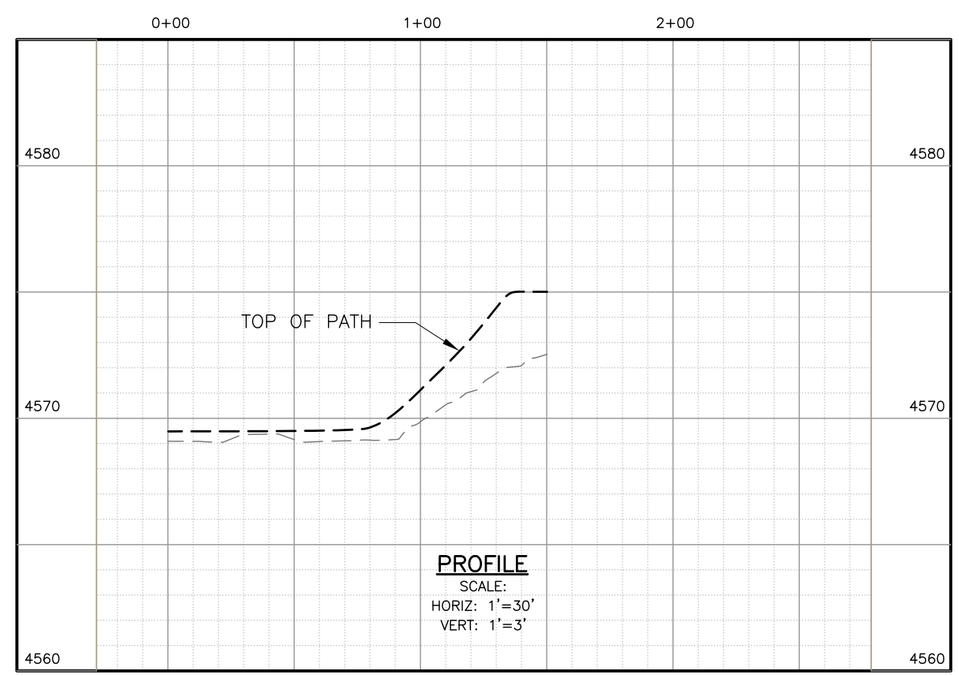
N

15 0 30 60
SCALE IN FEET









BOWEN COLLINS & ASSOCIATES, INC.
Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY – NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

CIVIL
PLAN AND PROFILE
TRAIL DESIGN

DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO.
PP-5

SHEET 7 OF 10

P:\Spanish Fork City\Task 1 – Spanish Fork River FEMA Study\Levee Design\Drawings\sht_PP05.dwg Jan06,2010 – 12:24pm

N

25 0 50 100
SCALE IN FEET

EXIST 24" STORM DRAIN

EXIST 30" STORM DRAIN

EXIST 24" STORM DRAIN

RAISE EXIST SDMH
NEW RIM 4572.87
REMOVE EXIST GRADE RINGS
AND TOP OF EXIST 4' X 4' BOX.
INSTALL TWO (2) 4' X 4' X 3' RISERS
AND TWO (2) 6" GRADE RINGS.

NEW 60" SDMH
ON EXISTING 30" PIPE
(SEE DETAIL 6/C-3)
RIM 4570.57
FL 8" 4566.38
FL 30" 4563.60
N 7206133.16
E 1591563.84

REMOVE EXISTING
CONCRETE BOX

PLUG ABANDONED PIPE
WITH CONCRETE

EXIST 30" STORM DRAIN

CONSTRUCT 8 LF 30"
CLASS II NRCP @ 0.20%

NEW 60" SDMH
SEE APWA STANDARD PLAN 341
SEE DETAIL 2/C-2
RIM 4573.15
FL 4563.45
BFE 4569.20
N 7206110.50
E 1591547.60

REMOVE APPROXIMATELY
35 LF EXISTING STORM DRAIN

CONSTRUCT 126 LF 30"
CLASS II NRCP @ 0.20%

EXIST 12"
STORM DRAIN

TOE DRAIN BY OTHERS
SEE PP-1 & PP-2

NEW 72" SDMH
ON EXISTING 36" PIPE
(SEE DETAIL 6/C-3)
RIM 4571.02
FL 8" 4564.60
FL 12" 4564.60
FL 36" 4563.43
N 7205898.32
E 1591750.04)

EXIST 36" STORM DRAIN

NEW 60" SDMH
SEE APWA STANDARD PLAN 341
RIM 4570.27
FL 4563.02
GROUND 4566.67
BFE 4569.30
N 7205988.12
E 1591577.97

EXIST 12" STORM DRAIN

CONSTRUCT 220 LF 30"
CLASS II NRCP @ 0.30%

REMOVE EXISTING
CONCRETE BOX

PLUG WITH
CONCRETE

CONSTRUCT 25 LF 36"
CLASS II RCP @ 0.30%

CONSTRUCT 173 LF 36"
CLASS II RCP @ 0.40%

NEW 6 FOOT X 6 FOOT CLEANOUT BOX
SEE APWA STANDARD PLAN 330
RIM 4570.06
FL IN 4562.50
FL OUT 4560.50
GROUND 4568.15
BFE 4569.30
N 7205768.12
E 1591577.97

NEW 72" SDMH
SEE APWA STANDARD PLAN 341
SEE DETAIL 2/C-2
RIM 4573.16
FL 4563.20
BFE 4569.88
N 7205873.98
E 1591732.23

INSTALL TYPE P FILTER MATERIAL (SUPPLIED BY CITY)
ALONG 40 LF OF SD PIPE (SEE DETAIL 4/C-3). INSTALL
TYPE I LEVEE MATERIAL BACKFILL (SUPPLIED BY CITY)
FLUSH WITH TOP OF EXISTING ASPHALT. REPLACE ANY RIP
RAP ON CHANNEL BANK REMOVED DURING CONSTRUCTION.

CONSTRUCT 359 LF 42" CLASS II RCP @ 0.40%

REMOVE APPROXIMATELY
30 LF EXISTING STORM DRAIN

PLUG ABANDONED PIPE WITH CONCRETE

PLUG ABANDONED PIPE WITH CONCRETE

NEW 72" SDMH
SEE APWA STANDARD PLAN 341
RIM 4568.64
FL 4558.19
GROUND 4566.52
BFE 4567.22
N 7205593.10
E 1591078.72

CONSTRUCT 201 LF 42"
CLASS II RCP @ 0.40%

CONSTRUCT 70 LF 42" CLASS II RCP @ 0.40%

NEW 72" SDMH
SEE APWA STANDARD PLAN 341
RIM 4568.08
FL 4558.69
GROUND 4568.64
BFE 4567.79
N 7205570.45
E 1591278.36

FL 4557.84
BFE 4567.50
N 7205565.36
E 1591044.59

SAW-CUT
EXISTING TRAIL

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

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BOWEN COLLINS & ASSOCIATES, INC.
Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK
SPANISH FORK CITY, UTAH

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

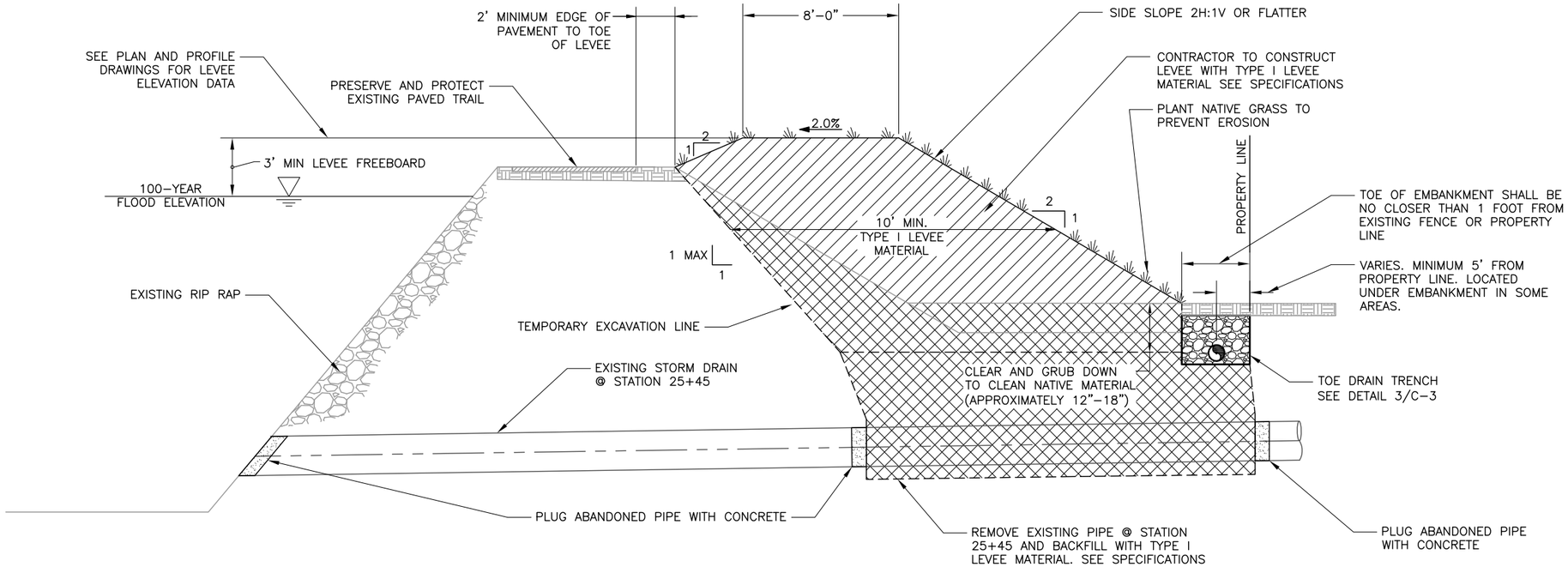
DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

CIVIL
STORM DRAIN IMPROVEMENTS

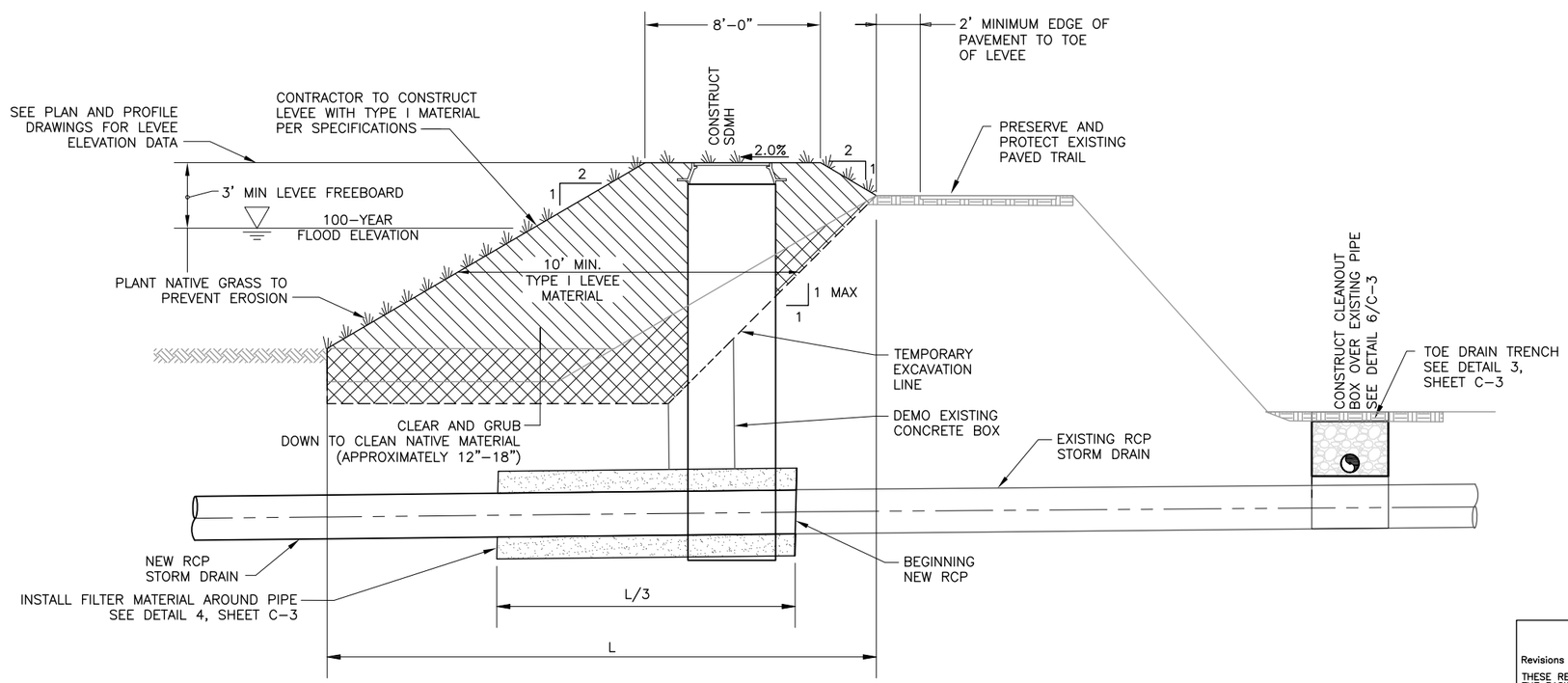
PROJECT NUMBER 204-08-01
DATE: 1/4/10

DRAWING NO. C-1
SHEET 8 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\ADDENDUM-1\SHT\ADDENDUM1_2040801_C01.dwg Jan06,2010 - 12:37pm



TYPICAL LEVEE SECTION (1)
1"=40'



TYPICAL LEVEE PENETRATION SECTION (2 / C-1)
1"=40'

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

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BOWEN COLLINS & Associates, Inc. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY - NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

REVIEW CHECKED C. BAGLEY APPROVED C. BAGLEY

DESIGN DESIGN M. STAYNER DRAWN B. SCOTT

CIVIL
STANDARD DETAILS 1

DATE: 1/4/10 PROJECT NUMBER 204-08-01

DRAWING NO. C-2

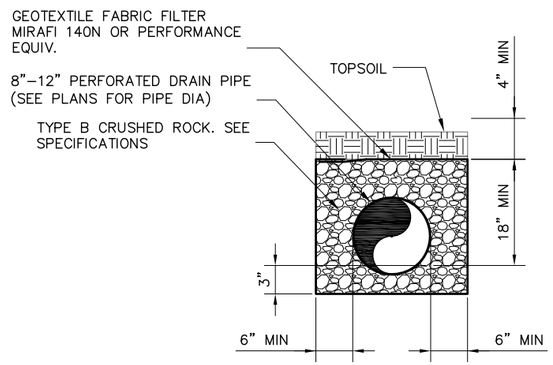
SHEET 9 OF 10

P:\Spanish Fork City\Task 1 - Spanish Fork River FEMA Study\Levee Design\Drawings\sht_C02.dwg Jan06,2010 - 12:38pm

RECORD DRAWINGS

Revisions Drawn by JUSTIN COLLINS Date 01-04-2010

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.



TOE DRAIN TRENCH DETAIL
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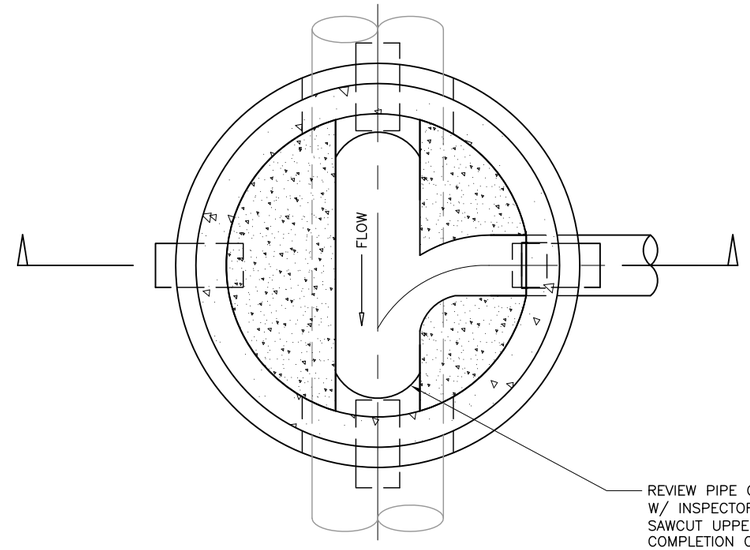
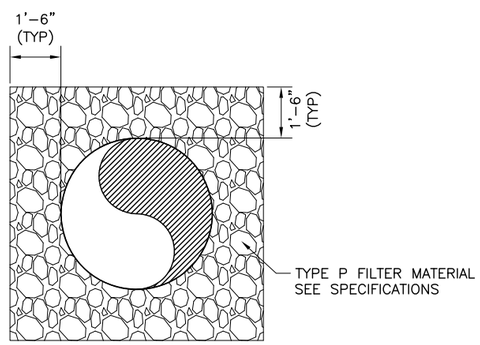
3 / C-2



REVIEW PIPE OPENING SIZE W/ INSPECTOR PRIOR TO CUTTING. SAWCUT UPPER 1/3 OF PIPE AFTER COMPLETION OF MANHOLE. SAWCUT FOR NEW PIPES AS APPROVED BY INSPECTOR.

PLAN VIEW



PIPE SECTION
NTS
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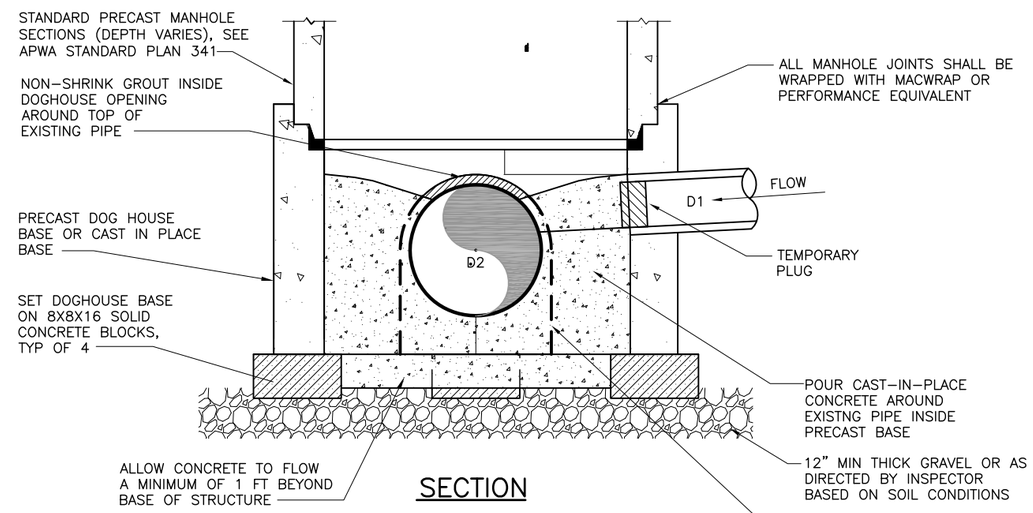
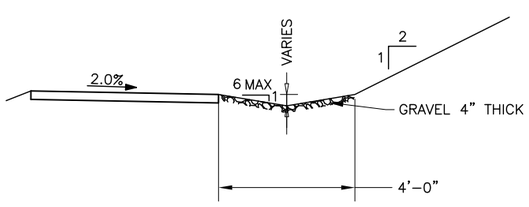


SECTION



TRAIL DRAINAGE CHANNEL
NTS
5 / PP-5

NOTES:

1. AFTER ALL GRADING AROUND MANHOLE HAS BEEN COMPLETED AND FINAL SURFACING IS IN PLACE, REMOVE DEBRIS AND TEMPORARY PLUGS OR PLYWOOD FROM INSIDE OF MANHOLES.
2. IF MANHOLE IS TO BE POURED IN PLACE, FOLLOW SAME PATTERN AS SHOWN EXCEPT USE 10" MIN WALL THICKNESS.
3. CONTACT INSPECTOR 48 HOURS (2 BUSINESS DAYS) PRIOR TO CONSTRUCTION.

MANHOLE ON EXISTING PIPE
NTS
6 / C-1

BOWEN COLLINS & Associates, Inc. Consulting Engineers

NO.	DATE	REV. BY	DESCRIPTION

REVISIONS

SPANISH FORK RIVER LEVEE PROJECT
PRELIMINARY – NOT FOR CONSTRUCTION
SPANISH FORK CITY
SPANISH FORK CITY, UTAH

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

REVIEW
CHECKED C. BAGLEY
APPROVED C. BAGLEY

DESIGN
DESIGN M. STAYNER
DRAWN B. SCOTT

CIVIL
STANDARD DETAILS 2

DATE: 1/4/10
PROJECT NUMBER 204-08-01

DRAWING NO. C-3

SHEET 10 OF 10

P:\Spanish Fork City\Task 1 – Spanish Fork River FEMA Study\Levee Design\Drawings\sht_C03.dwg Jan06,2010 – 12:39pm

ATTACHMENT 3
BANK STABILITY ANALYSIS

SPANISH FORK RIVER BANK STABILITY ANALYSIS

Prepared for:

City of Spanish Fork
40 South Main
Spanish Fork, Utah 84660

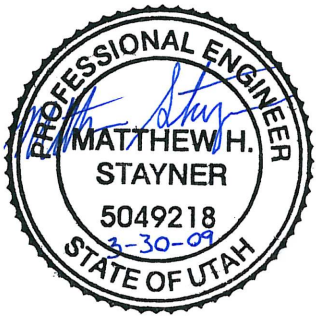
Prepared by:

BOWEN COLLINS & Associates, Inc.
Consulting Engineers

756 East 12200 South
Draper, Utah 84020

Mach 2009

SPANISH FORK RIVER BANK STABILITY ANALYSIS



Prepared by:

BOWEN COLLINS & Associates, Inc.
Consulting Engineers

756 East 12200 South
Draper, Utah 84020

Mach 2009

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(Located at the end of this report)

1A	Inventory of Bank Slope Data and Locations of Uncertified Levees
1B	Inventory of Bank Slope Data and Locations of Uncertified Levees
2A	Channel Bank Erosion Potential and Conceptual Stabilization Improvements
2B	Channel Bank Erosion Potential and Conceptual Stabilization Improvements

APPENDICIES

A	Photographs
B	HEC-RAS Output

PURPOSE

The purpose of this study was to perform a general assessment of the stability of the Spanish Fork River banks and to recommend bank stabilization improvements, where appropriate. Rivers are the most dynamic landform on earth and they tend to change over time, including lateral migration. River lateral migration is a natural process and normally is not a cause for concern. However, if the area near the river is developed, the channel banks may require stabilization in order to limit the potential for the river to migrate and damage existing buildings or infrastructure.

The study reach of the Spanish Fork River is from Powerhouse Road (near the canyon mouth) on the upstream end to down to Interstate 15. This study identifies areas of low, medium and high bank erosion potential in the study reach. General bank stabilization improvements are also recommended for this reach

EVALUATION CRITERIA

The channel bank stability was evaluated based on field observations, river bank side-slope analysis and average water velocities in the channel during a 1%-annual chance flood event. Each of these criteria are described in more detail below.

Field Observation

In order to accomplish the objects of this study, field observations were made of the channel banks from bridges, accessible locations along the banks, and from a raft in the river. In much of the study area dense vegetation exists on both river banks (see Photo 1 below), making it difficult to observe much of the river from the banks. Therefore, areas of greatest interest were identified on an aerial map before the field observations were made, and photographs were taken of those areas. The locations where photographs were taken are shown on Figure 1. The photographs are included in Appendix A.

In order to get a better view of the channel banks, representatives from Spanish Fork City and Bowen, Collins and Associates floated the river. The view from the raft made it possible to observe the channel banks in a way that was not possible from land. The thick bank vegetation still presented problems. In many areas the low hanging branches and trees that had fallen across the river made it nearly impossible to navigate down the river. In one area the rafters had to portage around a fallen tree (see Photo 2).

In general, the banks are heavily vegetated. The river bank soils appear to mostly consist of highly erodable sands and gravel. There are areas where the river bank is near vertical. However, these areas are relatively small and there are no structures that currently appear to be in danger.

There are also some areas that have been stabilized with riprap. The riprap appears to have been placed either after the 1983 flood or within the last 5 – 7 years. Both the old and the new riprap will help stabilize the banks. There are other areas where materials such as broken up concrete,

abandoned cars, and other debris line the river banks. It appears these materials will do little to properly stabilize the channel banks.

Photo 1 – Example of Dense Vegetation on Channel Banks

Photo 2 – Example of River Blockage Encountered During River Rafting Field Observations

River Bank Side Slope Analysis

The side slope of the river banks was analyzed to evaluate erosion potential. In general, the steeper the bank side slopes, the higher the potential for erosion.

Spanish Fork City obtained topographic aerial mapping with 1-foot contours in April 2008. This digital topographic information was used to generate a Digital Terrain Model (DTM) in ArcMap. GIS technology was used to evaluate the channel side-slope information using the DTM. For the purposes of this study, channel bank side slopes were analyzed as follows:

- Less than 3H:1V – Stable
- 3H:1V – 2.5H:1V – Low potential for bank instability
- 2.5H:1V – 2H:1V – Moderate potential for bank instability
- 2H:1V – 1.5H:1V –High potential for bank instability
- Steeper than 1.5H:1V – Very high potential for bank instability

The banks that are steeper than 3H:1V are shown on Figure 1. Figure 1 also shows where levees that do not meet FEMA certification requirements for flood control structures are located along the study reach.

Average Channel Water Velocity

The average channel water velocity during a 1%-annual chance flood was also estimated. Higher water velocities are associated with higher erosion potential.

Bowen, Collins and Associates developed a HEC-RAS model to estimate the average channel velocity during a 100-year flood event. Cross sections of the river channel were field surveyed at intervals of approximately 500 feet. Geometry for the overbank from the April, 2008 1-foot contours was combined with the survey cross section data and imported into a HEC-RAS model. The HEC-RAS model output, including flow line profile, is included in Appendix B.

The average calculated water velocities are shown on Figure 2. The velocities are divided into three categories for the purpose of evaluating erosion potential:

- Less than 5 feet/second – Low erosion potential
- 5 – 7 feet/second – Moderate erosion potential
- Greater than 7 feet/second – High erosion potential

RESULTS

The overall erosion potential for the river banks was estimated using a combination of field observations, river bank side slope analysis and average channel water velocity. Figure 2 shows the combined erosion potential for the river banks. As can be seen on the figure, there are 8 areas where high erosion potential exists and 15 areas of moderate erosion potential. Figure 2 also shows the preferred bank stabilization alternatives for unstable areas.

CONCLUSIONS AND RECOMMENDATIONS

There are several reach in the study area where the erosion potential is moderate to high. However, at the time of the study there does not appear to be any existing infrastructure or development at risk of being damaged by erosion. Therefore, there does not appear to be a need to stabilize or armor the banks at this time.

Management Recommendations

The greatest risk of damage to infrastructure appears to be the dead trees and vegetation in the river channel. During a flood event, the trees and vegetation could be dislodged from the banks and carried down the river. If the debris is deposited at a restriction in the river, such as a bridge crossing, the river could become dammed and overflow its banks causing damage to the surrounding area. It is therefore recommended that the following management actions be implemented immediately.

- **Beaver Control** – Beaver activity should be monitored. Mitigative action should be taken when beaver activity threatens trees and bank stability along the river.

- **Vegetation Clearing** – Spanish Fork City and/or Utah County should develop a regular maintenance program for the Spanish Fork River to keep the channel clear of dead trees and other debris.

- **Existing Vegetation** – Existing vegetation should be preserved and protected where possible. The mature vegetation on the channel banks provides stability to the channel and enhances the riverine experience.

- **Monitor Existing Stabilization Measures** – Any existing slope stabilization measures, including riprap, should be inspected regularly and after flood events. Mitigative action should be indemnified if the stability of the channel bank is threatened due to damaged or ineffective stabilization controls.

Development Recommendation

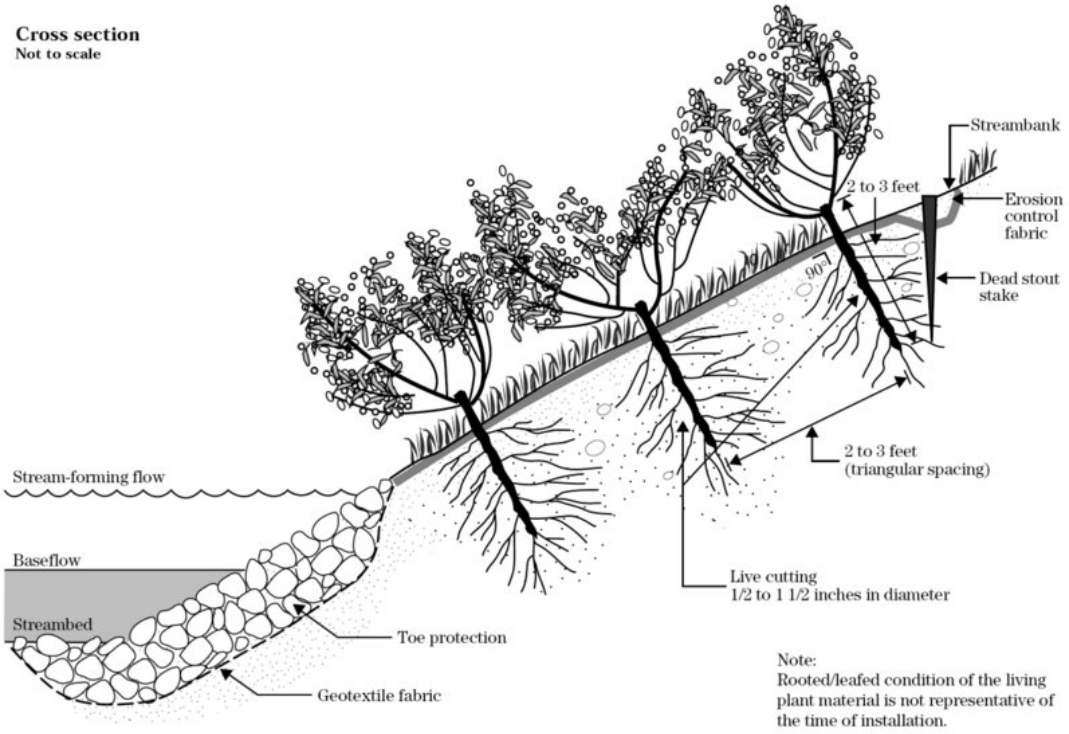
There is development pressure along the study reach. The general recommendations below should be considered where infrastructure or development is planned to encroach on the river and bank stabilization is required for protection. Bank stabilization should be considered as a requirement for any permanent structure within 200 feet of the center line of the Spanish Fork River.

- **Detailed Study** – A detailed study should be performed by an engineer before any development is allowed adjacent to the river. This study is general in nature and the recommendations found herein will need to be applied on a site specific basis depending on the nature of the proposed development and the protection required for that development. The detailed study should follow the guidelines found in the

NRCS Engineering Field Handbook (EFH), Chapter 16 "Streambank and Shoreline Protection" or similar publication.

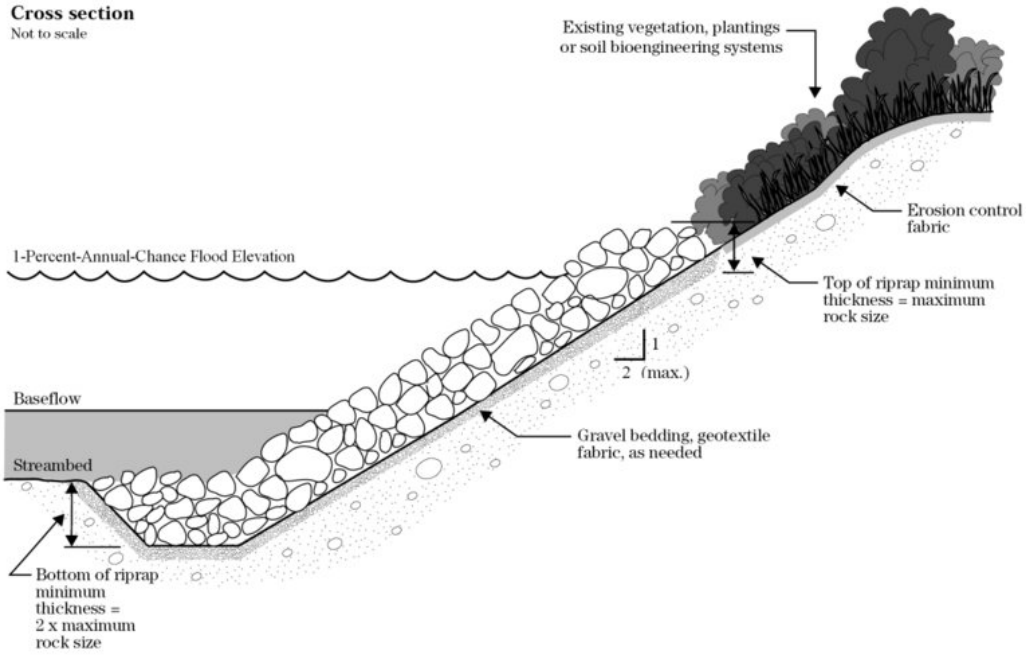
- **Set Back** – No permanent structure should be located within 200 feet of the center line of the Spanish Fork River without:
  - A bank stability/erosion hazard analysis, performed by a licensed professional engineer, and
  - A geotechnical investigation that includes an engineer's recommendation with regard to the lowest elevation(s) of all new and substantially improved structures.
- **Average Channel Velocity (1%-annual-chance flood)**
  - 4 – 7 feet/second – Protect toe (see EFH Figure 16-4) or construct buried rock trench behind the river bank. In areas where revegetation is required, use woody vegetation as described in the EFH.
  - > 7 feet/second – riprap channel bank (see EFH Figure 16-32) or construct buried rock trench behind the river bank.
- **Channel Bank Slope** – Lay the channel bank back if the existing slope is steeper than 2:1 (3:1 is desirable). Use woody vegetation (see EFH Figure 16-4) to stabilize channel bank.
- **River Bends and Structures** – Riprap channel banks on the outside bends in the river, and upstream and downstream of structures.

Figure 16–4 Live stake details



(210-vi-EFH, December 1996) 16–13

Figure 16–32 Rock riprap details



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FIGURES

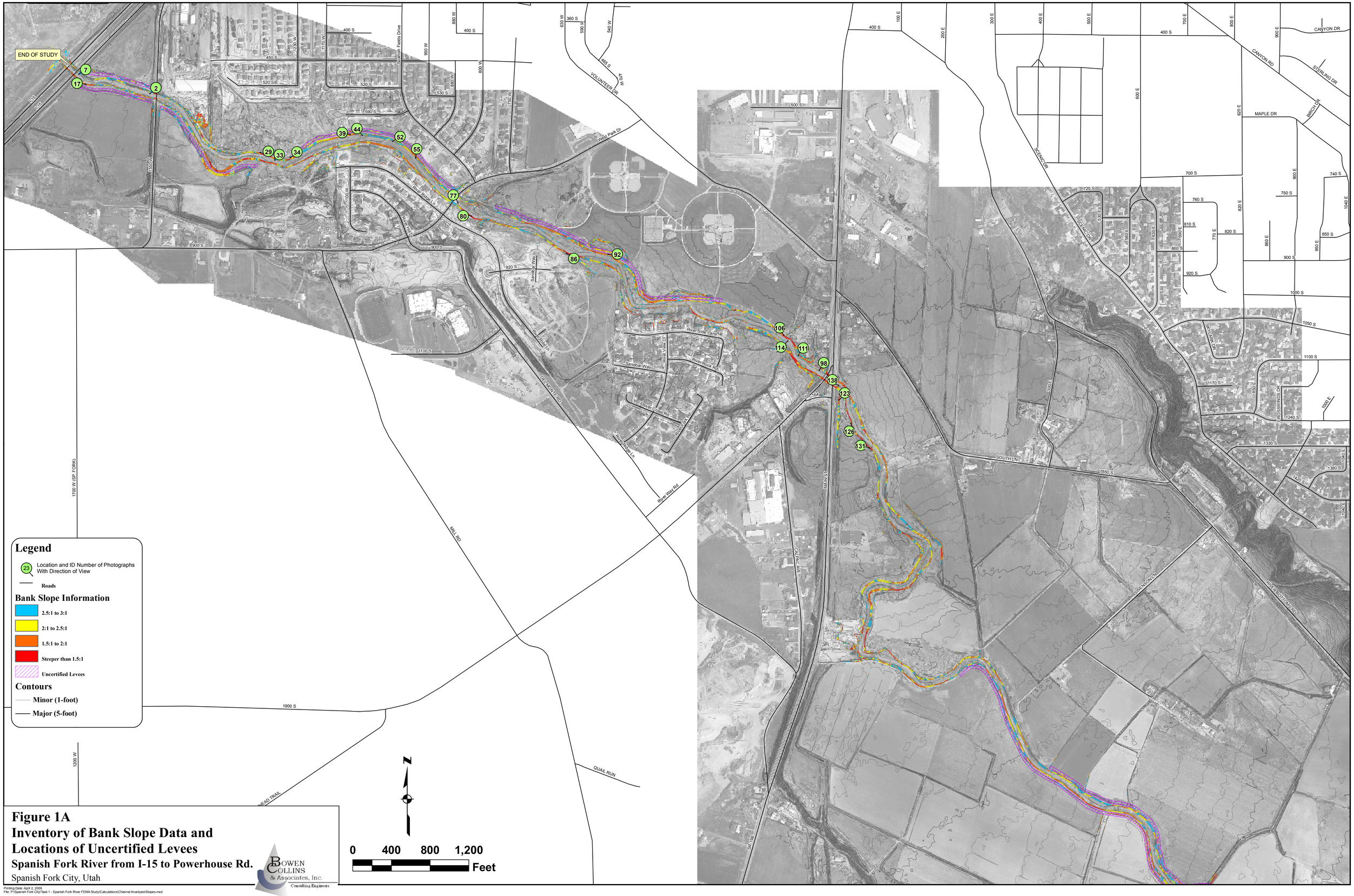

Figure 1A
Inventory of Bank Slope Data and Locations of Uncertified Levees
Spanish Fork River from I-15 to Powerhouse Rd.
Spanish Fork City, Utah

Bowen Collins & Associates, Inc.
Consulting Engineers

Printing Date: April 2, 2009
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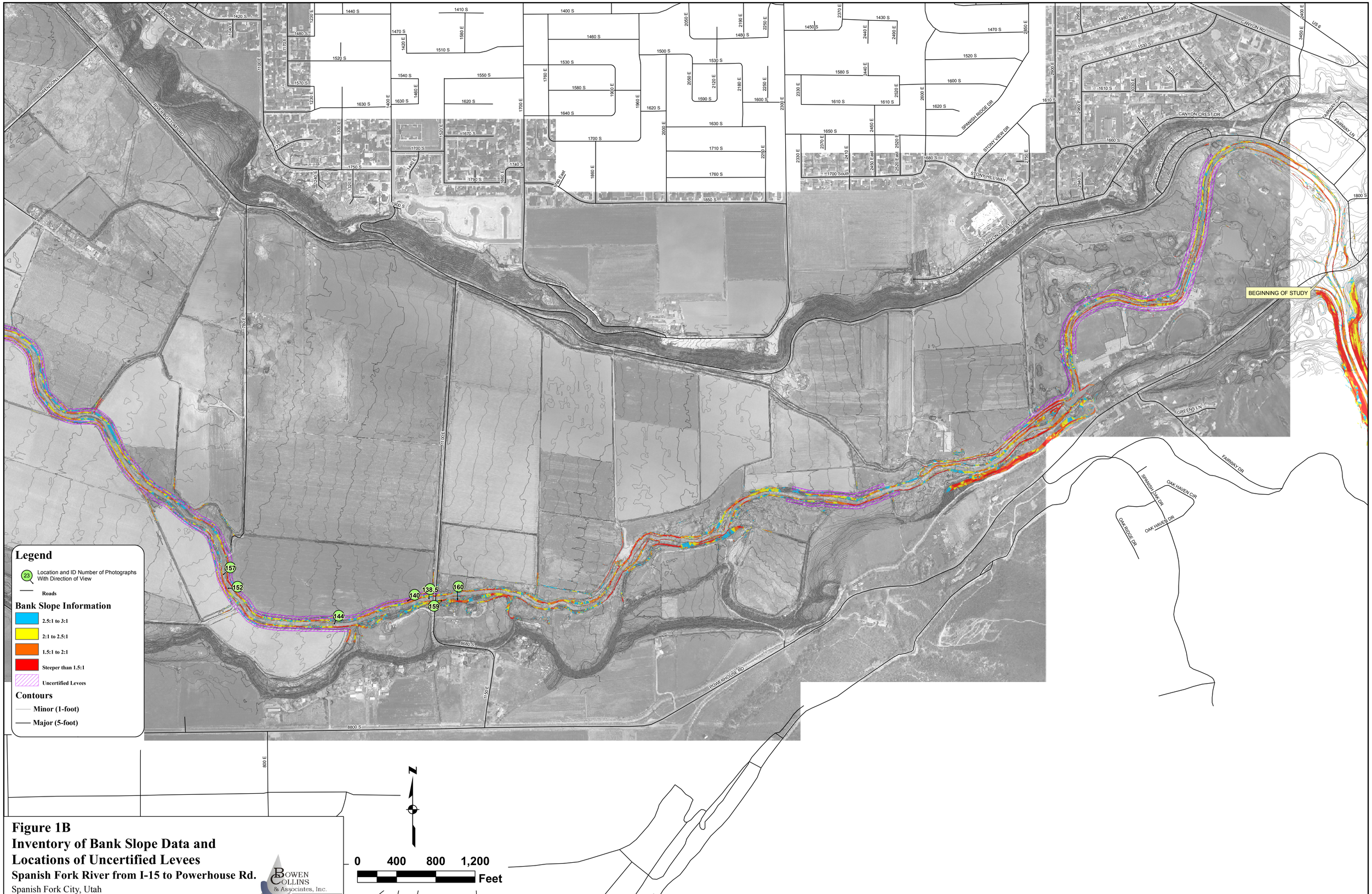

Figure 1B
Inventory of Bank Slope Data and Locations of Uncertified Levees
Spanish Fork River from I-15 to Powerhouse Rd.
Spanish Fork City, Utah

BOWEN COLLINS & Associates, Inc.
Consulting Engineers

Printing Date: April 2, 2009
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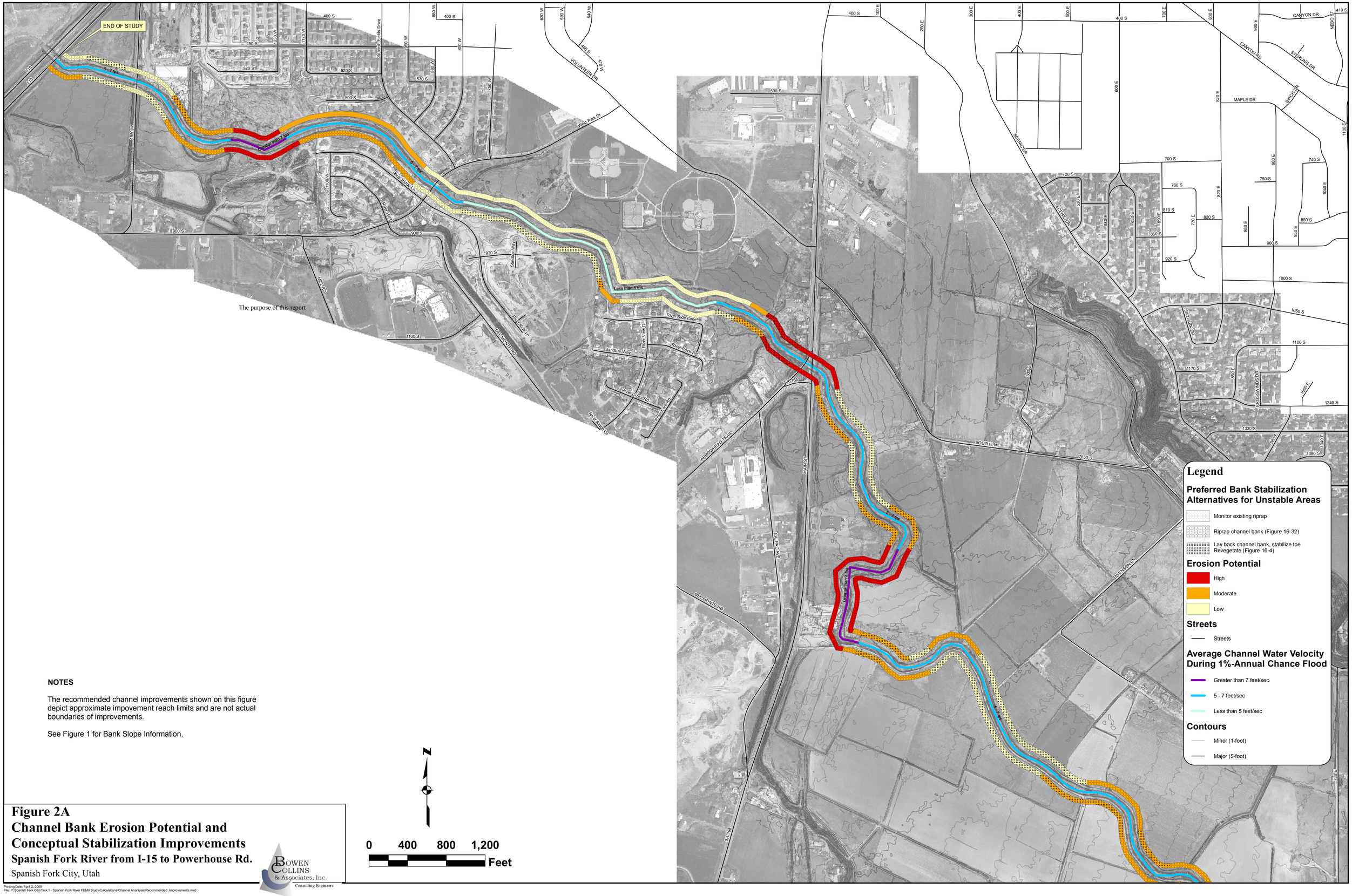

The purpose of this report

NOTES

The recommended channel improvements shown on this figure depict approximate impovement reach limits and are not actual boundaries of improvements.

See Figure 1 for Bank Slope Information.

Figure 2A
Channel Bank Erosion Potential and Conceptual Stabilization Improvements
Spanish Fork River from I-15 to Powerhouse Rd.
Spanish Fork City, Utah

Bowen Collins & Associates, Inc.
Consulting Engineers

Printing Date: April 2, 2009
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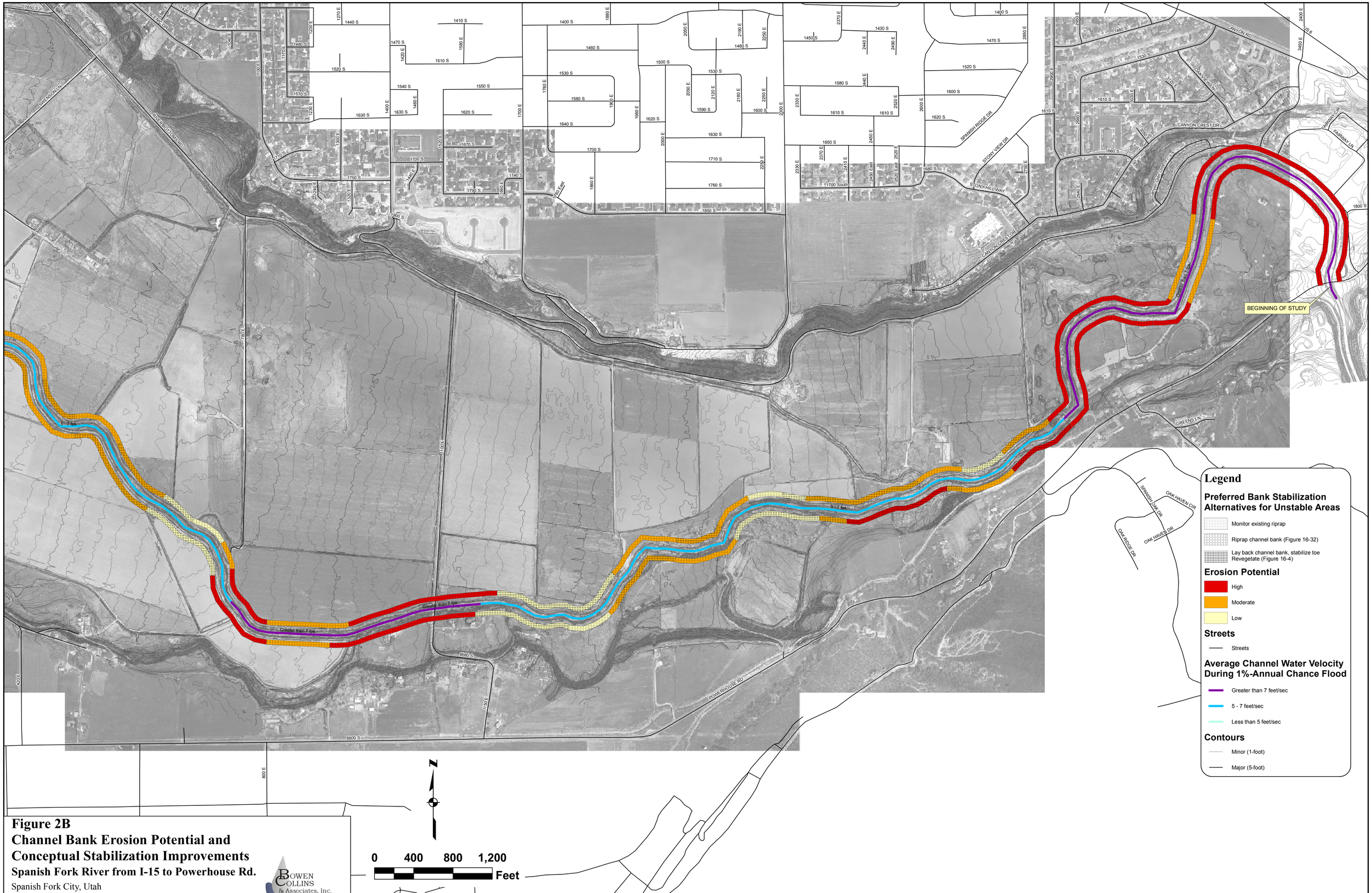

Figure 2B
Channel Bank Erosion Potential and Conceptual Stabilization Improvements
Spanish Fork River from I-15 to Powerhouse Rd.
Spanish Fork City, Utah

Bowen Collins & Associates, Inc.
Consulting Engineers

Printing Date: April 2, 2009
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APPENDIX A

PHOTOGRAPHS

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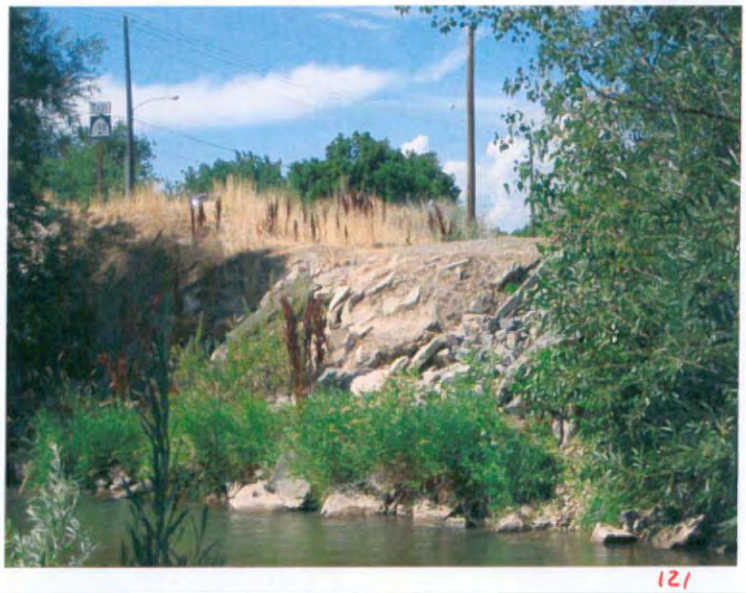

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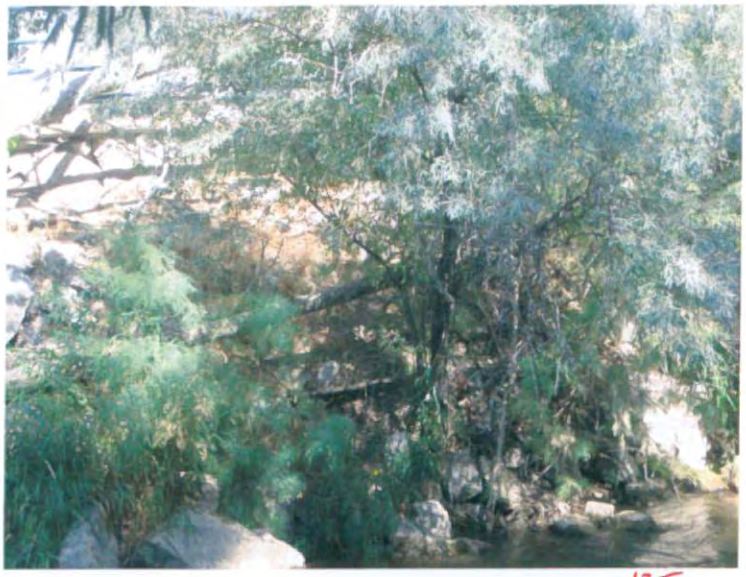

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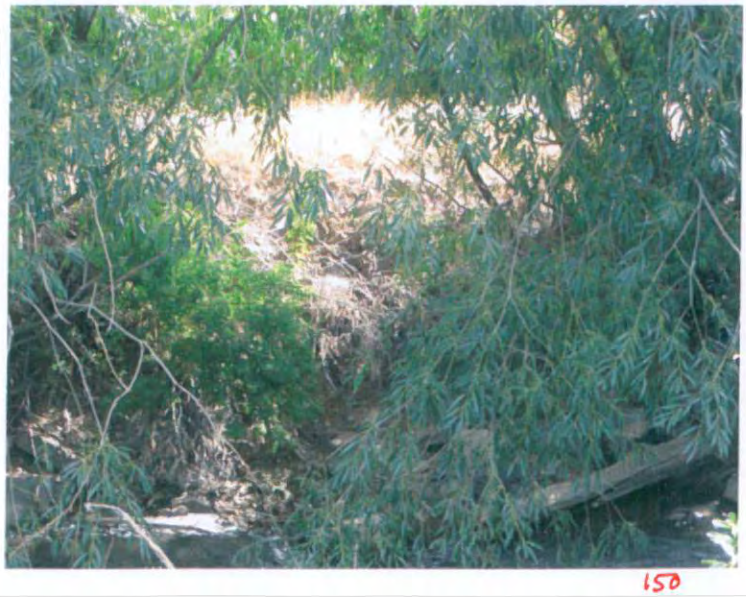

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APPENDIX B

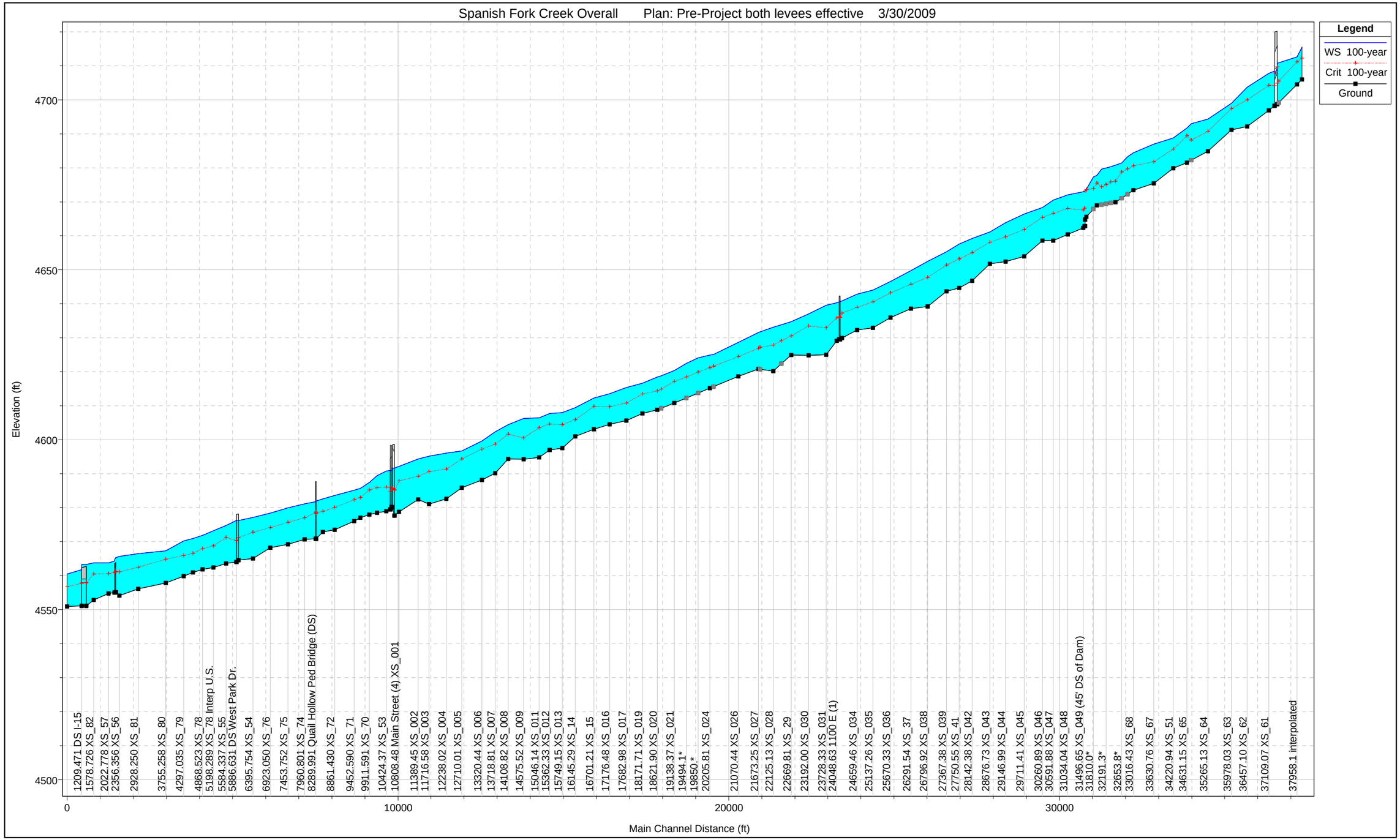
HEC-RAS OUTPUT

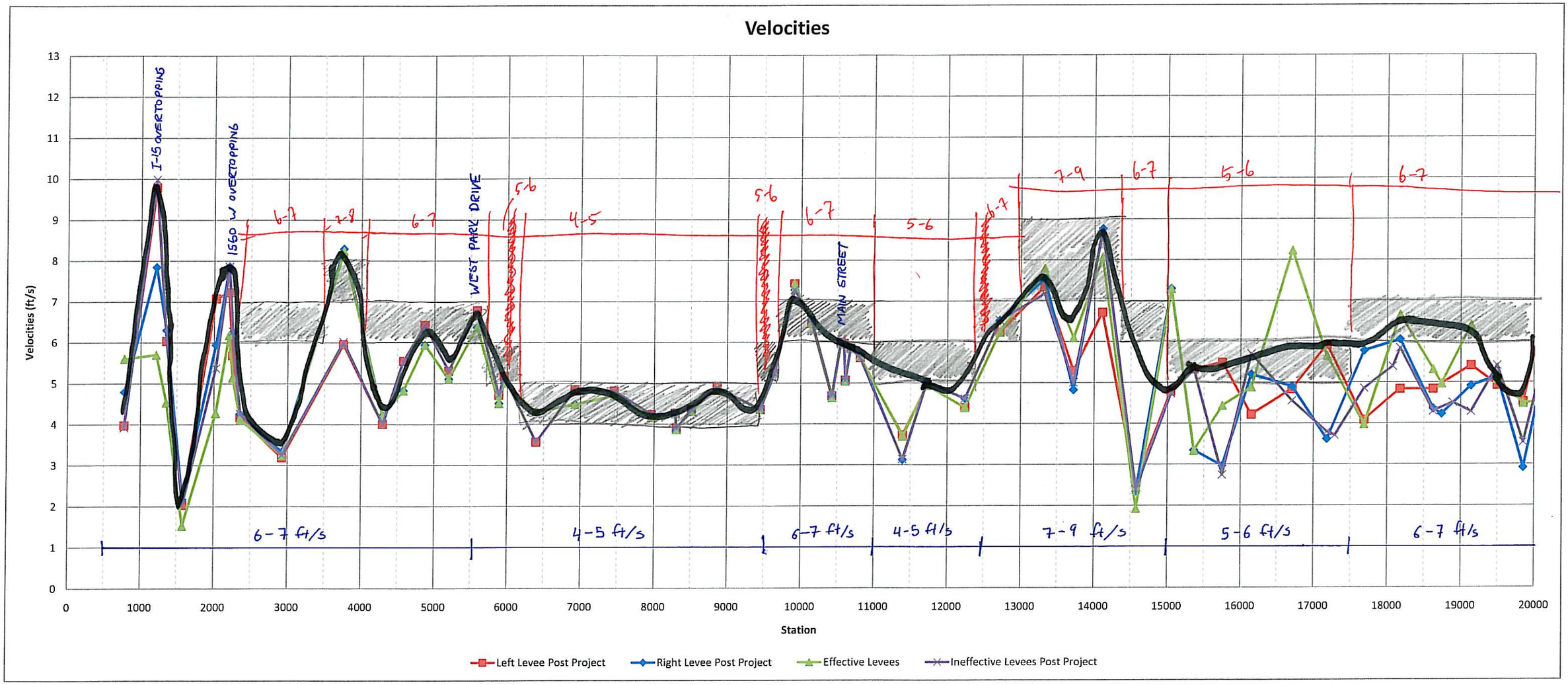
HEC-RAS Plan: pre both River: Spanish Fork Ck Reach: Overall Profile: 100-year

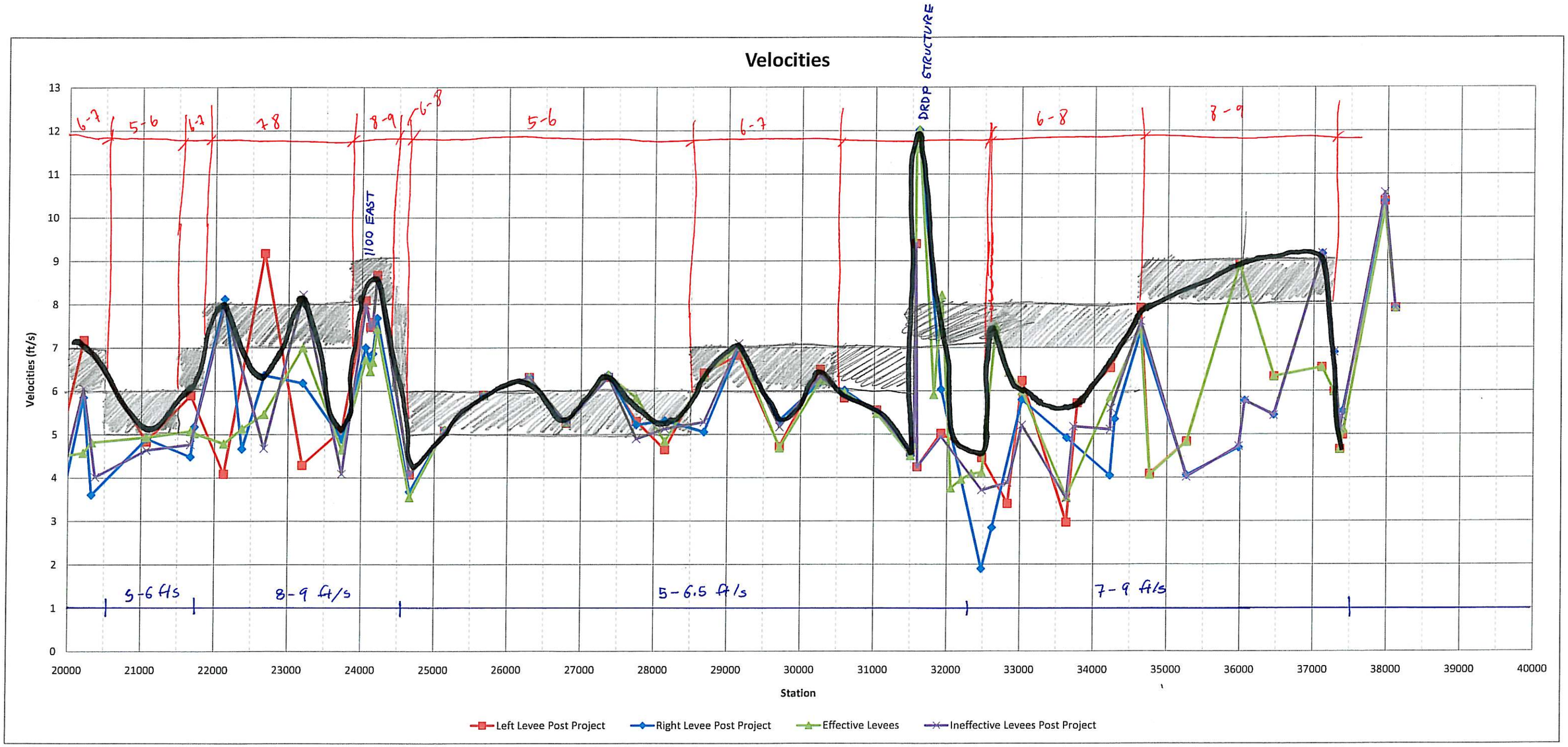
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Overall	38108.14	100-year	3750.00	4706.00	4715.48	4712.23	4716.46	0.010420	7.91	473.97	61.03	0.50
Overall	37958.1	100-year	3750.00	4704.54	4712.60	4711.16	4714.21	0.021804	10.17	368.68	58.71	0.72
Overall	37408.3*	100-year	3750.00	4699.17	4710.86	4705.53	4711.26	0.001996	5.10	793.73	134.89	0.32
Overall	37360.89	100-year	3750.00	4698.71	4710.85	4704.87	4711.17	0.000624	4.65	867.19	180.96	0.26
Overall	37331		Culvert									
Overall	37276.73	100-year	3750.00	4698.29	4708.43	4704.19	4708.98	0.001540	5.98	626.91	82.33	0.37
Overall	37109.07	100-year	3750.00	4696.87	4707.82	4704.23	4708.48	0.006602	6.54	580.33	114.08	0.44
Overall	36457.10	100-year	3750.00	4692.16	4703.76	4700.00	4704.38	0.005929	6.33	592.88	84.57	0.42
Overall	35978.03	100-year	3750.00	4691.14	4698.95	4697.40	4700.18	0.013784	8.91	421.09	73.98	0.66
Overall	35265.13	100-year	2000.00	4684.85	4694.36	4690.72	4694.72	0.003192	4.82	416.72	93.03	0.36
Overall	34765.1*	100-year	2000.00	4682.21	4692.98	4688.19	4693.24	0.002687	4.06	493.72	82.66	0.27
Overall	34631.15	100-year	3750.00	4681.50	4691.67	4689.41	4692.47	0.008780	7.46	541.06	155.24	0.52
Overall	34220.94	100-year	2800.00	4679.88	4688.82	4685.54	4689.36	0.005973	5.86	477.70	83.96	0.41
Overall	33630.76	100-year	2500.00	4675.46	4686.98	4681.80	4687.17	0.002218	3.54	705.84	102.26	0.24
Overall	33016.43	100-year	3100.00	4673.45	4684.41	4680.58	4684.97	0.005681	5.99	517.58	74.29	0.40
Overall	32835.1*	100-year	3100.00	4672.26	4683.20	4679.67	4683.84	0.006680	6.42	482.54	70.16	0.43
Overall	32653.8*	100-year	3100.00	4671.08	4681.46	4678.81	4682.34	0.010285	7.49	413.73	64.41	0.52
Overall	32472.61	100-year	1700.00	4669.89	4680.75	4676.09	4681.01	0.003230	4.11	415.19	80.54	0.28
Overall	32331.9*	100-year	1700.00	4669.65	4680.32	4675.83	4680.58	0.002882	4.08	416.45	65.01	0.28
Overall	32191.3*	100-year	1700.00	4669.42	4679.94	4675.08	4680.18	0.002782	3.95	435.75	89.15	0.28
Overall	32050.6*	100-year	1700.00	4669.18	4679.58	4674.37	4679.80	0.002483	3.75	467.09	97.11	0.26
Overall	31910.04	100-year	3100.00	4668.94	4677.81	4675.48	4678.86	0.012765	8.21	377.59	65.42	0.60
Overall	31810.0*	100-year	3100.00	4667.90	4677.35	4673.86	4677.89	0.005680	5.91	524.10	80.35	0.41
Overall	31588.16	100-year	3750.00	4665.58	4673.73	4673.61	4675.97	0.010881	12.02	312.03	106.97	0.97
Overall	31552.63	100-year	3750.00	4664.79	4673.24	4673.24	4675.32	0.025429	11.58	323.95	117.63	0.99
Overall	31550		Inl Struct									
Overall	31540.34	100-year	3750.00	4662.82	4673.03	4668.11	4673.38	0.001400	4.75	789.81	99.89	0.30
Overall	31496.65	100-year	3750.00	4662.32	4672.99	4667.58	4673.30	0.001303	4.50	832.99	128.95	0.27
Overall	31034.04	100-year	3750.00	4660.39	4672.07	4668.07	4672.54	0.002067	5.47	684.95	127.41	0.42
Overall	30591.88	100-year	3750.00	4658.56	4670.52	4666.63	4671.07	0.006092	5.96	629.41	103.49	0.43
Overall	30260.89	100-year	3750.00	4658.54	4668.34	4665.43	4668.94	0.006740	6.23	602.10	99.56	0.45
Overall	29711.41	100-year	3750.00	4653.92	4666.39	4661.85	4666.69	0.002611	4.68	1011.22	266.55	0.30
Overall	29146.99	100-year	3750.00	4652.39	4663.86	4659.65	4664.63	0.005156	7.03	533.08	70.53	0.45
Overall	28676.73	100-year	3750.00	4651.76	4661.12	4658.11	4661.74	0.007178	6.32	593.19	98.23	0.45
Overall	28142.38	100-year	3750.00	4646.71	4659.21	4655.07	4659.48	0.002590	4.83	1191.52	1327.00	0.30
Overall	27750.55	100-year	3750.00	4644.67	4657.54	4653.17	4658.07	0.005575	5.83	643.25	96.65	0.40
Overall	27367.38	100-year	3750.00	4643.63	4655.26	4651.39	4655.89	0.005736	6.37	588.83	88.26	0.43
Overall	26796.92	100-year	3750.00	4639.21	4652.47	4647.78	4652.90	0.004623	5.27	712.52	120.21	0.38
Overall	26291.54	100-year	3750.00	4638.57	4649.75	4645.71	4650.36	0.005332	6.31	594.54	118.53	0.40
Overall	25670.33	100-year	3750.00	4635.89	4646.55	4643.18	4647.09	0.005174	5.89	636.31	98.40	0.41
Overall	25137.26	100-year	3750.00	4632.94	4644.02	4640.52	4644.39	0.004772	5.10	825.22	225.31	0.37
Overall	24659.46	100-year	3750.00	4632.31	4642.86	4638.94	4643.01	0.001738	3.54	1260.70	692.38	0.24
Overall	24202.60	100-year	3750.00	4629.89	4640.81	4637.27	4641.66	0.005290	7.42	506.56	75.00	0.48
Overall	24146.85	100-year	3750.00	4629.53	4640.64	4636.13	4641.33	0.003882	6.67	562.26	59.59	0.38
Overall	24124.18		Bridge									
Overall	24114.35	100-year	3750.00	4629.52	4640.59	4636.11	4641.24	0.004108	6.45	581.07	67.74	0.39
Overall	24048.63	100-year	3750.00	4629.08	4640.28	4635.88	4640.98	0.003439	6.72	558.39	70.98	0.42
Overall	23728.33	100-year	3750.00	4624.99	4639.58	4632.89	4639.91	0.002624	4.64	808.22	102.39	0.29
Overall	23192.00	100-year	3750.00	4624.85	4636.97	4633.50	4637.73	0.006727	7.00	536.07	77.12	0.47
Overall	22669.81	100-year	2700.00	4624.94	4634.73	4630.57	4635.20	0.003105	5.46	494.36	76.36	0.38
Overall	22369.8*	100-year	2700.00	4622.33	4633.79	4629.07	4634.19	0.003484	5.12	527.85	75.49	0.34
Overall	22125.13	100-year	2600.00	4620.20	4633.06	4627.78	4633.42	0.002772	4.78	544.30	68.10	0.30
Overall	21725.1*	100-year	2600.00	4620.74	4631.73	4627.15	4632.12	0.003838	5.02	517.56	81.07	0.35
Overall	21673.25	100-year	2600.00	4620.81	4631.52	4626.91	4631.91	0.003983	5.07	513.26	81.26	0.36
Overall	21070.44	100-year	2450.00	4618.60	4628.64	4624.47	4629.02	0.005964	4.93	496.71	97.56	0.39
Overall	20320.4*	100-year	2450.00	4615.62	4625.12	4621.68	4625.48	0.003808	4.81	509.32	87.65	0.35
Overall	20205.81	100-year	2400.00	4615.16	4624.89	4621.21	4625.21	0.001471	4.57	525.42	86.78	0.33
Overall	19850.*	100-year	2400.00	4613.70	4624.09	4619.87	4624.40	0.003939	4.48	536.08	87.54	0.32
Overall	19494.1*	100-year	2400.00	4612.23	4622.42	4618.43	4622.81	0.005018	5.06	474.41	80.16	0.37
Overall	19138.37	100-year	2600.00	4610.77	4620.38	4617.19	4621.01	0.004967	6.40	406.38	64.00	0.45
Overall	18738.3*	100-year	2600.00	4609.24	4618.83	4614.87	4619.21	0.003770	4.96	523.75	77.27	0.34
Overall	18621.90	100-year	2900.00	4608.79	4618.42	4614.36	4618.86	0.002469	5.31	545.93	75.32	0.35
Overall	18171.71	100-year	2900.00	4607.72	4616.64	4613.41	4617.32	0.004858	6.65	436.40	64.41	0.45
Overall	17682.98	100-year	2300.00	4605.62	4615.32	4610.80	4615.57	0.002237	3.97	579.09	87.04	0.27
Overall	17176.48	100-year	2150.00	4604.49	4613.54	4609.73	4614.03	0.004278	5.64	381.38	61.35	0.40
Overall	16701.21	100-year	3500.00	4603.11	4612.24	4609.85	4613.29	0.008399	8.22	425.86	66.60	0.57
Overall	16145.29	100-year	2000.00	4600.94	4609.45	4605.88	4609.82	0.003565	4.88	409.61	69.27	0.35
Overall	15749.15	100-year	1800.00	4597.52	4608.02	4604.47	4608.32	0.003928	4.43	405.96	74.70	0.34
Overall	15362.33	100-year	3750.00	4596.97	4607.74	4604.59	4607.84	0.000697	3.33	2127.77	3103.91	0.26
Overall	15046.14	100-year	3750.00	4594.81	4606.45	4603.52	4607.27	0.007120	7.28	514.99	75.83	0.49
Overall	14575.52	100-year	3750.00	4594.28	4606.23	4600.52	4606.27	0.000715	1.92	2427.15	2943.34	0.14
Overall	14108.82	100-year	3750.00	4594.37	4604.44	4601.60	4605.45	0.006465	8.06	465.53	65.37	0.53
Overall	13718.81	100-year	3750.00	4590.12	4602.31	4598.70	4602.88	0.006035	6.09	615.98	96.09	0.42
Overall	13320.44	100-year	3750.00	4588.15	4599.59	4597.25	4600.53	0.008374	7.79	481.57	75.92	0.54
Overall	12710.01	100-year	3750.00	4585.86	4596.71	4594.37	4597.32	0.003421	6.23	601.81	110.54	0.47
Overall	12238.02	100-year	3750.00	4582.63	4596.09	4591.31	4596.39	0.001074	4.39	854.26	123.02	0.29

HEC-RAS Plan: pre both River: Spanish Fork Ck Reach: Overall Profile: 100-year (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Overall	11716.58	100-year	3750.00	4581.02	4595.17	4590.58	4595.51	0.003074	4.93	915.50	310.11	0.31
Overall	11389.45	100-year	3750.00	4582.39	4594.35	4589.26	4594.54	0.002522	3.69	1135.91	413.93	0.26
Overall	10808.48	100-year	3750.00	4578.76	4592.14	4587.91	4592.63	0.004300	5.63	665.64	88.47	0.36
Overall	10677.22	100-year	3750.00	4577.70	4591.69	4585.27	4592.21	0.002349	5.83	643.11	57.53	0.31
Overall	10644.18		Bridge									
Overall	10604.88	100-year	3750.00	4580.00	4591.66	4585.65	4592.05	0.000802	5.04	743.63	76.54	0.29
Overall	10586.59	100-year	3750.00	4580.20	4591.44	4586.05	4591.99	0.001008	5.94	631.76	71.15	0.33
Overall	10564.18		Culvert									
Overall	10544.21	100-year	3750.00	4579.50	4590.98	4585.97	4591.53	0.002610	5.96	628.71	66.11	0.34
Overall	10424.37	100-year	3750.00	4578.99	4590.81	4586.01	4591.11	0.002322	4.64	888.29	216.73	0.28
Overall	10144.61	100-year	3750.00	4578.46	4589.39	4585.85	4590.04	0.006045	6.45	581.42	84.69	0.43
Overall	9911.591	100-year	3750.00	4577.93	4587.40	4585.23	4588.26	0.009696	7.42	505.52	87.15	0.54
Overall	9641.955	100-year	3750.00	4577.00	4585.64	4583.00	4586.07	0.006181	5.23	717.20	135.58	0.40
Overall	9452.590	100-year	3750.00	4576.07	4585.11	4582.29	4585.40	0.002050	4.35	884.23	200.95	0.34
Overall	8861.430	100-year	3750.00	4573.53	4583.62	4580.08	4583.98	0.002830	4.85	803.93	216.66	0.39
Overall	8508.846	100-year	3750.00	4572.89	4582.55	4578.92	4582.84	0.003603	4.31	870.25	145.86	0.31
Overall	8306.124	100-year	3750.00	4570.81	4581.96	4578.32	4582.15	0.001994	3.86	1101.34	189.01	0.24
Overall	8298		Bridge									
Overall	8289.991	100-year	3750.00	4570.81	4581.78	4578.59	4582.00	0.002055	4.25	1065.74	191.55	0.26
Overall	7960.801	100-year	3750.00	4570.65	4581.13	4577.08	4581.40	0.001561	4.16	901.16	152.79	0.30
Overall	7453.752	100-year	3750.00	4569.24	4579.94	4575.71	4580.29	0.003274	4.69	799.32	119.49	0.32
Overall	6923.050	100-year	3750.00	4568.22	4578.45	4574.12	4578.75	0.002534	4.48	868.92	177.58	0.30
Overall	6395.754	100-year	3750.00	4565.04	4577.13	4572.73	4577.41	0.002515	4.30	907.61	166.90	0.28
Overall	5957.691	100-year	3750.00	4564.53	4576.27	4571.19	4576.66	0.001159	5.01	747.86	108.66	0.31
Overall	5921		Bridge									
Overall	5886.631	100-year	3750.00	4564.06	4576.23	4570.37	4576.55	0.002268	4.51	832.41	104.78	0.28
Overall	5584.337	100-year	3750.00	4563.53	4574.75	4571.20	4575.38	0.006381	6.37	589.12	97.02	0.46
Overall	5198.289	100-year	3750.00	4562.38	4573.23	4568.75	4573.63	0.003148	5.10	735.70	101.40	0.33
Overall	4868.523	100-year	3750.00	4561.80	4571.85	4567.97	4572.40	0.004398	5.94	631.76	90.67	0.40
Overall	4577.467	100-year	3750.00	4560.93	4570.92	4566.61	4571.28	0.003101	4.82	778.59	111.83	0.32
Overall	4297.035	100-year	3750.00	4559.83	4570.24	4565.94	4570.51	0.002247	4.20	893.09	129.39	0.28
Overall	3755.258	100-year	3750.00	4557.88	4567.26	4564.82	4568.32	0.008459	8.23	455.49	68.00	0.56
Overall	2928.250	100-year	3750.00	4556.11	4566.45	4562.49	4566.62	0.000705	3.24	1196.39	819.66	0.24
Overall	2356.356	100-year	3750.00	4554.15	4565.69	4561.13	4565.97	0.002238	4.12	893.11	879.94	0.27
Overall	2251.318	100-year	3750.00	4555.14	4565.34	4561.25	4565.68	0.003267	5.14	908.05	532.41	0.38
Overall	2227		Bridge									
Overall	2202.338	100-year	3750.00	4555.06	4564.27	4560.95	4564.81	0.004463	6.18	728.14	359.69	0.43
Overall	2022.778	100-year	3750.00	4554.71	4563.80	4560.60	4564.08	0.002459	4.27	888.03	2034.33	0.30
Overall	1578.726	100-year	3750.00	4552.83	4563.75	4560.48	4563.79	0.000214	1.52	2213.69	2167.47	0.10
Overall	1350.304	100-year	3750.00	4551.14	4563.30	4557.85	4563.60	0.001811	4.53	1031.87	736.18	0.28
Overall	1325		Bridge									
Overall	1209.471	100-year	3750.00	4551.14	4561.76	4557.77	4562.26	0.002428	5.70	657.93	97.02	0.39
Overall	777.1708	100-year	3750.00	4550.88	4560.47	4556.75	4560.95	0.003807	5.60	669.57	100.63	0.38


Spanish Fork Creek Overall Plan: Pre-Project both levees effective 3/30/2009
Legend
WS 100-year
Crit 100-year
Ground
Elevation (ft)
4700
4650
4600
4550
4500
0
10000
20000
30000
Main Channel Distance (ft)
1209.471 DS I-15
1578.726 XS_82
2022.778 XS_57
2356.356 XS_56
2928.250 XS_81
3755.258 XS_80
4297.035 XS_79
4868.523 XS_78
5198.289 XS_78 Interp U.S.
5584.337 XS_55
5886.631 DS West Park Dr.
6395.754 XS_54
6923.050 XS_76
7453.752 XS_75
7960.801 XS_74
8289.991 Quail Hollow Ped Bridge (DS)
8861.430 XS_72
9452.590 XS_71
9911.591 XS_70
10424.37 XS_53
10808.48 Main Street (4) XS_001
11389.45 XS_002
11716.58 XS_003
12238.02 XS_004
12710.01 XS_005
13320.44 XS_006
13718.81 XS_007
14108.82 XS_008
14575.52 XS_009
15046.14 XS_011
15362.33 XS_012
15749.15 XS_013
16145.29 XS_14
16701.21 XS_15
17176.48 XS_016
17682.98 XS_017
18171.71 XS_019
18621.90 XS_020
19138.37 XS_021
19494.1*
19850.*
20205.81 XS_024
21070.44 XS_026
21673.25 XS_027
22125.13 XS_028
22669.81 XS_29
23192.00 XS_030
23728.33 XS_031
24048.63 1100 E (1)
24659.46 XS_034
25137.26 XS_035
25670.33 XS_036
26291.54 XS_37
26796.92 XS_038
27367.38 XS_039
27750.55 XS_41
28142.38 XS_042
28676.73 XS_043
29146.99 XS_044
29711.41 XS_045
30260.89 XS_046
30591.88 XS_047
31034.04 XS_048
31496.65 XS_049 (45' DS of Dam)
31810.0*
32191.3*
32653.8*
33016.43 XS_68
33630.76 XS_67
34220.94 XS_51
34631.15 XS_65
35265.13 XS_64
35978.03 XS_63
36457.10 XS_62
37109.07 XS_61
37958.1 interpolated


Velocities
Velocities (ft/s)
Station
I-15 OVERTOPPING
1560 W OVERTOPPING
WEST PARK DRIVE
MAIN STREET
6-7
7-8
6-7
5-6
4-5
5-6
6-7
5-6
6-7
7-9
6-7
5-6
6-7
6-7 ft/s
4-5 ft/s
6-7 ft/s
4-5 ft/s
7-9 ft/s
5-6 ft/s
6-7 ft/s
Left Levee Post Project
Right Levee Post Project
Effective Levees
Ineffective Levees Post Project


Velocities
DRDP STRUCTURE
1100 EAST
6-7
5-6
6-7
7-8
8-9
6-8
5-6
6-7
6-8
8-9
5-6 ft/s
8-9 ft/s
5-6.5 ft/s
7-9 ft/s
Velocities (ft/s)
Station
Left Levee Post Project
Right Levee Post Project
Effective Levees
Ineffective Levees Post Project

ATTACHMENT 4
CHANNEL MAINTENANCE ACTIVITIES

CHANNEL MAINTENANCE ACTIVIES

Prepared for:

Prepared by:

154 East 14000 South
Draper, Utah 84020

October 2011

Project No. 204-10-01

CHANNEL MAINTENANCE

Open channels, including the Spanish Fork River, Dry Creek, and some irrigation canals or ditches, are an integral part of Spanish Fork City's drainage system. Maintaining the condition and conveyance capacity of these major drainage facilities is important to ensure that they will function properly. In general, open channels are naturally subject to erosion and sediment deposition that can impact channel capacity and safety of nearby structures. Since water is normally flowing in these facilities, phreatophytic vegetation (vegetation that obtains its water from shallow groundwater or a nearby shallow water source) tends to grow and proliferate in or near the main channels. Invasive species like Tamarisk and Russian Olive trees can grow so thick that the conveyance capacity of an open channel can be significantly reduced. Other plant species like cattails and phragmites can also grow in the channels and reduce conveyance capacities. Trees near a channel can also die and fall into a channel to create debris dams and erosion problems.

It is recommended that the following general channel maintenance and management recommendations be followed in an effort to maintain the capacities and condition of open channel facilities.

ADMINISTRATIVE ACTIVIES

- Maintain existing natural drainage channels. If natural channels need to be filled to accommodate development, the channel should be piped to maintain historic drainage patterns.

- Ensure that all development located within Special Flood Hazard Areas defined on FEMA Flood Insurance Rate Maps are properly permitted and reviewed in accordance with National Flood Insurance Program (NFIP) requirements and Spanish Fork City's Ordinances.

- Keep development out of floodway areas defined on FEMA floodplain maps.

MAINTENANCE ACTIVITIES

The following activities should be completed on an annual basis, between October 25th and March 1st of each water year:

- Walk the channel banks to inspect for erosion, dead trees, debris, etc. Also inspect the condition of existing riprap or channel armoring. Identify trees or root balls that may need to be removed to prevent them from falling into the channel and causing problems downstream. Identify areas where debris and deadwood need to be cleared from the channel. Identify areas where low-hanging limbs may impede water flow or catch debris. Identify where riprap or other channel repairs are needed.

- Clear and snag debris and deadwood from the channel as needed to maintain an open waterway.

- Remove low-hanging limbs or non-indigenous trees with low-hanging limbs as required to maintain an open waterway.

- Monitor sediment deposition in key channel sections, particularly in canals.

- Remove sediment deposits in canals or rivers as needed to maintain capacity. This may require obtaining permits from the State of Utah or the US Army Corps of Engineers.

- Inspect levees and earthen embankments for erosion, ground cover, rodent holes, and woody vegetation. Complete needed repairs or mitigation measures.

- Follow written operating and maintenance guidelines for FEMA-certified levees. See Attachment 2 – Levee Operation and Maintenance Procedures.

- The activities identified in this section should be completed so that mitigative actions can be completed before spring runoff begins each year. Open channels should also be closely inspected for these items after a large runoff event if the magnitude of the spring runoff is large or if runoff in a channel from an intense rainfall event is significant.

- Vegetation in the floodplain should be managed to maintain a healthy, functional floodplain and needed conveyance capacity. Maintenance activities could include clearing dead trees, removing invasive trees like Tamarisk and Russian Olive, and clearing vegetation so that water can flow through the natural floodplain. Most of this work will need to be done by hand with equipment on the channel banks.

- Identify any areas where property owners may have placed fill in the channel (FEMA floodway), thus reducing the conveyance capacity of the channel and raising the water elevation in the channel. If illegal fill has been place in the channel, take proper measures to have the fill removed or to otherwise ensure that the City can remain in compliance with NFIP regulations.

ATTACHMENT 5
FLOODPLAIN ORDINANCE

PART 4 DEVELOPMENT

CHAPTER 20 Flood Damage Prevention

15.4.20.010 Warning and Disclaimer of Liability

15.4.20.020 General Provisions

15.4.20.030 Administration

15.4.20.040 Provisions for Flood Hazard Reduction

15.4.20.050 Penalties for Violation

15.4.20.010 Warning and Disclaimer of Liability

The degree of flood protection required by this ordinance is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. On rare occasions greater floods can and will occur and flood heights may be increased by man-made or natural causes. This ordinance does not imply that land outside the areas of special flood hazards or uses permitted within such areas will be free from flooding or flood damages. This ordinance shall not create liability on the part of the community or any official or employee thereof for any flood damages that result from reliance on this ordinance or any administrative decision lawfully made thereunder.

15.4.20.020 General Provisions

A. The ordinance shall apply to all areas with defined flood hazards within the jurisdiction of City.

B. The flood hazard areas for the purposes of this ordinance are those flood hazard areas in City that are identified by the current Federal Emergency Management Agency on Flood Insurance Rate Maps and Flood Boundary-Floodway Maps (FIRM and FBFMand any revisions thereto and any accompanying scientific and engineering Flood Insurance Study Report are hereby adopted by reference and declared to be a part of this ordinance.

C. Preliminary plat approval, site plan approval, or a building permit shall be required to ensure conformance with the provisions of this ordinance.

D. No structure or land shall hereafter be located, altered, or have its use changed without full compliance with the terms of this ordinance and other applicable regulations.

E. This ordinance is not intended to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this ordinance and another ordinance, easement, covenant, or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

F. In the interpretation and application of this ordinance, all provisions shall be:

1. Considered as minimum requirements;
2. Liberally construed in favor of the governing body; and
3. Deemed neither to limit nor repeal any other powers granted under State statutes.

15.4.20.030 Administration

A. The Spanish Fork City Engineer or his/her appointee is hereby appointed the Floodplain Administrator to administer and implement the provisions of this ordinance and other appropriate sections of 44 CFR (National Flood Insurance Program Regulations) pertaining to floodplain management.

B. The duties and responsibilities of the Floodplain Administrator shall include, but not be limited to, the following:

1. Maintain and hold open for public inspection all records pertaining to the provisions of this ordinance.
2. Review permit application to determine whether proposed building site, including the placement of manufactured homes, will be reasonably safe from flooding from both surface and groundwater as well as from flood-related erosion.
3. Review, approve or deny all applications for development permits required by adoption of this ordinance.
4. Review permits for proposed development to assure that all necessary City permits have been obtained.
5. Where interpretation is needed as to the exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions) the Floodplain Administrator shall make the necessary interpretation.
6. Notify, in riverine situations, adjacent communities and the State Engineer's office prior to any alteration or relocation of a watercourse, and submit evidence of such notification to the Federal Emergency Management Agency.
7. Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained.
8. When base flood elevation data has not been provided in accordance with §030(B) the Floodplain Administrator shall obtain, review and reasonably utilize any base flood elevation data and floodway data available from a Federal, State or other source, in order to administer the provisions of §050.
9. When a regulatory floodway has not been designated, the Floodplain Administrator must require that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on City's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within City.

C. Application for a preliminary plat, site plan, or building permit within a special floodplain hazard area shall be presented to the Floodplain

Administrator on forms furnished by him/her and may include, but not be limited to, plans in duplicate drawn to scale showing the location, dimensions, and elevation of proposed landscape alterations, existing and proposed structures, and the construction of fences, and the location of the foregoing in relation to areas of special flood hazard and areas of special erosion hazard. Additionally, the following information is required:

1. Elevation (in relation to mean sea level), of the lowest floor (including basement) of all new and substantially improved structures;
2. Elevation in relation to mean sea level to which any nonresidential structure shall be flood proofed;
3. A certificate from a licensed professional engineer or architect that the nonresidential flood proofed structure shall meet the flood proofing criteria of §050(B)(2);
4. Description of the extent to which any watercourse or natural drainage will be altered or relocated as a result of proposed development.
5. A bank stability/erosion hazard analysis performed by a licensed professional engineer, including site photographs, that evaluates potential flood-related erosion hazards and identifies appropriate erosion hazard mitigation measures to protect any structural improvements proposed in the area of special erosion hazard.
6. A geotechnical report that includes: at least one measurement of the ambient groundwater surface elevation on the site of proposed development collected between May 1 and May 31 (unless otherwise approved by the Floodplain Administrator); 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; and an engineer's recommendation with regard to the lowest elevation(s) that the lowest floor(s) (including basement) 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.
7. A grading permit shall be obtained from the Floodplain Administrator before any excavation or fill work that could modify the flood hazards defined on the community's FIRM is completed in the area of special erosion hazard area.
8. Maintain record of all such information in accordance with §040(B)(1).

D. Approval or denial of a preliminary plat, site plan, or any permit required by City shall be based on all of the provisions of this ordinance and the following relevant factors:

1. The danger to life and property due to flooding or erosion damage;
2. The susceptibility of the proposed facility and its contents to flood and/or erosion damage and the effect of such damage on the individual owner;
3. The danger that materials may be swept onto other lands to the injury of others;
4. The safety of access to the property in times of flood for ordinary and emergency vehicles;
5. The costs of providing governmental services during and after flood conditions including maintenance and repair of streets and bridges, and public utilities and facilities such as sewer, gas, electrical and water systems;
6. The expected heights, velocity, duration, rate of rise and sediment transport of the flood waters and the effects of wave action, if applicable, expected at the site;
7. The necessity to the facility of a waterfront location, where applicable;
8. The availability of alternative locations, not subject to flooding or erosion damage, for the proposed use;
9. The relationship of the proposed use to the comprehensive general plan for that area

15.4.20.040 Provisions For Flood Hazard Reduction

A. General Standards.

1. In all areas of special flood hazards the following provisions are required for all new construction or substantial improvements:
   a. All new construction or substantial

improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

b. All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damage;

c. All new construction or substantial improvements shall be constructed with materials resistant to flood damage;

d. All new construction or substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

e. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system;

f. All new construction shall be required to connect to City's sanitary sewer system.

g. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

h. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special flood hazard shall be constructed in a position or direction contrary to the direction of flowing water.

2. In all areas of special erosion hazards the following provisions are required for all new construction or substantial improvements:

a. No new construction or substantial improvements shall be designed or constructed until a licensed professional engineer certifies that no erosion hazard exists on the reach of open channel adjacent to or upstream from the proposed site for a distance of at least 150 feet or until any potential erosion hazard is mitigated by measures designed by a registered professional engineer and accepted by the Floodplain Administrator.

b. 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.

c. No excavation or fill that could modify the flood hazards defined on the FIRM shall be performed without applying for and receiving a grading permit from the Floodplain Administrator.

d. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special erosion hazard shall be constructed in a position or direction contrary to the direction of flowing water.

3. In all areas of special flood hazard, all areas of special erosion hazard, and areas with potentially high groundwater levels, the following provisions are required for all new construction or substantial improvements:

a. As part of the building or development permit process, a geotechnical report shall be completed that includes a licensed professional engineer's recommendation with regard to the lowest elevation(s) that the lowest floor(s) (including basement) 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, in accordance with §040(C)(6).

B. Specific Standards

In all areas of special flood hazards where base flood elevation data has been provided as set forth in (i) §030(B); (ii) §040(B)(8); or (iii) §050((C)(3), the following provisions are required:

1. Residential Construction - new construction or substantial improvement of any residential structure shall have the lowest floor (including basement), elevated a minimum of two feet above the base flood elevation. A licensed professional engineer or land surveyor shall submit a certification to the Floodplain Administrator that the standard of this subsection as proposed in §040(C)(1), is satisfied.

2. Nonresidential Construction - new construction or substantial improvements of any commercial, industrial or other nonresidential structure shall either have the lowest floor (including basement) elevated a minimum of two feet above the base flood level or together with attendant utility and sanitary facilities, be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. A registered professional engineer or architect shall develop and/or review structural design, specifications, and plans for the construction, and shall certify that the design and methods of construction are in accordance with accepted standards of practice as outlined in this subsection. A record of such certification which includes the specific elevation (in relation to mean sea level) to which such structures are flood proofed shall be maintained by the Floodplain Administrator.

3. Enclosures - new construction or substantial improvements, with fully enclosed areas below the lowest floor that are usable solely for parking of vehicles, building access or storage in an area other than a basement, and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a licensed professional engineer or meet or exceed the following minimum criteria:
    a. A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.
    b. The bottom of all openings shall be no higher than one foot above grade.
    c. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.
4. Manufactured Homes
    a. Require that all manufactured homes to be placed within Zone A on a community's FHBM or FIRM shall be installed using methods and practices which minimize flood damage. For the purposes of this requirement, manufactured homes must be elevated and anchored to resist flotation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable State and local anchoring requirements for resisting wind forces.
    b. Require that manufactured homes that are placed or substantially improved on a permanent foundation such that the lowest floor of the manufactured home is elevated a minimum of two feet above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.
    c. Require that manufactured homes be placed or substantially improved on sites in an existing manufactured home park or subdivision with Zones A1-30, AH and AE on the community's FIRM that are not subject to the provisions of paragraph (4) of this section be elevated so that either:
        i. The lowest floor of the manufactured home is at least two feet above the base flood elevation, or
        ii. The manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.
5. Recreational vehicles,trailers,or motor homes placed on sites within Zones A1-30**,** AH**,** and AE on the community's FIRM must meet one of the following criteria:
    a. Be on the site for fewer than 30 consecutive days,
    b. Be fully licensed and ready for highway use, or
    c. Meet the permit requirements of §040(C)(1), and the elevation and anchoring requirements for "manufactured homes" in paragraph (4) of this section. A recreational vehicle, trailer, or motor home is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions.

C. Standards for Subdivision Proposals.
    1. All subdivision proposals shall be consistent with this ordinance.
    2. All proposals for the development of subdivisions including the placement of manufactured home parks and subdivisions shall meet Development Permit requirements of §030(C); §040(C); and the provisions of §050 of this ordinance.
    3. Base flood elevation data shall be generated for subdivision proposals and other proposed development (including the placement of manufactured home parks and subdivisions) greater than 50 lots or 5 acres, whichever is lesser, if not otherwise provided pursuant to §030(B), or §040(B)(8) of this ordinance.
    4. All subdivision proposals including the placement of manufactured home parks and subdivisions shall have adequate drainage provided to reduce exposure to flood hazards form both surface water and groundwater.
    5. All subdivision proposals including the placement of manufactured home parks and subdivisions shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize or eliminate flood damage.

D. Standards for Areas of Shallow Flooding
    1. Located within the areas of special flood hazard established in §030(B), are areas designated as shallow flooding (AO and AH Zones). These areas have special flood hazards associated with base flood depths of 1 to 3 feet where a clearly defined channel does not exist and where

the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow; therefore, the following provisions apply:

a. All new construction or substantial improvements of residential structures shall have the lowest floor (including basement) elevated at least two feet above the base flood level.

b. All new construction or substantial improvements of non-residential structures;

i. Have the lowest floor (including basement) elevated at least two feet above the base flood level.

ii, Together with attendant utility and sanitary facilities be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads of effects of buoyancy.

c. A licensed professional engineer shall submit a certification to the Floodplain Administrator that the standards of this Section, as proposed in §040(C)(5) and §040(C)(6), are satisfied.

d. Require within Zones AH or AO adequate drainage paths around structures on sloping ground, to guide flood waters around and away from proposed structures.

2. City's FIRM may also identify areas of shallow flooding hazards with an average depth less than 1 foot deep (shaded Zone X), as established in §030(B). These areas may be between the flood hazard boundaries defined for the 1- and 0.2-percent-chance-annual-flood or associated with base flood depths less than 1 foot where a clearly defined channel does not exist and where the path of flooding is unpredictable and where velocity may be evident. Such flooding is generally characterized by sheet flow; therefore the following provisions apply:

a. All new construction or substantial improvements of residential and non-residential structures;

i. All new construction or substantial improvements have the lowest floor (including basement) elevated above the estimated depth of the base flood and above the highest groundwater level that is anticipated to occur during periods of flooding.

ii. Require within shaded X Zones positive ground slopes away from structures and adequate drainage paths around structures on sloping ground to guide flood water around and away from proposed structures.

iii. A registered professional engineer shall submit certification to the Floodplain Administrator that the standards of this Section, as proposed in §040(C)(5) and §040(C)(6)are satisfied.

E. Floodways

Floodways (located within areas of special flood hazard established in §030(B)) are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of flood waters which carry debris, potential projectiles and erosion potential, the following provisions shall apply:

1. Encroachments are prohibited, including fill, new construction, substantial improvements and other development within the adopted regulatory floodway *unless* it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge.

2. If §050(A)(7) above is satisfied, all new construction or substantial improvements shall comply with all applicable flood hazard reduction provisions of Article 5.

F. Standards for Areas of Special Erosion Hazard

In order to prevent damage to structures in areas subject to special erosion hazards, the following provisions shall apply:

1. No structural development will be allowed to be constructed in an area of special erosion hazard unless the potential erosion hazards have been evaluated and mitigated and buildings meet minimum setback requirements in accordance with §050(A)(2).

2. No excavation or fill that could modify flood hazard boundaries defined on the FIRM shall be performed in areas of special erosion hazard without a grading permit, in accordance with §050(C)(7).

3. No solid walls, solid fences, or other structures that could disrupt flowing water in an area of special flood hazard or special erosion hazard shall be constructed in a position or direction contrary to

the direction of flowing water to create additional flooding and erosion hazards.

15.4.20.050. Penalties for Violation.

A. No structure or land shall hereafter be constructed, located, extended, converted, or altered without full compliance with the terms of this ordinance and other applicable regulations.

B. Violation of the provisions of this ordinance by failure to comply with any of its requirements (including violations of conditions and safeguards established in connection with conditions) shall constitute a class B misdemeanor. In addition to any fine, a violater shall pay all costs and expenses involved in the case.

C. Nothing herein contained shall prevent City from taking such other lawful action as is necessary to prevent or remedy any violation.

(Ord 07-09, Creating 02/20/2009)