2012 STORM DRAIN MASTER PLAN

Prepared for:

Herriman City

Prepared by:

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

August 2012

Project No. 217-11-06

2012 STORM DRAIN MASTER PLAN

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Prepared for:

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Founded 1851
Herriman

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Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS

August 2012

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CHAPTER 1
INTRODUCTION AND BACKGROUND

INTRODUCTION

The City of Herriman (City) retained Bowen Collins & Associates (BC&A) to prepare this master plan for the City's storm drain system. A Storm Drain Master Plan was prepared in 2009 by Psomas (2009 Master Plan). The City determined that a new storm water master plan was needed before a new Capital Facilities Plan could be completed. Suggested technical changes to the 2009 Master Plan are detailed in the technical memorandum in Appendix A. To bring the 2009 Master Plan into coordination with the changes presented in that technical memorandum, the City has retained BC&A to prepare a master plan for its storm drain system.

After the completion of the 2009 Master Plan, issues were discovered with the estimated storm water runoff flow rates and other miscellaneous items (for a detailed description of the issues, see the technical memorandum in Appendix A). Because of those issues, the City has retained BC&A to prepare a new, more defendable, master plan for its storm drain system.

The primary purpose of this Storm Drain Master Plan is to provide recommended improvements to resolve existing and projected future deficiencies in the City of Herriman storm drain system based on the City's adopted General Plan. The resulting Impact Fee Facilities Plan will be used establish Impact Fees for the City.

This document is a working document. Some of the recommended improvements identified in this report are based on the assumption that development and/or potential annexation will occur in a certain manner. If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years as well.

SCOPE OF SERVICES

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

Task 1: Collect and review existing information pertinent to the City's storm drain system.

Task 2: Import storm drain system infrastructure from the City's Geographic Information System (GIS) database into an Autodesk Storm and Sanitary Analysis (ASSA) software model.

Task 3: Conduct field reconnaissance to verify and validate the hydraulic model network.

Task 4: Develop a hydrologic computer model of the study area. Drainage basins boundaries developed as part of the previous master plan will be used as a basis for this model. This update consists primarily of correcting and updating model parameters, adding current detention basin stage-storage curves, and updating flood channel information.

Task 5: Establish appropriate rainfall depths for the hydrologic model for a storm with a 10% probability of occurring in any given year (10-yr Storm) and a storm with a 1% probability of occurring in any given year (100-yr Storm). The Farmer Fletcher storm distribution was used for master planning purposes to be consistent with Salt Lake County's (County) regional flood control master plan for the area (i.e. the 2002 Southwest Canal and Creek Study (SWCC)).

Task 6: Develop storm runoff hydrographs for Herriman's four major watersheds (Rose Creek, Midas Creek, Butterfield Creek and Wood Hollow). The hydrographs developed were consistent with the hydrographs developed for these watersheds as part of the County's SWCC study.

Task 7: Develop hydrologic models for both existing and future (full build-out) land use conditions, using City zoning and land use information.

Task 8: Use the updated hydrologic models to estimate potential runoff and identify needed improvements to the City's storm drain system.

Task 9: Use the model results to identify existing storm drain system deficiencies and future storm drain improvement needs.

Task 10: Use the results of the modeling tasks to develop a list of recommended storm drain trunkline and detention facility improvements that are needed to provide the desired level of service to the City.

Task 11: Compare estimated storm water runoff at City boundaries with estimates made by Salt Lake County Flood Control, Riverton City and Bluffdale City.

Task 12: Prepare for and attend regular progress meeting during the project.

Task 13: Develop a user-friendly report that summarizes the results of the study, references clear, concise figure and tables, and documents the procedures that were used to develop the Storm Drain Master Plan.

This report is prepared as part of Task 13.

AUTHORIZATION

Herriman contracted the services of BC&A to prepare this Sanitary Storm drain System Capital Facilities Plan in November of 2011. The facility plan study and associated report were completed in May 2012.

PROJECT STAFF

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

Craig Bagley	Project Manager/Principal-In-Charge
Kameron Ballentine	Project Engineer
Angela Hansen	Word Processing

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CHAPTER 2
EXISTING SYSTEM DESCRIPTION

SERVICE AREA

The City of Herriman, which was first incorporated as a town in 1851, is located about 20 miles southwest of Salt Lake City, and is one of the fastest growing cities in the County. As a result of the rapid growth Herriman has recently experienced, much of their infrastructure is relatively new. The topography of the majority of the City slopes from west to east toward Jordan River, and North to South towards Rose Creek, Midas Creek, Butterfield Creek, or Wood Hollow. Figure 2-1 shows the approximate planning extent of Herriman along with the City's storm water collection system components.

STORM DRAINAGE PIPES

Table 2-1 lists the recorded length of existing pipe in the City's storm drain system as documented in the City's GIS as of February 2012.

Table 2-1
Herriman Storm Drain Pipe Lengths

Diameter (in)	Length (ft)	Length (mi)
12	7,894	1.5
15	71,444	13.5
18	145,965	27.6
21	6,785	1.3
24	46,985	8.9
30	18,240	3.5
36	24,289	4.6
42	1,317	0.2
48	6,742	1.3
60	4,754	0.9
72	490	0.1
Total	**334,905**	**63.4**

DETENTION BASINS

There are over 40 detention facilities in the existing storm drain system. The primary purpose of the detention facilities is to attenuate peak storm water discharges. Many of the detention facilities serve the dual purpose of a recreational park. Figure 2-1 shows the detention facilities included in the model.

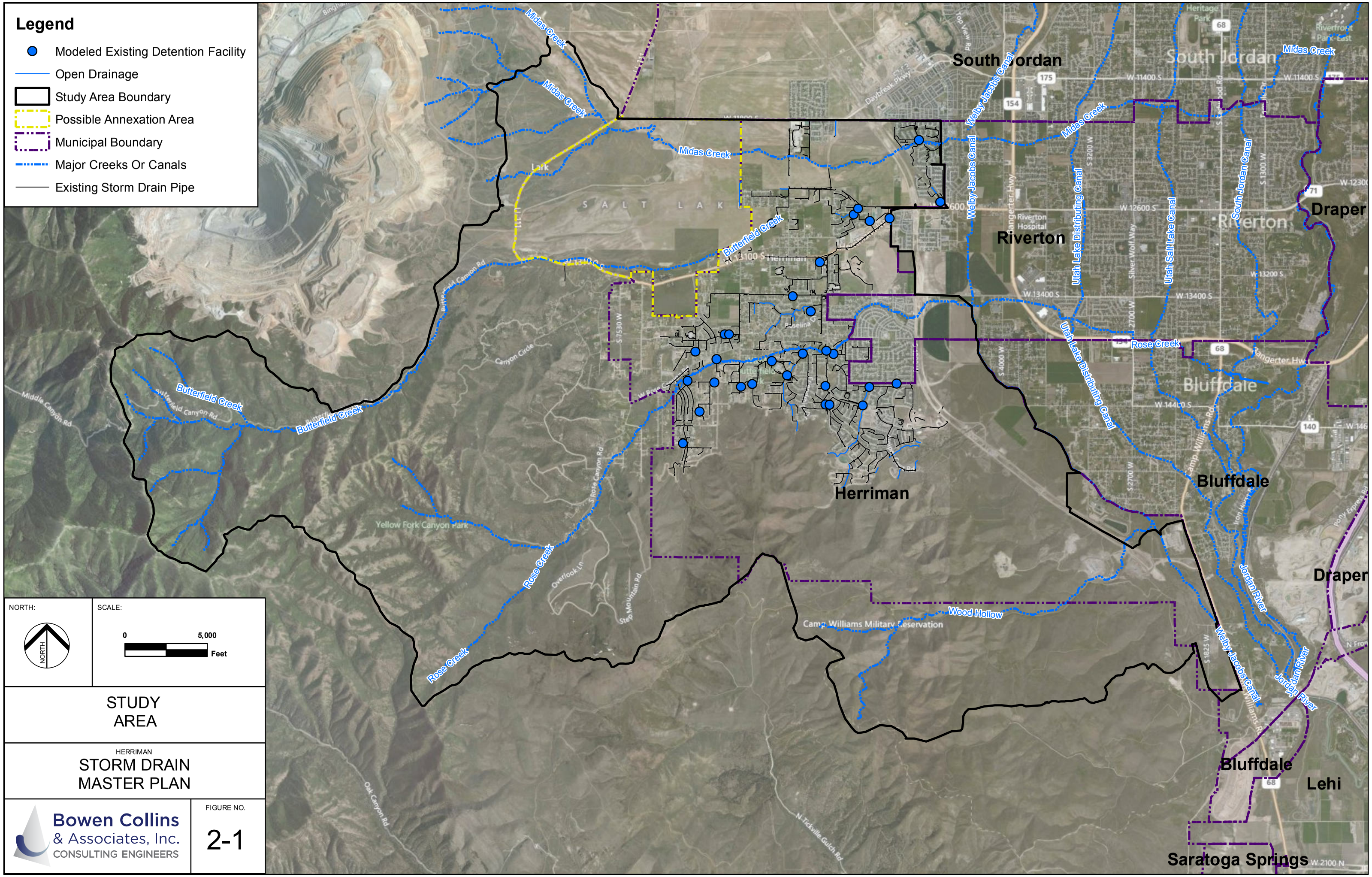
Legend
Modeled Existing Detention Facility
Open Drainage
Study Area Boundary
Possible Annexation Area
Municipal Boundary
Major Creeks Or Canals
Existing Storm Drain Pipe
NORTH:
SCALE:
0
5,000
Feet
STUDY AREA
HERRIMAN
STORM DRAIN MASTER PLAN
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FIGURE NO.
2-1
South Jordan
Riverton
Draper
Bluffdale
Herriman
Lehi
Saratoga Springs
Midas Creek
Butterfield Creek
Rose Creek
Wood Hollow
Jordan River
Welby Jacobs Canal
Utah Lake Distributing Canal
Utah Salt Lake Canal
South Jordan Canal
Camp Williams Military Reservation
Yellow Fork Canyon Park
Riverton Hospital
Heritage Park
Riverfront Park East
Lark
Herriman
Daybreak Pkwy
Top View Rd
W 11400 S
W 12600 S
W 13400 S
W 13200 S
W 14410 S
W 2100 N
Mangerter Hwy
Silver Wolf Way
Lamp Williams Rd
Iron Horse Rd
Pony Express Rd
Canyon Circle
Middle Canyon Rd
Butterfield Canyon Rd
S Rosa Canyon Rd
Overlook Ln
Step Mountain Rd
Oak Canyon Rd
N Tickville Gulch Rd
S 7530 W
S 4000 W
S 2700 W
S 1300 W
S 3200 W
S 1825 W
68
175
154
71
140

Most of the detention facilities in Herriman were originally installed with orifice plates. However, some of the orifice plates have been removed. The removal of the orifice plates has decreased the effectiveness of the detention facilities in attenuating the peak storm water discharge rates and may also increase the peak flow rates in Rose and Midas Creeks. The City is starting to install flow control gates to replace the orifice plates on some of these detention facilities to better regulate detention facility operation. It is recommended that the City continue installing flow control gates on detention facility outlets, and that gate actuators and supervisory control and data acquisition (SCADA) be installed with each gate.

NATURAL CHANNELS

There are several natural tributary drainages that convey runoff to Wood Hollow, Rose Creek, Midas Creek, and Butterfield Creek. Several natural drainages have been preserved and are used for conveyance purposes in the Herriman storm drain system. Based on conversations with the City, the natural channels will continue to function as an important part of the storm drain conveyance system. In areas of future development, the natural drainages will need to be preserved and protected for hillside runoff. Figure 2-1 shows the natural drainages in the Herriman storm drain system.

MAJOR CREEKS

As stated above, the natural topography in Herriman slopes towards Wood Hollow, Rose Creek, Midas Creek, and Butterfield Creek. Those drainages ultimately receive all the storm water runoff from the Herriman storm drain system. It is important to note that Wood Hollow, Rose Creek, Midas Creek, and Butterfield Creek (County Facilities) are managed by Salt Lake County. Salt Lake County's code 17.08 states that projects relating to stormwater or floodwater that regulate flow through Wood Hollow, Rose Creek, Midas Creek or Butterfield Creek are subject to Salt Lake County. The maximum recommended capacities for these County Facilities was estimated and published in the SWCC study. Since that time, the County has made significant improvements in some of those drainages to accommodate their maximum estimated flow rates. To avoid redoing those costly improvements to the County Facilities, it is important to estimate the peak flow rates in those drainages and ensure that they are below the allowable maximum flow rates, as defined by the SWCC study. To achieve consistency between this master plan and the SWCC study, the hydrologic and hydraulic parameters used in this study were developed using the same methodology as the SWCC study (see Chapters 3 and 4).

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CHAPTER 3
HYDROLOGIC ANALYSIS

A hydrologic computer model of the study area was developed in ASSA, version 6.4, for the purpose of estimating storm water runoff volume and peak discharges generated by a design cloudburst event. ASSA uses an Environmental Protection Agency Storm Water Management Model (EPA-SWMM) based engine to perform computations. As with EPA-SWMM, ASSA can be used to model the hydrologic and hydraulic components of the study. See Chapter 4 for a description of the hydraulic modeling.

The model development process includes delineating drainage basins, estimating hydrologic parameters, developing a design storm and calibrating the model. Each one of these steps is described below.

DRAINAGE BASIN DELINEATION

The first step in developing a computer hydrologic model is to delineate drainage basins and subbasins. Drainage basins and subbasins were delineated as part of the 2009 Master Plan. After reviewing subbasins boundaries with the City, it was decided that the subbasins that were developed as part of the 2009 Master Plan would be acceptable for this project. Drainage basins and subbasin boundaries associated with the hydrologic model are shown on Figure 3-1.

It is important to note that Kennecott land occupied by the Bingham Open Pit Mine was not included in the drainage basin delineation. Kennecott currently has a surface runoff collection system for the waste rock adjacent to Butterfield Creek and Midas Creek. They also have a cut off walls, downstream of their waste rock, that collect runoff from the drainages that contribute flow to Butterfield and Midas Creeks. Those surface collections systems mitigate storm water runoff from Kennecott land entering Butterfield and Midas Creeks.

HYDROLOGIC MODEL PARAMETERS

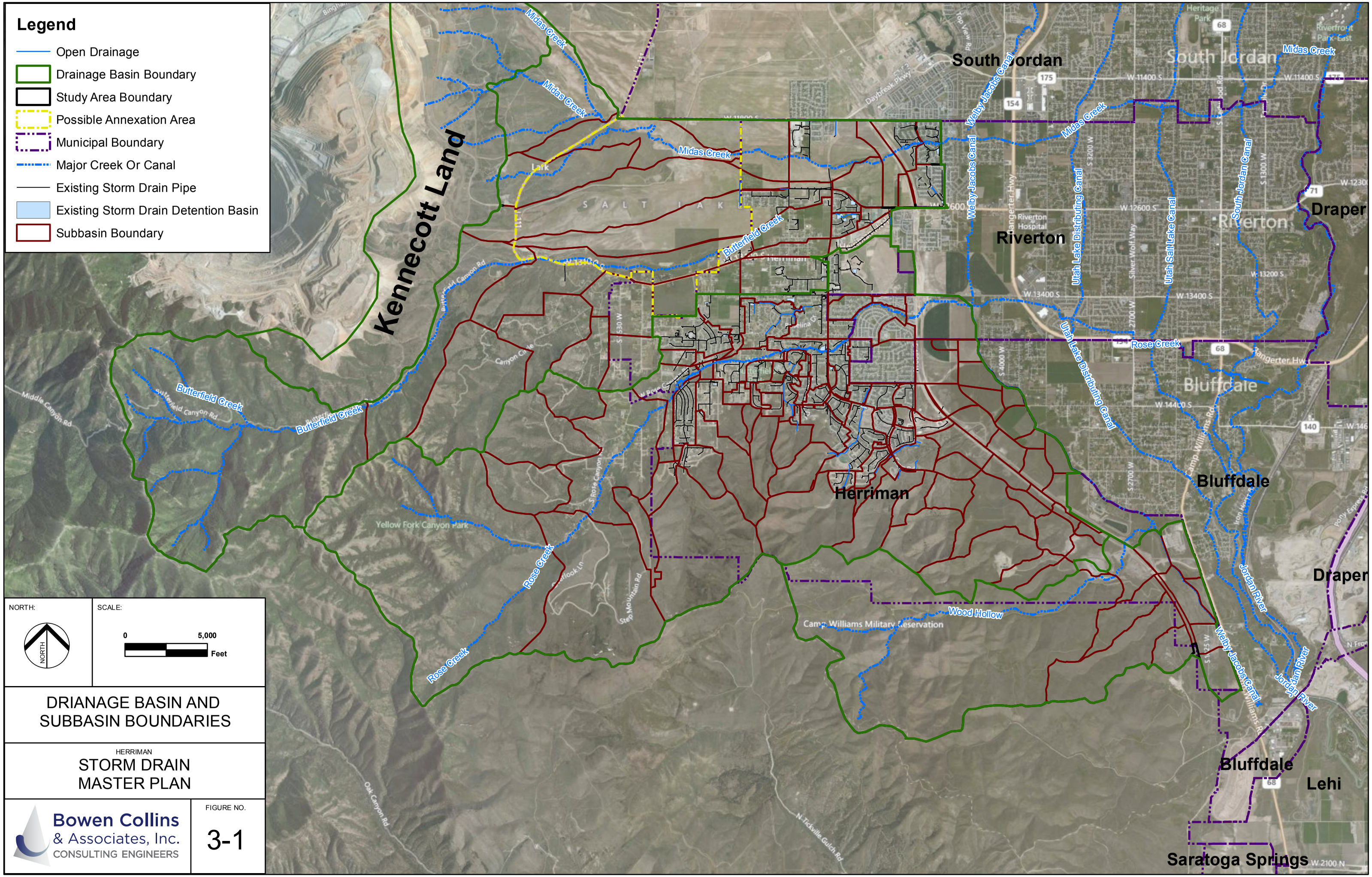
The following hydrologic model parameters were used to develop the ASSA computer model.

Hydrology Method

In the ASSA software there are multiple options for Hydrology Method, including the EPA-SWMM method and Hydrologic Engineering Center (HEC-1) method, among others. For this study, the HEC-1 method was chosen. The HEC-1 method is the same engine HEC-HMS uses.

Unit Hydrograph 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. In non-urban areas (hillsides) drainage basin lag times were calculated based on approximate collection channel lengths and slopes using the Corps of Engineers version of Snyder’s equation for lag time (Flood Hydrology Manual, 1989). In urban areas, worksheet 3 in Technical Release 55 (TR-55) was used to estimate the time of concentration (see Appendix B for an example of a time of concentration worksheet). Previous studies have shown that the lag time in urban areas can be approximated as the time of


Legend
Open Drainage
Drainage Basin Boundary
Study Area Boundary
Possible Annexation Area
Municipal Boundary
Major Creek Or Canal
Existing Storm Drain Pipe
Existing Storm Drain Detention Basin
Subbasin Boundary
Kennecott Land
South Jordan
Riverton
Draper
Herriman
Bluffdale
Lehi
Saratoga Springs
Midas Creek
Butterfield Creek
Rose Creek
Wood Hollow
Welby Jacobs Canal
Utah Lake Distributing Canal
Utah Salt Lake Canal
South Jordan Canal
Jordan River
Camp Williams Military Reservation
Yellow Fork Canyon Park
Riverton Hospital
Heritage Park
Riverfront Park East
NORTH:
SCALE:
0
5,000
Feet
DRIANAGE BASIN AND SUBBASIN BOUNDARIES
HERRIMAN
STORM DRAIN MASTER PLAN
Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS
FIGURE NO.
3-1

concentration. The Lag Time was adjusted during the calibration process for some subbasins. See "Model Calibration" below for a more detailed description.

Loss Method

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

Composite Curve Number. The Curve Numbers (CN) developed in the SWCC study were reviewed and used for this study. Where Curve Numbers were not available from the SWCC study, 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 Soil Survey Geographic (SSURGO) dataset. Table 3-1 shows the Curve Numbers used in this study from the SWCC study, or based on soil type and as assumed vegetative ground cover for developed areas. In some instances the Curve Number based on soil type was adjusted to reflect development. See "Model Calibration" below for a more detailed description. The CN values for the undeveloped areas come from the SWCC study.

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%"

Directly-Connected Impervious Area. The amount of directly-connected impervious area for existing conditions was estimated using the 2011 National Agriculture Imagery Program (NAIP). Each subbasin was analyzed and the estimated impervious area was recorded. The amount of directly-connected impervious area was also estimated for full build-out conditions. For areas that are currently undeveloped, the General Plan was used in conjunction with Table 3-2 to estimate the impervious area.

Table 3-2
Average Imperviousness Based on Land Use

General Plan Land Use Type	Directly Connected Imperviousness (Percent)
Low Density Residential	15% - 20%
Medium Density Residential	27-30%
High Density Residential	40% - 85%
Commercial and Business	85%
Industrial	72%

DESIGN STORM PARAMETERS

To be consistent with the SWCC study, the design storm for this storm drain master plan was copied from the SWCC study. The parameters for the design storm are found below:

- Storm Duration: 3 Hours
- Storm Distribution: Modified Farmer and Fletcher
- Recurrence Interval:
  - Storm Drain Pipelines: (10-yr Storm)
  - Detention Basins and Drainages: (100-yr Storm)
- Storm Depth (From NOAA Atlas 14):

  10-Year: 1.10 inches

  100-Year: 1.97 inches

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 for the study area generally produce peak runoff rates that range from 0.26 cfs/ac to 0.34 cfs/ac runoff for quarter-acre subdivision lots, on subbasins ranging in size from 50-100 acres. The calibration target range for runoff on a quarter acre subdivision lot is typically between 0.25 and 0.35 cfs/ac during a 10-year design storm, based on information in the Water-Resources Investigations Report 89-4095 entitled “Peak-Flow Characteristics of Small Urban Drainages Along the Wasatch Front, Utah” from the U.S. Geological Survey published in 1989.

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

HYDROLOGIC MODELING ASSUMPTIONS

The following assumptions were also made in completing the hydrologic analyses of the study area:

1. Rainfall return frequency is equal to associated runoff return frequency.
2. Design storm rainfall has a uniform spatial distribution over the watershed.
3. Normal (SCS Type 2) antecedent soil moisture conditions exist at the beginning of the design storm.
4. The hydrologic computer model adequately simulates watershed response to precipitation.
5. Hydrologic parameters for non-developable areas were assumed to have normal mid-summer vegetation cover, free from recent fire damage.
6. Runoff produced by the 100-yr storm event can collect in each detention basin and eventually flow into the County Facilities.

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 if necessary.

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CHAPTER 4
HYDRAULIC MODELING

A hydraulic computer model of the study area was developed in ASSA for the purpose of routing runoff and estimating the capacity of the existing facilities. ASSA uses an EPA-SWMM based engine to perform hydraulic computations. As with EPA-SWMM, ASSA can be used to model the hydrologic and hydraulic components of the study. See Chapter 3 for a description of the hydrologic modeling.

GEOMETRIC MODEL DEVELOPMENT

There are two major types of data required to create a hydraulic model of a storm drain system: geometric data and flow data. Geometric data consists of all information in the model needed to represent the physical characteristics of the system, including pipelines, open channels and detention basins.

Modeled Pipelines

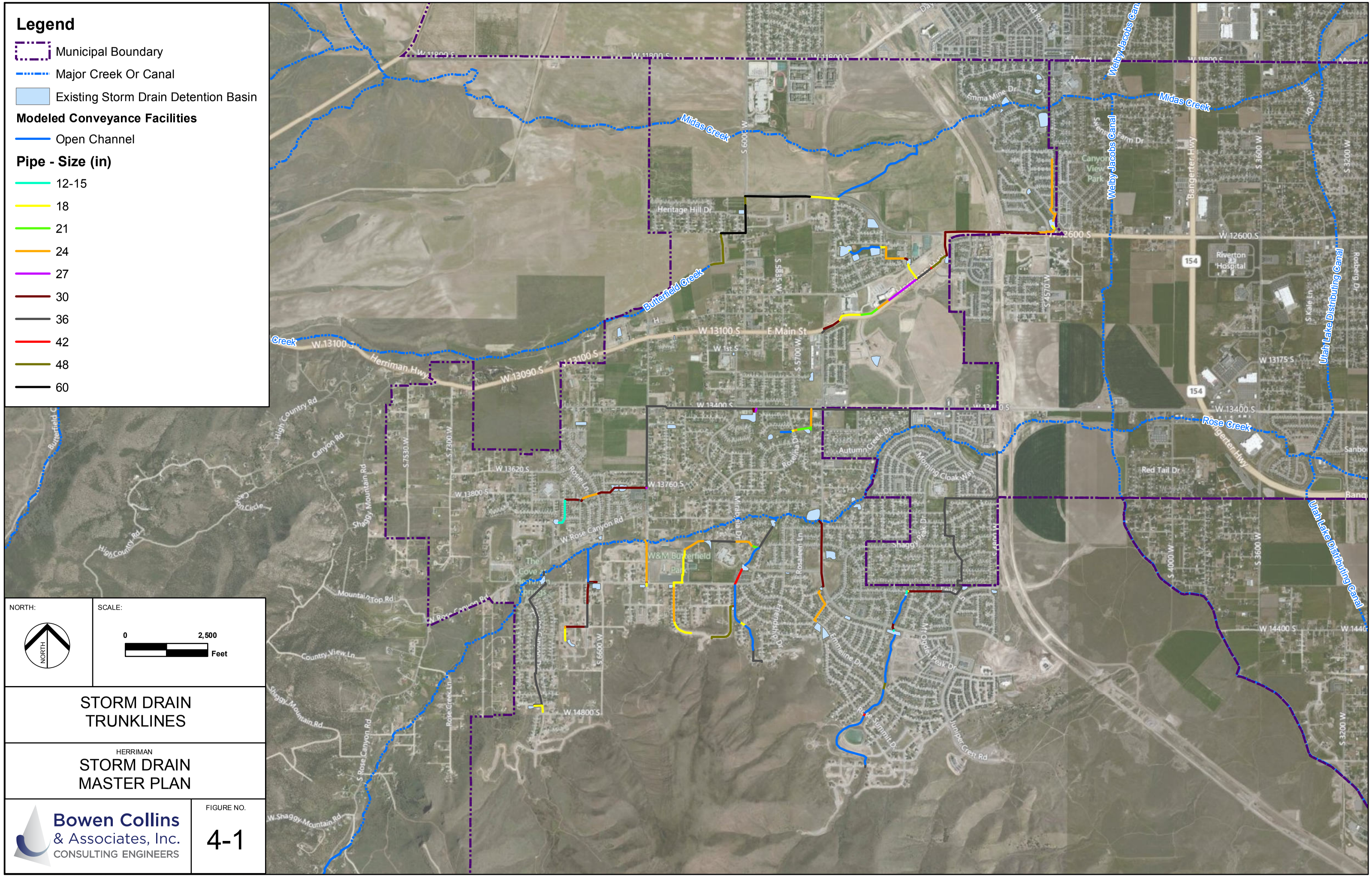
The scope of this storm drain master included a hydraulic analysis of only the storm drain trunklines. The storm drain trunklines included in the hydraulic model are shown in Figure 4-1. The storm drain trunk lines included in this model were selected by Herriman City.

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

Open Channels

Open Channels were divided into two major categories. They are listed below.

- **County Facilities –** Rose Creek, Midas Creek, Wood Hollow, and Butterfield Creek were analyzed in this study. To analyze those drainages a generic channel was used in the model to represent each creek, which was used for conveyance purposes only. Peak flows were estimated based on results from ASSA, at key locations along the creek. Those peak flow rates were then compared to the Creek's estimated capacity as defined in the SWCC study.
- **Minor Drainages –** As stated in Chapter 2, there are several natural drainages that have been preserved and are being used for the Herriman storm drain system. Those drainages were included in the model. They were identified from the U.S. Geological Survey (USGS) Quadrangle maps, or from the 2011 NAIP. Survey data was not provided for the minor drainages. Information about the open channels was derived from one foot topography developed in 2006, USGS quadrangle maps, and information obtained during field reconnaissance.


Legend
Municipal Boundary
Major Creek Or Canal
Existing Storm Drain Detention Basin
Modeled Conveyance Facilities
Open Channel
Pipe - Size (in)
12-15
18
21
24
27
30
36
42
48
60
NORTH:
SCALE:
0
2,500
Feet
STORM DRAIN TRUNKLINES
HERRIMAN
STORM DRAIN MASTER PLAN
Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS
FIGURE NO.
4-1
Midas Creek
Butterfield Creek
Rose Creek
Welby Jacobs Canal
Utah Lake Distributing Canal
W 13100 S
E Main St
Herriman Hwy
W 13090 S
W 12600 S
Riverton Hospital
W 13400 S
W 13760 S
W Rose Canyon Rd
W 14800 S
W 14400 S
Red Tail Dr
Autumn Creek Dr
Morning Cloak Way
Shaggy Peak Dr
Mt Ogden Peak Dr
Juniper Crest Rd
Rose Summit Dr
Emmeline Dr
Friendship Dr
Rosaleen Ln
Mirabella Dr
Rosie Ln
Rose Canyon Rd
S Rose Canyon Rd
Rose Creek Ln
Shaggy Mountain Rd
W Shaggy Mountain Rd
Country View Ln
Mountain Top Rd
High Country Rd
Canyon Rd
Canyon View Circle
Butterfield Canyon
Heritage Hill Dr
Smma Mine Dr
Swenson Farm Dr
Canyon View Park
Banger Hwy
S 5600 W
S 5830 W
S 5700 W
S 4570 W
S 7530 W
S 7300 W
S 6600 W
S 4000 W
S 3600 W
S 3200 W
W 13175 S
W 13620 S
W 13800 S
W 11800 S
W 1st S
S Kale Ln
Rosebrig Dr
Janice Dr
154

Detention Basins

The stage storage curves provided by the City for each of detention basins were entered into the model. Orifice information, including size, location, or lack thereof, was provided by the City, and was included in the existing conditions model. If a detention facility does not currently have an orifice, it is recommended that a flow control gate be installed to regulate flow. Therefore, an outlet or an orifice was included on all detention facilities in the future conditions model. Future detention basins were modeled with a synthetic stage storage curve and an outlet that released the appropriate flow rate.

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CHAPTER 5
SYSTEM EVALUATION

With the development and calibration of a hydraulic storm drain model, it is possible to simulate storm drain system operating conditions for both present and future conditions. The purpose of this chapter is to document the hydraulic performance evaluation of the collection system and identify potential hydraulic deficiencies.

EVALUATION CRITERIA AND LEVEL OF SERVICE

To define deficiencies in the system, the desired level of service for each of the storm drain components needs to be defined.

Storm Drain Pipelines

Storm drain pipelines are not allowed to surcharge to within two feet from the ground surface during the 10-year storm event. Storm drain pipes are also not to be smaller than 18 inches in diameter. It is important to note that roadways become the major storm water conveyance facility during storms that are larger than the 10-yr design event.

Open Channels

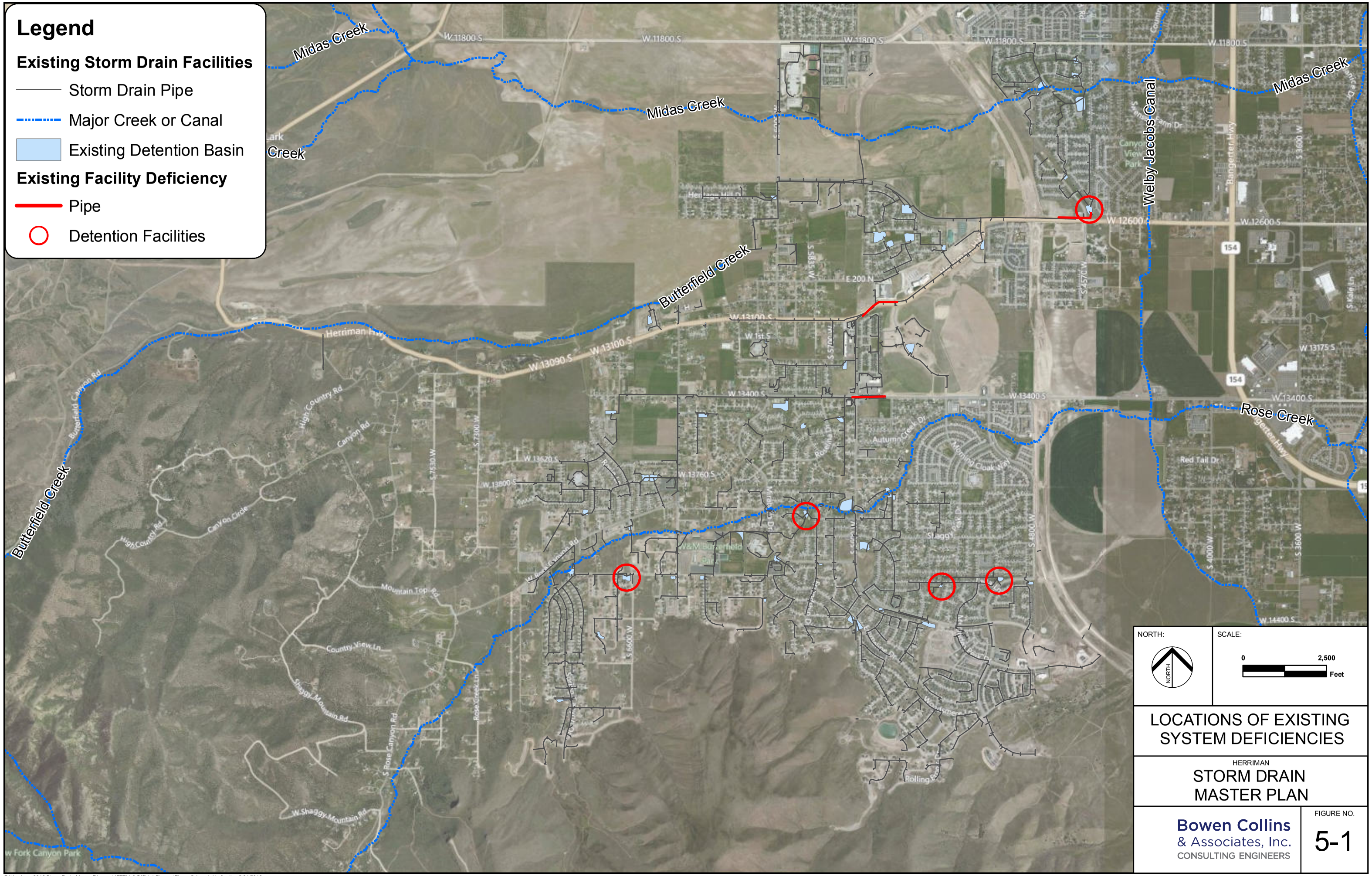
Open channels should have at least two feet of free board during the 100-year storm event. Open channels should also have protective lining. If velocities are less than 4 ft per second (ft/s), the channel should be grass lined. However, if the peak velocity in a channel is over 4 ft/s, then grass will not be sufficient to protect the channel from erosion damage and armoring will be required.

Detention Basins

Detention facilities need to have capacity for the 100-year storm, with at least one foot of freeboard, and have an emergency overflow that directs water away from private property.

EXISTING CONVEYANCE SYSTEM ANALYSIS

Figure 5-1 shows the deficiencies in the storm drain system under existing development conditions. As can be seen from Figure 5-1, most of the existing deficiencies are the detention basins. However, most of Herriman's storm drain system is sufficient to manage runoff from the existing conditions scenario.



LOCATIONS OF EXISTING SYSTEM DEFICIENCIES

HERRIMAN
STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
5-1

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FUTURE CONVEYANCE SYSTEM ANALYSIS

A few of the existing storm drain collection trunks in Herriman are undersized for ultimate development conditions in Herriman. Additional trunks will need to be constructed. Also, there are several detention basins that need to be added/modified. Chapter 7 discusses conceptual improvements that will be needed to serve the growing areas of Herriman.

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CHAPTER 6
COMPARISON TO SWCC STUDY

As stated in Chapter 2, one of the purposes of this study is to estimate peak storm water discharges rates in Rose Creek, Midas Creek, Wood Hollow, and Butterfield Creek. Each of those Creeks is discussed individually below.

ROSE CREEK

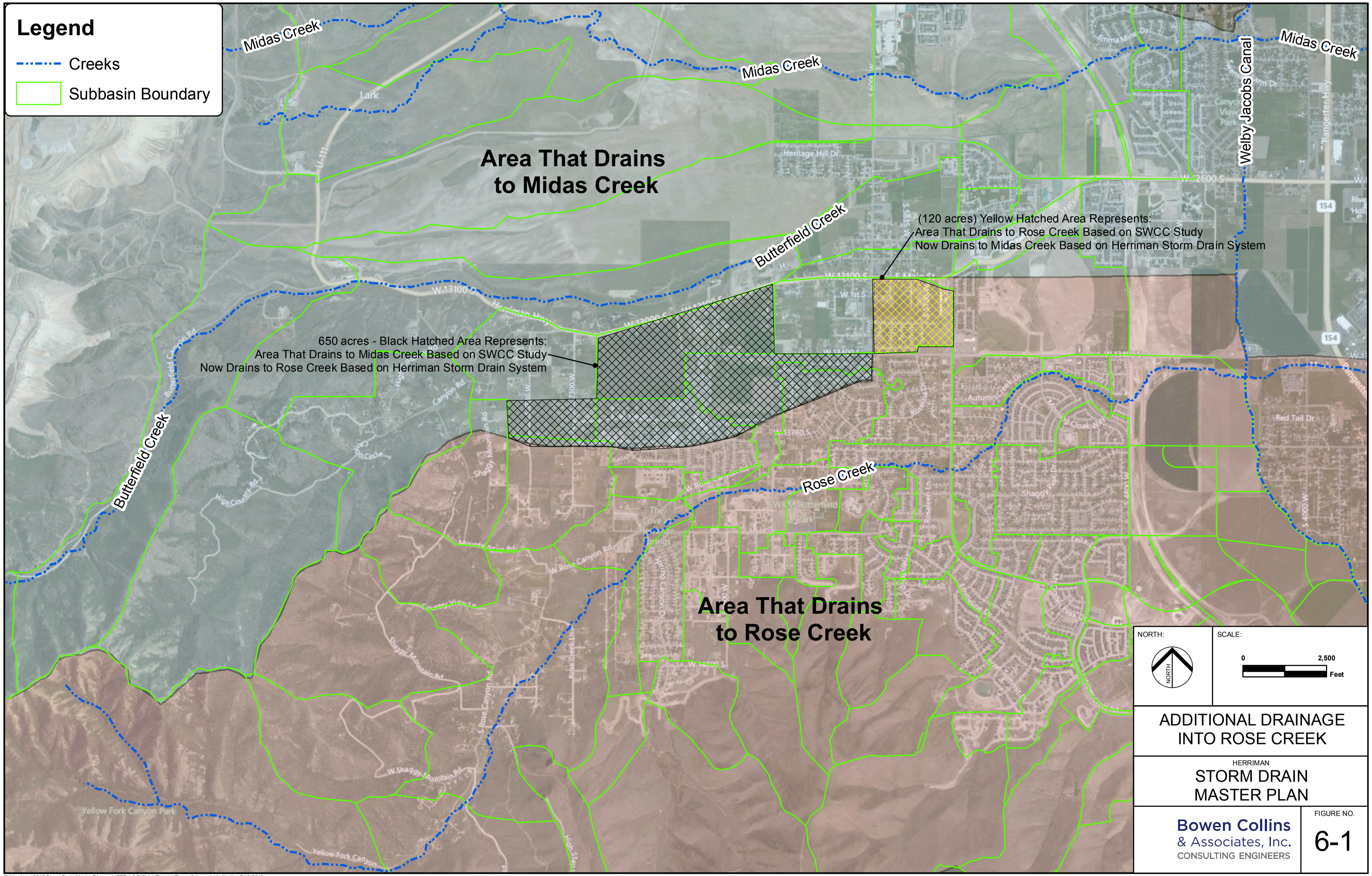
Peak flows rates in Rose Creek were estimated based on results from the ASSA model. Based on those results, Rose Creek has very little capacity available for storm water runoff from future development. The reasons for the lack of available capacity in Rose Creek are listed below.

- **Additional Drainage Area into Rose Creek -** The hydrologic model developed as part of the SWCC study was developed at a regional scale. Drainage basin and subbasin delineations were made based on the best available data at the time (the report was published in 2002). It is important to note that prior to publishing of the SWCC study, personnel from Herriman and other cities were provided with the opportunity to review and provide input on the draft report including upfront coordination of anticipated land use patterns for the study area. Since that time, the previously anticipated development patterns in Herriman have changed significantly. As a result, there is a large area (approximately 430 acres, shown on Figure 6-1) of the City which was previously designated to drain to Midas Creek that will now drain to Rose Creek.

- **Additional Development** – The SWCC study generally assumed that developable areas would detain storm water runoff from the 100-yr storm to a maximum discharge rate of 0.2 cfs per acre (cfs/ac). The remainder of the system would discharge at the pre-development flow rate (generally between 0.02-0.05 cfs/ac for the 100-yr storm). As stated in the previous bullet point, the anticipated development patterns in Herriman have changed significantly since the SWCC study was published. There are sections of Herriman that have developed that were not originally anticipated for development. Those areas are discharging at 0.2 cfs/ac when they were originally anticipated to discharge at only 0.02-0.05 cfs/ac.

- **Runoff From South Herriman -** The SWCC study indicated that the majority of South Herriman was going to discharge storm water runoff into Rose Creek at the Utah Lake Distributing Canal crossing. However, due to the annexation of South Herriman, they will be discharging into Rose Creek at the Welby Jacobs Canal. Because the South Herriman area was not originally intended to discharge into Rose Creek so far upstream, Rose Creek has very little capacity for South Herriman's runoff at the Welby Jacob Canal.

Due to the additional drainage area that is discharging into Rose Creek, the additional development in Herriman, and because South Herriman will be discharging into the Rose Creek at the Welby Jacob's Canal, the reach of Rose Creek east of 4800 West has little remaining capacity to accommodate storm water runoff from future development.



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Rose Creek Recommendations

After discussing the issue with representatives Herriman City and discussing the limited available capacity in Rose Creek at the Welby Jacobs Canal, it was decided that South Herriman can discharge into Rose Creek immediately upstream of the Welby Jacobs Canal if following requirements are met:

- **Detain Flows To 0.02 cfs/ac -** Flow rates from developable areas are detained to a maximum discharge rate of 0.02 cfs/ac. The maximum discharge rates applies to all developable land, including, but not limited to, major and minor roads, parking lots, sidewalks, lawns, roofs, driveways, park strips, etc. Areas that are not going to be developed, based on Herriman's 2009 General Plan, can continue to discharge at their native discharge rates (0.02-0.05 cfs/ac)

- **Regional Detention Facility -** A regional detention facility will need to be constructed in the vicinity of 4800 West and Juniper Crest to collect storm water runoff from a large area in the southeast section of Herriman (see DB 2 on Figure 7-2 in Chapter 7). That area is largely developed, with flow rates being detained to 0.2 cfs/ac before discharging into Rose Creek. The purpose of the regional facility is to detain storm drain runoff to approximately 0.04 cfs/ac before discharging into Rose Creek. This will allow South Herriman to discharge at the rate of 0.02 cfs/ac without exceeding Rose Creek's capacity.

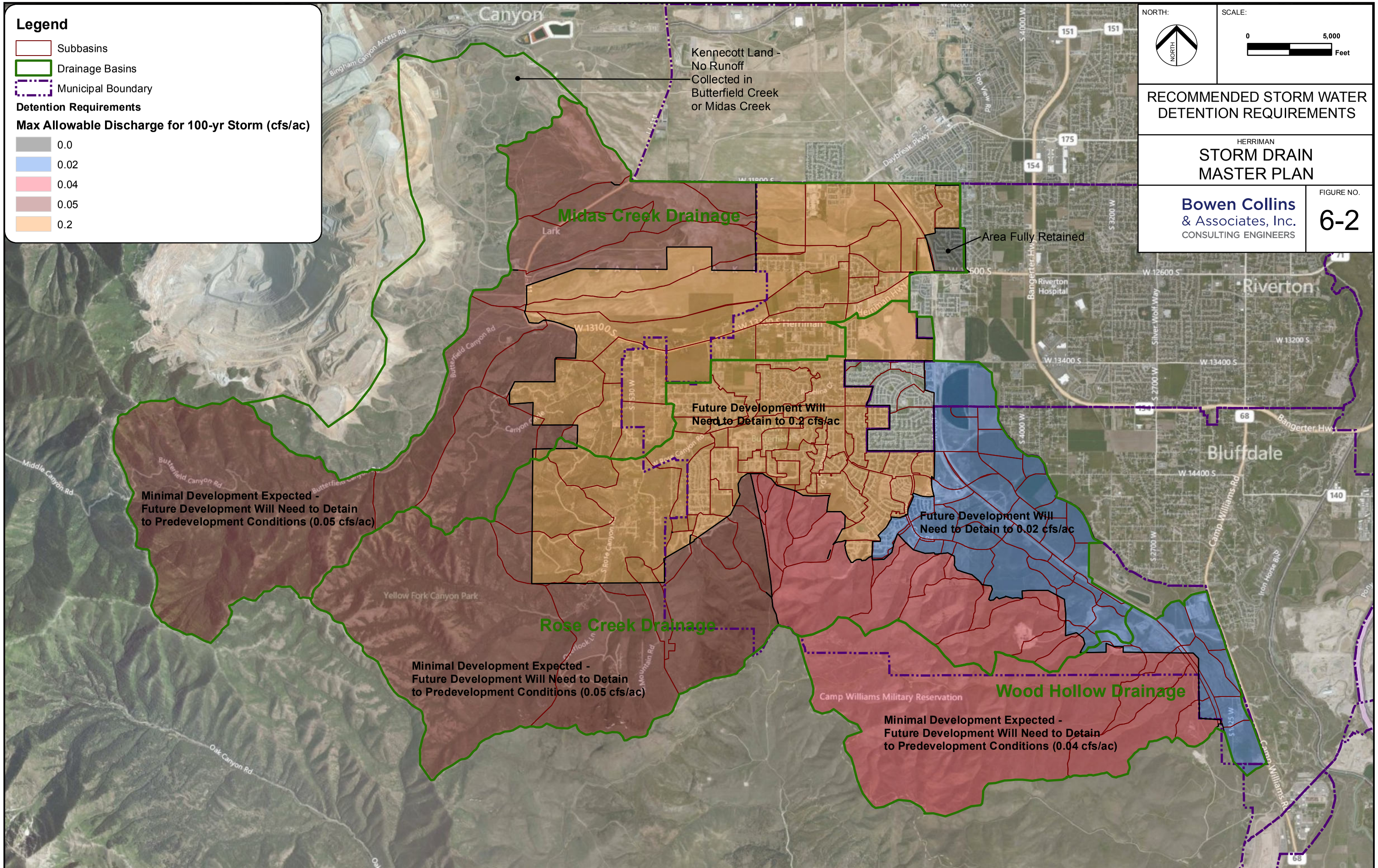
If the recommended policy and recommended improvements listed above are implemented, the estimated peak discharges from the design storm at key points along Rose Creek are presented in Table 6-1. The flow rates summarized on Table 6-1 represent peak discharges during the 100-yr storm from the Future Conditions Model.

Table 6-1
Estimated Future Peak 100-Year Discharge Rates in Rose Creek

Location	SWCC Study (cfs)	Herriman SDMP (cfs)
5775 West	485	420
4800 West	380	330
Immediately Upstream Welby Jacob Canal	500	475
Immediately Downstream Welby Jacob Canal*	500	496

* The only flow going into Rose Creek from Herriman immediately downstream of the Welby Jacob Canal is from the Herriman Towne Center.

As can be seen from Table 6-1, the flows rates in Rose Creek will be below the maximum allowable value if the recommended improvements listed above are implemented. Figure 6-2 shows the maximum allowable discharge rates for the 100-yr storm.



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MIDAS CREEK

Peak flows rates in Midas Creek were estimated based on results from the ASSA model. Based on those results, Midas Creek has capacity available for storm water runoff for future development. There is also a significant amount of developable land that will need to discharge storm water runoff into Midas Creek. If those areas detain flows to a maximum of 0.2 cfs/ac, then the peak flows in Midas Creek during the 100-yr storm will not exceed their maximum allowable value based on the SWCC study. The flow rates at key points along Midas Creek are summarized in Table 6-2, based on the required detainment level of 0.2 cfs/ac. The flow rates summarized on Table 6-2 represent peak flows during the 100-yr storm from the Future Conditions Model.

Table 6-2
Estimated Future Peak 100-Year Discharge Rates in Midas Creek

Location	SWCC Study (cfs)	Herriman SDMP (cfs)
6000 West	620	300
4720 West	805	572
4510 West	805	595

As can be seen from Table 6-2, the peak flow rates in Midas Creek will be significantly below the maximum allowable value. The reason the peak flows are significantly lower is because the updated model does not include runoff from Kennecott Land (See Chapter 3). The SWCC study was developed under the assumption that the runoff from Kennecott land did contribute to flows in Midas and Butterfield Creeks.

It is important to note that the surface runoff system for Kennecott's Bingham Pit area was reportedly designed to collect hillside runoff from the 10-yr 24-hr storm. During larger storms, surface runoff from that area may bypass the runoff collection system and contribute to Midas Creek. As a result, the peak flows in Midas Creek may be higher than those shown in Table 6-2. However, because the estimated peak flows in Midas Creek are significantly lower than the maximum allowable flows estimated in the SWCC study, Midas Creek may not have capacity problems during the 100-yr storm event. To estimate the surface runoff from Kennecott Land during the 100-yr storm event, it is recommended that a more detailed analysis of the surface runoff contributing to Midas Creek from Kennecott Land be completed.

BUTTERFIELD CREEK

Most of Butterfield Creek flows through unincorporated county land; only a short section of Butterfield Creek is within the Herriman Municipal Boundary. Butterfield Creek discharges into a 60" storm drain pipe in the vicinity of Starlite Hill Lane and 12700 South which ultimately conveys runoff to Midas Creek at approximately 5200 West. Similar to Midas Creek, there is also a significant amount of developable land that will need to discharge storm water runoff into Butterfield Creek. If those areas detain flows to a maximum of 0.2 cfs/ac, then storm water

runoff in Butterfield Creek will not exceed its maximum allowable limit during the 100-yr storm. The flow rates at the only key point along Butterfield Creek is summarized in Table 6-3, based on the required detainment level of 0.2 cfs/ac. The flow rate summarized on Table 6-3 represents the peak flow during the 100-yr storm from the Future Conditions Model.

Table 6-3
Estimated Future Peak 100-Year Discharge Rates in Butterfield Creek

Location	SWCC Study (cfs)	Herriman SDMP (cfs)
6000 West	200	165

As can be seen from Table 6-3, the estimated design storm peak discharges in Butterfield Creek is below the maximum allowable value. The reasons and recommendations are the same as those documented for Midas Creek.

WOOD HOLLOW

The recommended improvements for Wood Hollow Drainage from Salt Lake County include downstream channel improvements, culvert crossings at the canals and Redwood Road that would ultimately convey runoff to the Jordan River. Those recommended improvements are currently on Salt Lake County's Capital Improvements Plan, but have not been constructed. County personnel indicated that there are no plans to complete those improvements in the near future. To avoid the possibility of flooding downstream development, any future development in the Wood Hollow Drainage that is completed before the County improvements are implemented will need to detain storm water runoff to 0.02 cfs/ac. This will prevent the peak flow rates in Wood Hollow from increasing above pre-development conditions. Costs for those improvements were not included in this storm drain master plan because they are included on the County's Capital Improvements Plan.

CHAPTER 7
RECOMMENDED SYSTEM IMPROVEMENTS

The hydraulic model was used to evaluate various alternatives for correcting the identified deficiencies and sizing future storm drain facilities under projected future development conditions. In accordance with instruction from City personnel, the 2009 Master Plan's recommended improvements were used as a basis for recommended improvements outlined in this chapter. This chapter describes the storm drain improvements, based on estimated runoff and ground slopes.

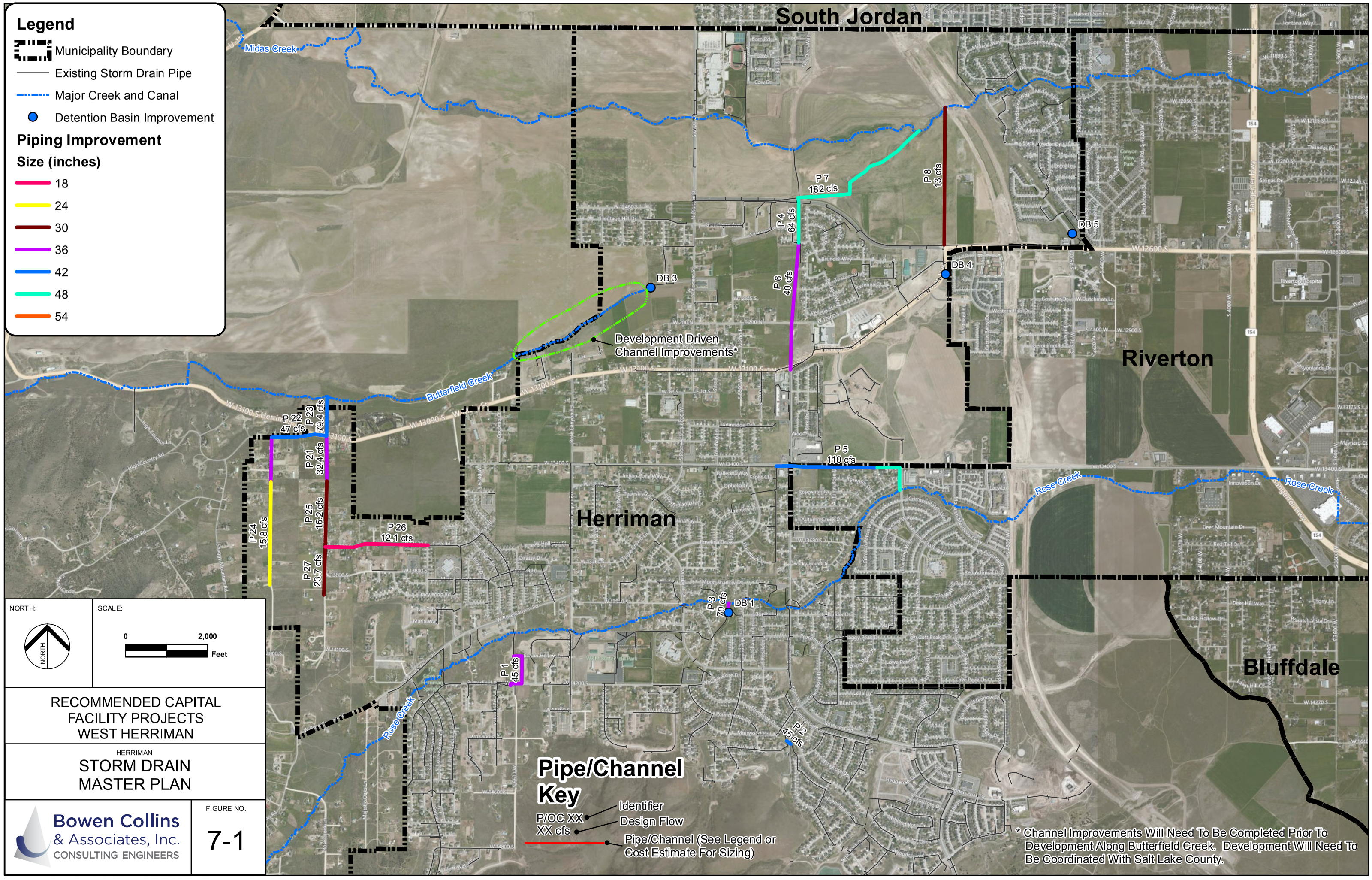
TYPES OF RECOMMENDED IMPROVEMENTS

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

- **Major Conveyance Facilities** – Major storm drain conveyance facilities include pipelines or major channels that typically that service multiple developments. Local facilities include smaller storm drain conveyance facilities that typically only serve only one small development, and are used to convey storm water runoff from the 100-yr design storm to the major conveyance facilities.
- **Regional Detention Facilities –** Based on discussions with Herriman personnel, the City has decided to require each development to provide local detention facilities to attenuate peak discharge from storm water runoff to the limits stated in this report. A major regional detention facility will attenuate peak runoff from the 100-yr design storm to levels that can be safely conveyed through existing downstream facilities.

RECOMMENDED PIPELINE IMPROVEMENTS

Figures 7-1 and 7-2 shows the location of recommended pipeline improvements that are needed to meet future growth in Herriman. Table 7-1 summarizes the cost of the proposed improvements in 2012 dollars.

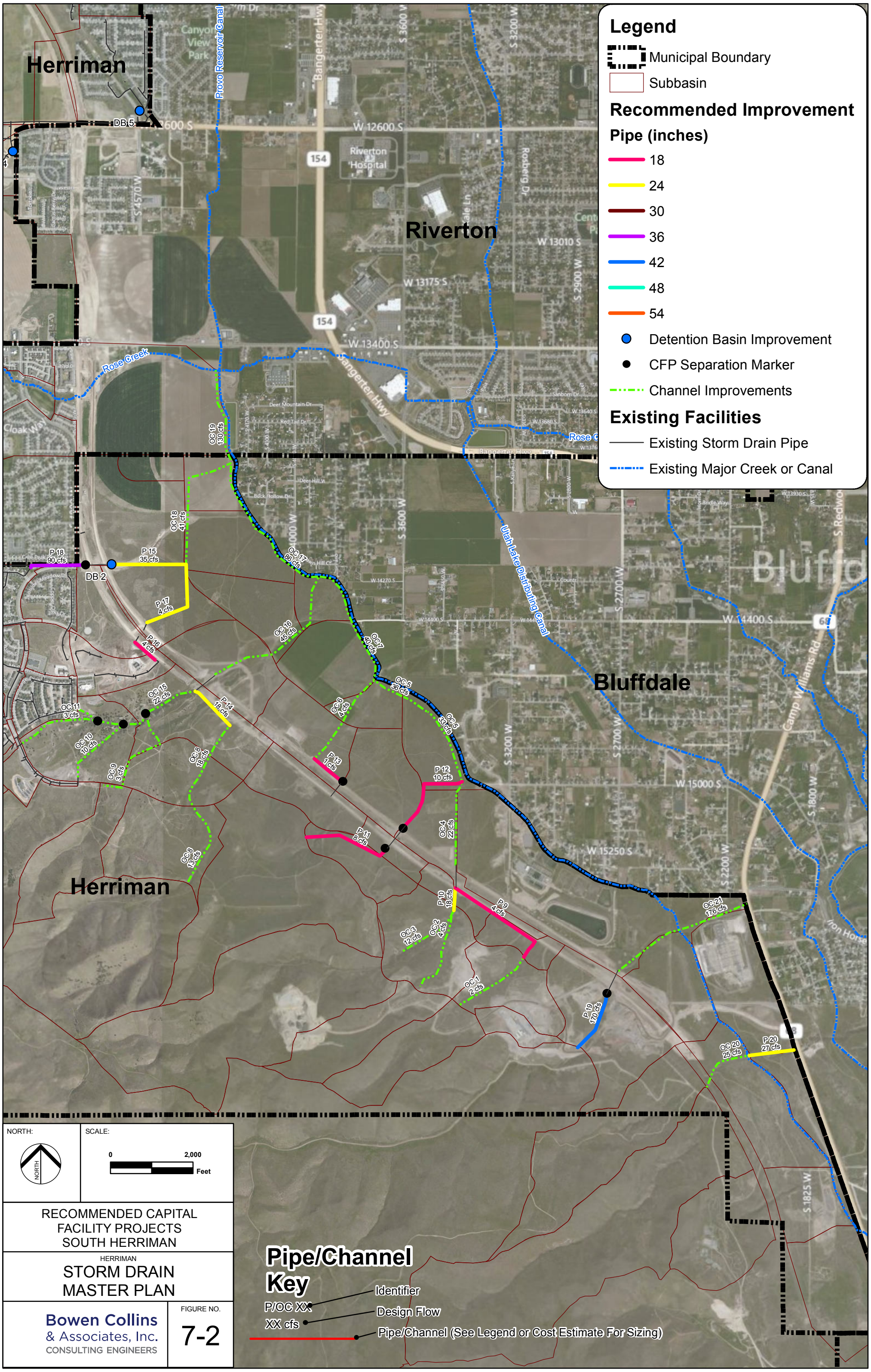


RECOMMENDED CAPITAL
FACILITY PROJECTS
WEST HERRIMAN

HERRIMAN
STORM DRAIN
MASTER PLAN

Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
7-1



RECOMMENDED CAPITAL FACILITY PROJECTS SOUTH HERRIMAN

HERRIMAN

STORM DRAIN MASTER PLAN

Bowen Collins & Associates, Inc.
CONSULTING ENGINEERS

FIGURE NO.
7-2

Table 7-1
Storm Drain Trunkline Improvements

Project ID	Total Length (ft)	Range of Diameters (in)	Cost (2012 Dollars)
P 1	1,182	36	$ 359,785
P 2	131	42	$ 37,118
P 3	108	36	$ 26,526
P 4	1,104	48	$ 357,199
P 5	3,553	42-48	$ 1,276,292
P 6	3,088	36	$ 716,837
P 7	3,654	48	$ 1,198,750
P 8	3,338	30	$ 666,021
P 9	2,805	18	$ 447,678
P 10	548	24	$ 92,301
P 11	1,882	18	$ 296,716
P 12	2,103	18	$ 336,515
P 13	909	36	$ 214,590
P 14	1,186	24	$ 196,819
P 15	1,797	24	$ 305,216
P 16	649	18	$ 102,628
P 17	2,069	24	$ 354,858
P 18	1,303	36	$ 304,821
P 19	1,460	42	$ 404,377
P 20	1,093	24	$ 184,255
P 21	1,094	36	$ 335,829
P 22	2,415	36-42	$ 608,514
P 23	956	42	$ 346,562
P 24	2,499	24	$ 596,546
P 25	1,604	30	$ 435,475
P 26	2,514	18	$ 462,793
P 27	1,165	30	$ 307,594
Total	**-**	**-**	**$10,973,000**

OPEN CHANNEL IMPROVEMENTS

Figures 7-1 and 7-2 shows the location of recommended open channel improvements that are needed to meet future growth in Herriman on facilities that are not under the jurisdiction of Salt Lake County. Table 7-2 lists the recommended local open channel improvements in Herriman.

Salt Lake County's SWCC study indicates that channel improvements need to be completed in Butterfield Creek within Herriman City limits prior to development. The location of the

Table 7-2
Natural Channel Improvements

Channel ID	Total Length (ft)	Assumed Bottom Width (ft)	Assumed Channel Depth (ft)	Cost (2012 Dollars)
OC 1	2005	3	4	$268,929
OC 2	2158	3	4	$289,580
OC 3	1657	3	4	$222,262
OC 4	2069	3	4	$277,581
OC 5	2735	3	5	$447,271
OC 6	2406	3	4	$322,858
OC 7	3068	3	5	$501,762
OC 8	4364	3	4	$585,482
OC 9	2859	3	4	$383,504
OC 10	1804	3	4	$242,027
OC 11	2023	3	4	$271,348
OC 12	544	3	4	$73,017
OC 13	633	3	4	$84,929
OC 14	677	3	4	$90,818
OC 15	1343	3	4	$180,117
OC 16	3879	3	4	$520,364
OC 17	3811	5	6	$828,385
OC 18	3185	3	4	$427,246
OC 19	2339	10	6	$605,455
OC 20	1433	3	4	$192,310
OC 21	3058	3	5	$562,583
Total	**-**	**-**	**-**	**$7,377,827**

improvements is shown on Figure 7-1. It is recommended that development does not occur along Butterfield Creek until those improvements are completed or the County gives approval for development. The improvements along Butterfield Creek will not be included on Herriman's CIP.

DETENTION BASIN IMPROVEMENTS

Figures 7-1 and 7-2 shows the location of recommended detention basin improvements that are needed to meet future growth in Herriman. Table 7-3 lists the recommended detention volumes and costs for detention facilities in Herriman.

Table 7-3
Required Capacity at Detention Basins

Detention Basin	Future Required Volume (acre-feet)	Cost (2012 Dollars)
DB 1	3.0	$ 370,600
DB 2	11.0	$ 1,813,400
DB 3	23.9	$ 3,945,800
DB 4	3.4	$ 358,600
DB 5	7.3	$ 697,400
Total	**-**	**$ 7,185,800**

For a detailed cost estimate of each of the recommended improvements, see appendix C.

CHAPTER 8
CONCLUSIONS AND RECOMMENDATIONS

Recommended capital improvements pertaining to storm drain trunklines, natural channels, and detention facilities were identified in Chapters 7. There have also been general recommendations regarding the storm drain system that were documented in Chapters 2, 6 and 7. This chapter summarizes the general recommendations discussed in this report.

SUMMARY OF GENERAL RECOMMENDATIONS

Most of the general recommendations regarding Herriman's storm drain system can be broken into five groups: Detention facilities, Trunklines, Natural Channels, Detention Requirements, and Miscellaneous Recommendations. They are summarized below.

Detention Facilities

- **Install Gates on Detention Facilities (Chapter 2) -** Some of the existing detention facilities in Herriman currently do not have orifice plates, or means of regulating discharges out of the detention facilities. The City has started the process of installing flow control gates on some of those detention facilities. It is recommended that the City continue installing flow control gates on the detention facilities and that they include actuators and SCADA on the flow control gates. Also, we would recommend replacing existing orifice plates in detention facilities with flow control gates with actuators and SCADA to allow the operation of the detention facilities to be better regulated.
- **Detention Facility Freeboard Requirements (Chapter 5) -** Detention facilities need to have capacity for the 100-year storm, with a minimum of one foot of freeboard.
- **Local Detention Facilities (Chapter 7) –** Each development will need provide its own detention facilities before storm water runoff is discharged into a storm drain trunkline or natural channel.

Pipelines

- **Minimum Pipe Size (Chapter 5) -** Storm drain pipes are not to be smaller than 18 inches in diameter.
- **Pipe Surcharge Allowance (Chapter 5)** - Storm drain pipelines are not allowed to surcharge to within two feet from the ground surface during the 10-year storm event.

Natural Channels

- **Preserve Natural Drainages (Chapter 2) -** Several natural drainages have been preserved and are used for conveyance purposes in the Herriman storm drain system. In areas of future development it is recommended that the natural drainages be preserved for use in collecting and conveying hillside runoff and other storm water runoff.
- **Open Channel Freeboard Requirements (Chapter 5) -** Open channels need to have at least two feet of free board during the 100-year storm event.

- **Open Channel Protective Lining (Chapter 5) -** If velocities are less than 4 ft/s, the channel will need to be grass lined. However, if the peak velocity in a channel is over 4 ft/s, then grass will not be sufficient to protect the channel from erosion damage and armoring will be required.

- **SWCC Study Recommendation –** There is a short section Butterfield Creek that does not have capacity for storm water runoff from the 100-yr storm event, as identified in the SWCC study (see Figure 7-1). Prior to developing that section of Butterfield Creek, the capacity of the channel will need to be increased and development in that area will also need to be coordinated with the County.

Detention Requirements

- **East Herriman and Wood Hollow Detention Requirements (Chapter 6) -** Flow rates from developable areas in East Herriman and the area tributary to Wood Hollow need to be detained to a maximum discharge rate of 0.02 cfs/ac. The maximum discharge rates applies to all developable land, including, but not limited to, major and minor roads, parking lots, sidewalks, lawns, roofs, driveways, park strips, etc. Areas that are not going to be developed, based on Herriman's 2009 General Plan, can discharge storm water runoff at native rates (0.02-0.05 cfs/ac). If the those areas that not designated for development (based on the 2009 General Plan) are developed, they will need to detain storm water runoff to their pre-development discharge rates (0.02-0.05 cfs/ac).
- **Detention Requirements for the Majority of Herriman (Chapter 6) –** Areas of future development, with the exception of East Herrmian and Wood Hollow, need to be detained to a maximum discharge rate of 0.2 cfs/ac (as shown in Figure 6-1). As areas, within the study area, are annexed into Herriman City (as shown on Figure 2-1), they also need to detained to a maximum of 0.2 cfs/ac. Areas that are not going to be developed, based on Herriman's 2009 General Plan, can discharge storm water runoff at native rates (0.02-0.05 cfs/ac). If areas that are not designated for development (based on the 2009 General Plan) are developed (as shown in Figure 6-1), they will need to detain storm water runoff to pre-development discharge rates (0.02-0.05 cfs/ac).

Miscellaneous Recommendations

- **Master Plan Update -** If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations in this report may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years as well.
- **Kennecott Land -** To estimate the surface runoff from Kennecott Land during the 100-yr storm event, it is recommended that a more detailed analysis of the surface runoff contributing to Midas Creek and Butterfield Creek from Kennecott Land be completed. The channel improvements associated with Butterfield Creek in the SWCC study may also need to be updated once the analysis of the surface runoff from Kennecott is completed.

- **Herriman Towne Center –** A detailed analysis of the storm drain system for the Herriman Towne Center was not included in this Master Plan. The analysis of the Towne Center only included a review of the Towne Center report (see appendix D for a copy of the storm drain section of the Towne Center report), and enough information to adequately model the flow rate from the Towne Center to estimate the flow rate in Rose Creek. During the review of the Towne Center report, it was discovered that the detention facilities were only designed for the 10-yr storm. It is recommended that the detention facilities be designed for a 100-yr design storm, as is the rest of Herriman City as required by Salt Lake County.

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APPENDIX A
TECHNICAL MEMO

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Bowen Collins
& Associates, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

DATE: July 28, 2010

TO: Trace Robinson, P.E., Tom Beesley, P.E.
Riverton City
12830 S. Redwood Road
Riverton, Utah 84065

FROM: Craig Bagley, P.E., Matt Stayner, P.E.
Bowen, Collins & Associates
154 East 14000 South
Draper, Utah 84020

SUBJECT: Hydrologic Evaluation of Rose Creek and Midas Creek

INTRODUCTION

Riverton City personnel have observed near bank-full flow conditions in Rose Creek west of Bangerter Highway after several rainfall events in the recent past. This has raised concerns at the City regarding the storm water discharges into the creek from upstream developed areas and the capacity of the creeks to convey runoff from a 100-year design flood event. In an effort to address these concnerns, Riverton City (City) retained Bowen Collins & Associates (BC&A) to verify that the reaches of Rose and Midas Creek in Riverton City have capacity to safely convey runoff from future developed conditions from drainage areas in the City West of Bangerter.

Hydrologic conditions for The creeks were evaluated using existing studies, aerial mapping and Salt Lake County discharge permits. This technical memorandum includes a brief description of the existing studies used in the evaluation and resulting pertinent observations and conclusions that include:

- Master planned creek channel design discharge rates
- Apparent lack of existing detention facilities in Herriman
- Concern with the Herrriman SDMP rainfall-runoff computer model results
- Changes to master planned drainage areas

EXISTING STUDIES

The existing studies that were evaluated include:

- Salt Lake County <u>2002 Southwest Canal and Creek Study</u>

- Herriman 2009 Storm Drain Master Plan
- Riverton 2004 Storm Drain Master Plan Amendment

The Southwest Canal and Creek (SWCC) Study identifies 100-year design discharge rates at various locations and institutional and structural improvements needed to safely manage storm water runoff conveyed in the creeks and canals located in the southwest quadrant of the County. Salt Lake County uses that study to approve new storm water permit applications to the creeks and canals in the study, including Rose Creek and Midas Creek.

The Herriman and Riverton storm drain master plans are more recent studies. Those studies were performed to identify storm drain facilities needed to manage storm water runoff in these respective cities.

CREEK DESIGN DISCHARGE RATES

The SWCC established design discharge rates for various segments of Rose and Midas Creeks. A hydrologic model was developed as part of the SWCC study. That model was developed using the assumption that runoff from all developed areas would be detained to a peak unit discharge rate of 0.2 cfs per acre for the 100-year design storm.

The Rose Creek channel from Bangerter Highway to the Jordan River has been designed and constructed to convey discharge rates identified in the SWCC. The design discharge rate at Bangerter Highway is 520 cfs. See Appendix A for the recommended design discharge rates for all sections of Rose and Midas Creeks. Salt Lake County will not allow those design discharge rates to be increased. Otherwise, costly improvements to the downstream channel would need to be made.

APPARENT LACK OF EXISTING DETENTION FACILITIES IN HERRIMAN

Dozens of proposed detention basins have been recommended for construction in the Herriman Storm Drain Master Plan (SDMP). Based on a review of the drainage area and 2009 orthophotography, it appears that some of the proposed detention basins are in areas that have already developed. See Pond R7, R9C and R18 in the Herriman report for examples. This would seem to indicate that development has occurred before needed detention facilities have been constructed. This would result in higher runoff rates and might explain, in part, why the runoff from recent storms has appeared to nearly fill the Rose Creek channel to capacity.

CONCERN WITH THE HERRIMAN SDMP RAINFALL-RUNOFF COMPUTER MODEL RESULTS

The input parameters for the Herriman rainfall-runoff model were analyzed, including design storm and hydrologic model parameters. The Herriman SDMP, Riverton SDMP and SWCC each used slightly different design storms. Table 1 shows the design storm that was used as the basis of analysis in each study. For the Riverton SDMP, the design storm for the storm

drain trunk lines was used from the 2004 Storm Drain Master Plan. The Rivertion SDMP detention basin design storm was obtained from the Southwest Canal and Creek Study.

Table 1
Design Storm Criteria for Existing Studies

Study	Facility Study	Storm Recurrence Interval	Storm Duration (Hours)	Storm Depth (Inches)	Storm Distribution
SWCC	Creeks	100-Year	3	1.79 (Valley) 1.97 (High Elev)	Modified Farmer Fletcher
Herriman SDMP	Storm Drain Trunk Lines	100-Year	12	2.31	GBEA
Herriman SDMP	Detention Basins	100-Year	24	2.56	GBEA
Riverton SDMP	Storm Drain Trunk Lines	10-Year	3	1.13	Farmer-Fletcher 2nd Quartile
Riverton SDMP	Detention Basins	100-Year	3	1.79 (Valley) 1.97 (High Elev)	Modified Farmer Fletcher

Originally, it was believed that the Herriman 12-hour Great Basin Experimental Area (GBEA) storm might produce very different results than the SWCC 3-Hour Modificed Farmer Fletcher storm. Therefore, the Herriman HEC-HMS model was run using both design storms. The model results for urban drainage areas that discharge to Rose Creek are shown in Table 2 for comparison. It can be observed from the results shown in Table 2 that, even though the design storm depths and distributions are different for the two storms, the average unit discharges for the urban areas are similar: 0.19 cfs per acre for the GBEA storm, and 0.23 cfs/acre for the Modified Farmer-Fletcher storm.

The low peak unit discharge rates from the Herriman SDMP model for the 100-year storm event are concerning. Typical values for developed residential areas are 0.35 to 0.5 cfs per acre for the 10-year storm event and 0.6 to 1.1 cfs per acre for the 100-year storm event. The SWCC subbasins for the urban area of Herriman have an average unit discharge rate of 0.78 cfs per acre for the 100-year storm. In our opinion, the peak unit discharge rates from the Herriman SDMP model are significantly underestimated. If that is the case, the volumes of the detention facilities and size of storm drain pipes recommended in the Herriman SDMP have been significantly underestimated. The undersized detention basins could be another factor contributing to the observed high discharge rates in Rose Creek west of Bangerter Highway.

Table 2
Hydrologic Results from the Herriman SDMP Model

Recurrence Interval:		100-Year		100-Year	
Storm Distribution:		GBEA		Modified Farmer-Fletcher	
Storm Duration:		12 Hours		3 Hours	
Storm Depth:		2.31 in		1.77 - 1.97 in	
Element	Drainage Area (mi^2)	Discharge (cfs)	Unit Discharge (cfs/acre)	Discharge (cfs)	Unit Discharge (cfs/acre)
R12	0.1608	4.1	0.04	1.9	0.02
R15	0.1614	20.7	0.20	24.1	0.23
R16	0.2405	25.4	0.17	28.2	0.18
R16A	0.1136	16	0.22	19.2	0.26
R17	0.3364	48	0.22	59.9	0.28
R18 north	0.1199	15.8	0.21	20.1	0.26
R18 south	0.1199	15.5	0.20	18.3	0.24
R19	0.2797	53.3	0.30	82.4	0.46
R20	0.1589	32.7	0.32	51.4	0.51
R2A	1.1892	72.3	0.09	60.8	0.08
R7	0.4913	61.4	0.20	67	0.21
R8	0.0761	7	0.14	6.2	0.13
R9	0.5925	51.5	0.14	42.3	0.11
		Average:	**0.19**		**0.23**

CHANGES TO MASTER PLANNED DRAINAGE AREAS

The hydrologic model developed as part of the SWCC study was developed at a regional scale. Drainage basin and subbasin delineations were made based on the best available data at the time. Drainage basin boundaries were delineated for each major drainage and design flow rates were estimated based on those delineations. Figure 1 shows the SWCC drainage basin boundaries and modifications to those drainage basins boundaries based on the more recent Riverton and Herriman storm drain master plans.

It should be noted that the portion of the Rose Creek drainage area associated with the Riverton SDMP Amendment contains about 350 acres of land that the SWCC study assumed would drain to Midas Creek. Salt Lake County will not allow the peak discharge to be increased from what is shown in SWCC because structures have been designed and constructed downstream based on the SWCC flow rates. Therefore, Riverton City must mitigate the affects of the additional tributary areas by decreasing the allowable peak unit discharge rate for certain areas of the city so that there will not be no increase to the design flow rate in Rose Creek.

The Herriman Storm Drain Master Plan includes several other modifications to the SWCC drainage basin delineation. The result is that an additional 430 acres drains to Rose Creek that was not accounted for in SWCC. Also, the Herriman SDMP shows approximately 1,500 acres draining to Rose Creek just upstream of the Welby-Jacob Canal that, in SWCC, was

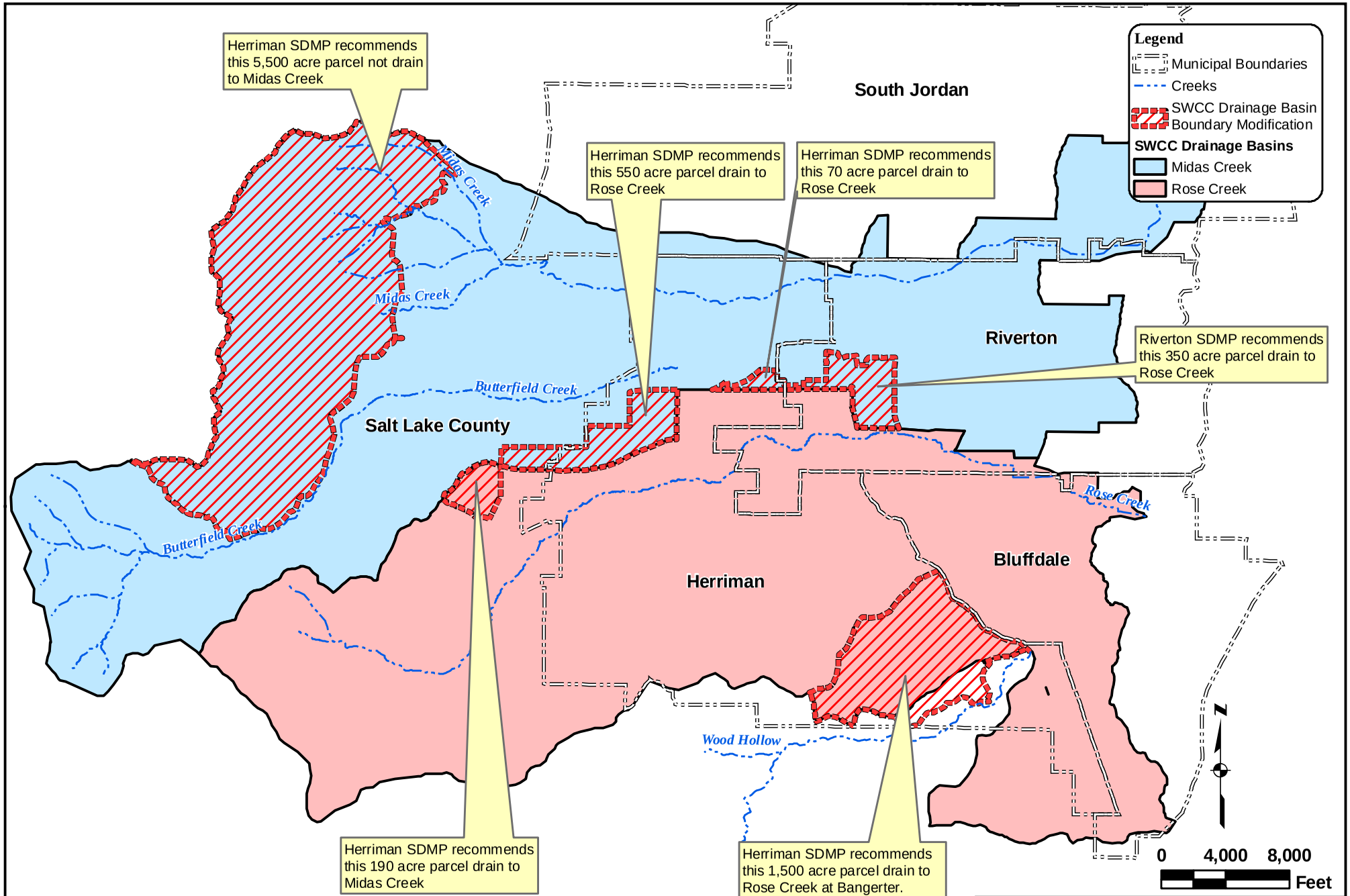

Figure 1
SWCC Drainage Basins and SDMP Modifications

Hydrologic Evaluation of Rose Creek and Midas Creek

Riverton City

Bowen Collins & Associates, Inc.
Consulting Engineers

Printing Date: May 14, 2010
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planned to discharge to Rose Creek at the Utah Lake Distributing Canal. It is not known if Herriman City has planned to properly mitigate for the planned additional 1,930 acres draining to Rose Creek at Welby Jacobs Canal.

CONCLUSIONS AND RECOMMENDATIONS

Below is a summary of conclusions and recommendations based on our hydrologic evaluation or Rose Creek and Midas Creek:

- The reach of Rose Creek east of Bangerter Highway has been constructed based on the design flow rates in the SWCC. The recommended design flow rates in Rose Creek cannot be increased.

- There are developed areas in Herriman City where there appears to be no downstream detention facilities. If this is the case, detention basins should be properly sized and constructed to restrict the peak unit discharge to a maximum rate of 0.2 cfs per acre. Future development in Herriman and Riverton should not be allowed until adequate detention facilities are operational.

- The average undetained peak unit discharge rate for urban areas computed by the Herriman SDMP model is 0.19 cfs per acre for the 100-year design storm event. There appears to be a problem with the hydrologic model input parameters, as typical runoff values for a 100-year design storm range from 0.6 to 1.1 cfs per acre. The Herriman SDMP peak unit rates are even low for the 10-year storm event, which typically range from 0.35 – 0.5 cfs per acre. If existing and proposed storm drain facilities have been designed based on the Herriman SDMP model, it is likely that those have been significantly undersized.

- Both the Riverton and Herriman storm drain master plans show modifications to the SWCC drainage basin delineations. This is a common occurrence when the level of study detail is increased from a regional study to a local study. However, the design flow rates in the creeks cannot be increased. Therefore, the cities need to make sure modifications to the SWCC drainage basins are mitigated and that the recommended design flow rates in the Rose Creek and Midas Creek are not increased. In order to compensate for the additional drainage area, a reduction in peak unit discharge rates to a level below 0.2 cfs per acre in the same area will be required.

The evaluation, conclusions and recommendations of this technical memorandum affect multiple entities. It is recommended that representatives from Riverton City, Herriman City and Salt Lake County meet and jointly develop and approach to address the issues and recommendations indicated above.

APPENDIX A
SWCC RECOMMENDED IMPROVEMENTS

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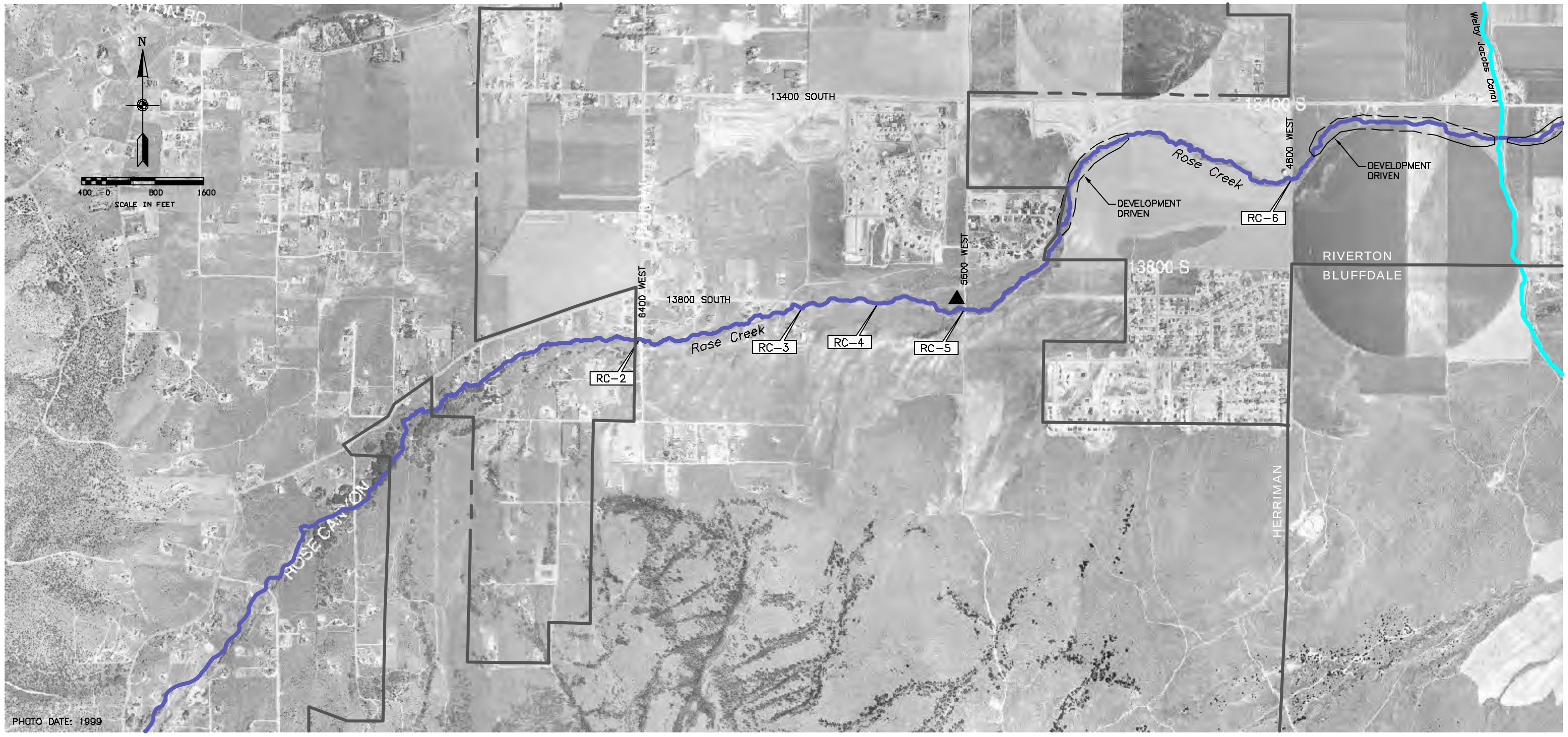

Facility ID	Existing Development: Estimated 100-year Peak Discharge	Future Development: Estimated 100-year Peak Discharge	Location	Estimated Hydraulic Capacity	Existing Drainage Facility	Photo	Recommended Improvements	Deficiency Level
RC-1	155 cfs	155 cfs	Rose Canyon near 8000 West(3)	~ 30 cfs(1)	36" CMP	RC_0490.JPG	60" RCP	I
RC-2	300 cfs	420 cfs	6400 West	500 cfs	72" RCP w/ concrete headwall	RC_0487.JPG		
RC-3	315 cfs	485 cfs	6000 West	700 cfs	60" RCP (2) w/ concrete headwall	RC_0485.JPG		
RC-4	315 cfs	485 cfs	5775 West	700 cfs	90" CMP	RC_0483.JPG		
RC-5	180 cfs	305 cfs	5600 West	200 cfs(2)	42" RCP w/ tapered inlet	RC_0447.JPG		
RC-6	235 cfs	380 cfs	4800 West	500 cfs	78" RCP w/ concrete headwall	RC_0113.JPG		

Notes:

(1) - Not modeled hydraulically. Estimated capacity based on open-channel flow using approximated slope of conveyance.

(2) - Detention basin outlet.

(3) - Not shown on map

Deficiency Level:

I - CAPACITY <= 50% of estimated 100-yr peak discharge for existing development

II - 50% of estimated 100-yr peak discharge for existing development < CAPACITY < 100% of estimated 100-yr peak discharge for existing development

III - 100% of estimated 100-yr peak discharge for existing development < CAPACITY < 85% of estimated 100-yr peak discharge for ultimate development

IV - Minor flooding for 100-yr peak discharge for ultimate development. No recommended improvement.

LEGEND

- CREEK
- CANAL
- CORPORATE CITY BOUNDARY
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL I
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL II AND III
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL IV OR NONE
- CHANNEL IMPROVEMENTS
- DETENTION BASIN

Figure 8-3A
ROSE CREEK
EXISTING DRAINAGE FACILITIES & RECOMMENDED IMPROVEMENTS

SOUTHWEST CANAL AND CREEK STUDY
Salt Lake County

Bowen Collins & Associates, Inc.

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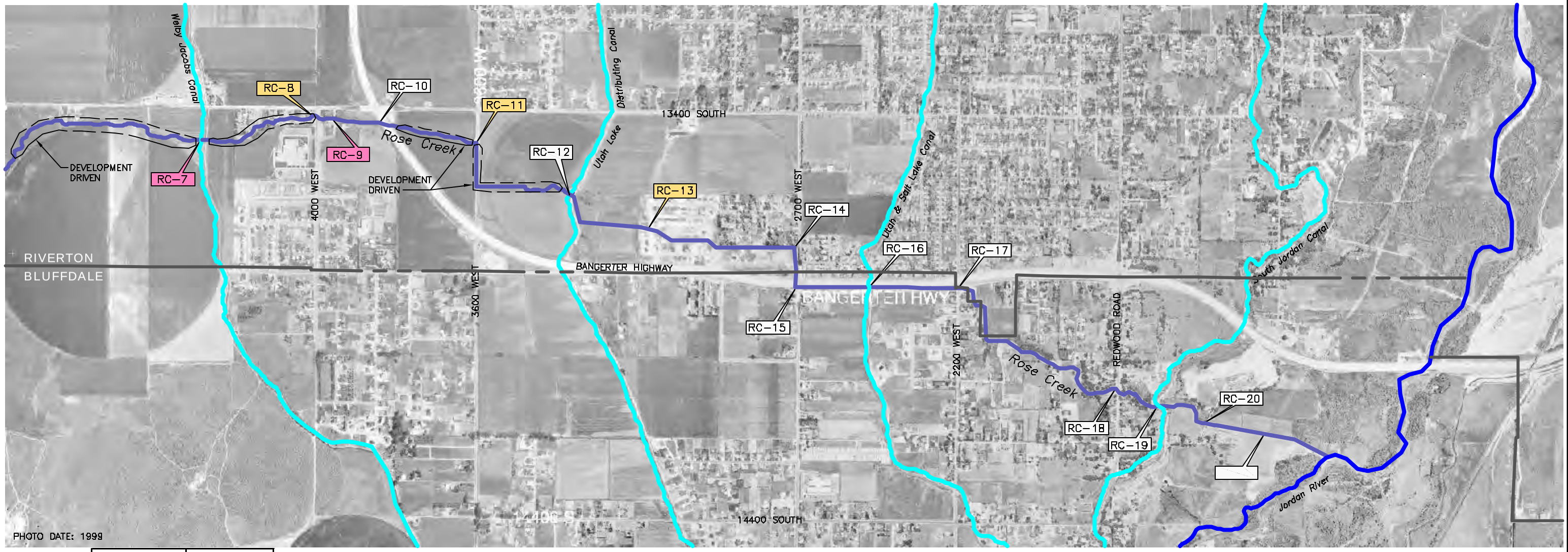

	Existing Development	Future Development						
Facility ID	**Estimated 100-year Peak Discharge**	**Estimated 100-year Peak Discharge**	**Location**	**Estimated Hydraulic Capacity**	**Existing Drainage Facility**	**Photo**	**Recommended Improvements**	**Deficiency Level**
RC-7	350 cfs	500 cfs	Welby Jacobs Canal Crossing	100 cfs	6' x 1.45' box culvert	RC_0117.JPG	Canal to be realigned and crossing replaced as part of development. 14' x 4' box culvert w/ headwall	I
RC-8	350 cfs	520 cfs	4000 West	250 cfs	6' x 5' box culvert	RC_0120.JPG	Add 6' x 5' box culvert w/ headwall; Improve approx. 1600' of channel from Welby Jacobs Canal to 4000 West	II
RC-9	350 cfs	520 cfs	Field east of 4000 West	~ 75 cfs(1)	Approximately 150' of 48" CMP in poor condition.	RC_0124.JPG	Remove pipe and restore channel	I
RC-10	350 cfs	520 cfs	Bangerter Highway	700 cfs	13' x 5' box culvert	RC_0491.JPG		
RC-11	350 cfs	520 cfs	3600 West	350 cfs	8' x 5' box culvert. Currently effectively 8' x ~ 3' with capacity ~ 100 cfs.	RC_0129.JPG	Replace with 10' x 5' box culvert w/ headwall(4)	III
RC-12	350 cfs	520 cfs	Utah Lake Distributing Canal Crossing	700 cfs	17' x 4.8' box culvert	RC_1318.JPG		
RC-13	385 cfs	575 cfs	3160 West	350 cfs	10' x 3.7' box culvert.	RC_0134.JPG	Replace with 14' x 5' box culvert w/ headwall	II
RC-14	385 cfs	575 cfs	13760 South	500 cfs	6' x 5' box culvert and 42" HDPE	RC_0492.JPG		IV
RC-15	385 cfs	575 cfs	Bangerter Highway	700 cfs	12' x 5.65' box culvert	RC_0493.JPG		
RC-16	385 cfs	575 cfs	Utah & Salt Lake Canal Crossing	500 cfs	8' x 5' box culvert.	RC_0495.JPG		IV
RC-17	385 cfs	585 cfs	2200 West	700 cfs	13' x 5.3' box culvert	RC_0498.JPG		
RC-18	385 cfs	585 cfs	Redwood Road	1000 cfs	10' x 6' box culvert	RC_0496.JPG		
RC-19	385 cfs	585 cfs	South Jordan Canal Crossing	700 cfs	10' x 4' box culvert	RC_0500.JPG		
RC-20	385 cfs	585 cfs	1300 West	650 cfs	10' x 6' box culvert	RC_0501.JPG		
RC-21	385 cfs	585 cfs	Field Box Culvert	650 cfs	10' x 6' box culvert	No photo		

Notes:

(1) - Not modeled hydraulically. Estimated capacity based on open-channel flow using approximated slope of conveyance.
(2) - Detention basin outlet.
(3) - Not shown on map.
(4) - Clean existing box.

Deficiency Level:

I - CAPACITY <= 50% of estimated 100-yr peak discharge for existing development
II - 50% of estimated 100-yr peak discharge for existing development < CAPACITY < 100% of estimated 100-yr peak discharge for existing development
III - 100% of estimated 100-yr peak discharge for existing development < CAPACITY < 85% of estimated 100-yr peak discharge for ultimate development
IV - Minor flooding for 100-yr peak discharge for ultimate development. No recommended improvement.

LEGEND

- CREEK
- CANAL
- CORPORATE CITY BOUNDARY
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL I
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL II AND III
- RC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL IV OR NONE
- CHANNEL IMPROVEMENTS
- DETENTION BASIN

N

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SCALE IN FEET

Figure 8-3B
ROSE CREEK
EXISTING DRAINAGE FACILITIES & RECOMMENDED IMPROVEMENTS
SOUTHWEST CANAL AND CREEK STUDY
Salt Lake County

Bowen Collins & Associates, Inc.

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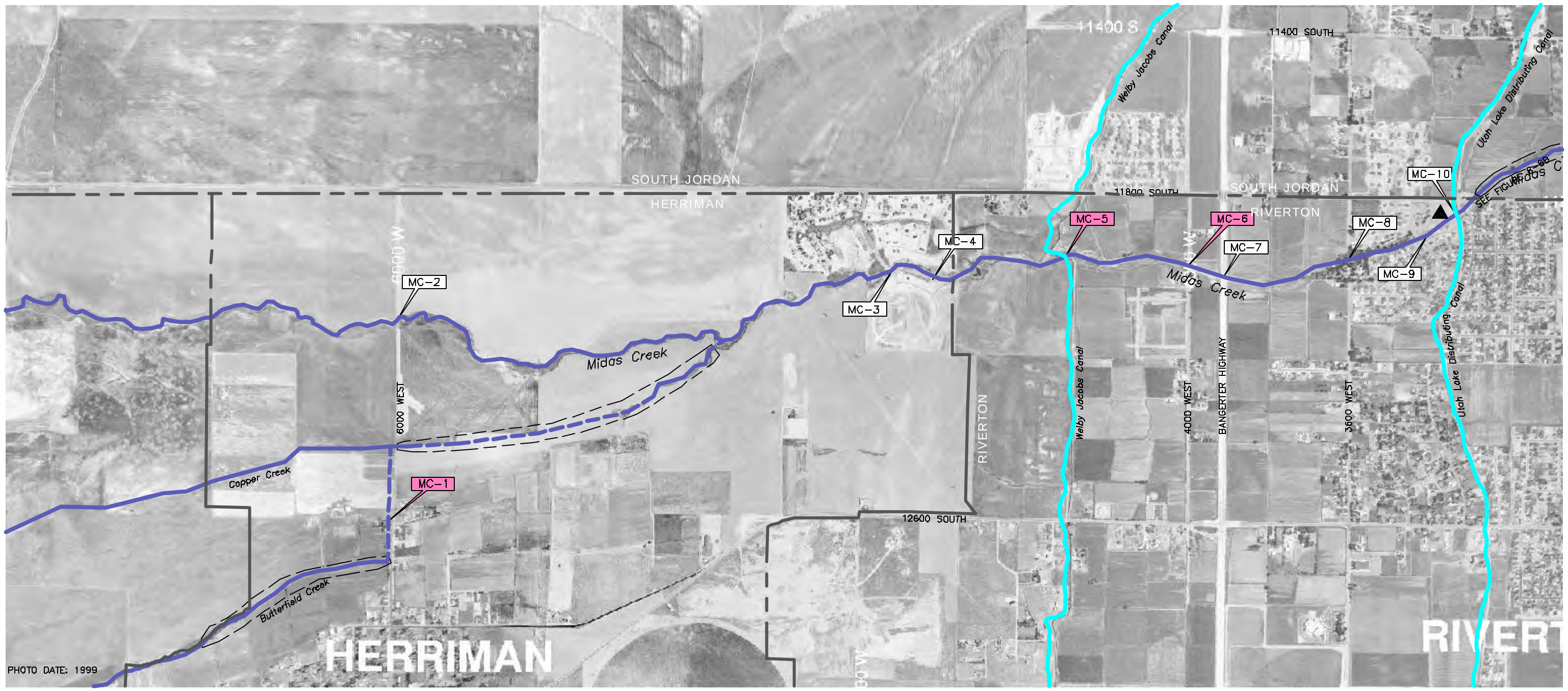

Facility ID	Existing Development Estimated 100-year Peak Discharge	Future Development Estimated 100-year Peak Discharge	Location	Estimated Hydraulic Capacity	Existing Drainage Facility	Photo	Recommended Improvements	Deficiency Level
MC-1	200 cfs	200 cfs	Butterfield Creek - 6000 West	NA	No existing storm drainage facility	MC_0553.JPG	Improve approximately 3500' of channel from 6400 West to 6000 West. Install approximately 2800' of 60" RCP along 6000 West to Copper Creek. Improve approx. 5700' of Copper Creek channel from 6000 West northeast to Midas Creek.	I
MC-2	520 cfs	620 cfs	6000 West	1000 cfs(1)	10' x 9' bridge	MC_0554.JPG		
MC-3	520 cfs	805 cfs	Midas Vista Road - 4720 West	900 cfs	10' x 6' box culvert	MC_0556.JPG		
MC-4	520 cfs	805 cfs	Park Haven Lane - 4510 West	1500 cfs	17' x 7.35' bridge	MC_0559.JPG		
MC-5	520 cfs	805 cfs	Welby Jacobs Canal Crossing	100 cfs	3.5' x 2.5' arch	MC_0561.JPG	Replace with 14' x 4' box culvert w/ headwall	I
MC-6	520 cfs	810 cfs	4000 West	150 cfs	48" RCP w/ headwall	MC_0562.JPG	Replace with 14' x 6' box culvert w/ headwall	I
MC-7	520 cfs	810 cfs	Bangerter Highway	1500 cfs	18' x 9.65' bridge	MC_0566.JPG		
MC-8	520 cfs	810 cfs	3600 West	780 cfs	72" CMP (2) w/ concrete headwall	MC_0568.JPG		IV
MC-9	520 cfs	810 cfs	Janice Drive - 3400 West	950 cfs	19' x 5.9' bridge	MC_0570.JPG		
MC-10	520 cfs	770 cfs	Utah Lake Distributing Canal Crossing	500 cfs(2)	60" RCP (2)	MC_0575.JPG		

Notes:

(1) - Not modeled hydraulically. Estimated capacity based on open-channel flow using approximated slope of conveyance.

(2) - Detention basin outlet.

Deficiency Level:

I - CAPACITY <= 50% of estimated 100-yr peak discharge for existing development

II - 50% of estimated 100-yr peak discharge for existing development < CAPACITY < 100% of estimated 100-yr peak discharge for existing development

III - 100% of estimated 100-yr peak discharge for existing development < CAPACITY < 85% of estimated 100-yr peak discharge for ultimate development

IV - Minor flooding for 100-yr peak discharge for ultimate development. No recommended improvement.

LEGEND

- CREEK
- CANAL
- CORPORATE CITY BOUNDARY
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL I
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL II AND III
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL IV OR NONE
- CHANNEL IMPROVEMENTS
- DETENTION BASIN

N

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SCALE IN FEET

Figure 8-6A
MIDAS CREEK
EXISTING DRAINAGE FACILITIES & RECOMMENDED IMPROVEMENTS

SOUTHWEST CANAL AND CREEK STUDY
Salt Lake County

Bowen Collins & Associates, Inc.
Consulting Engineers

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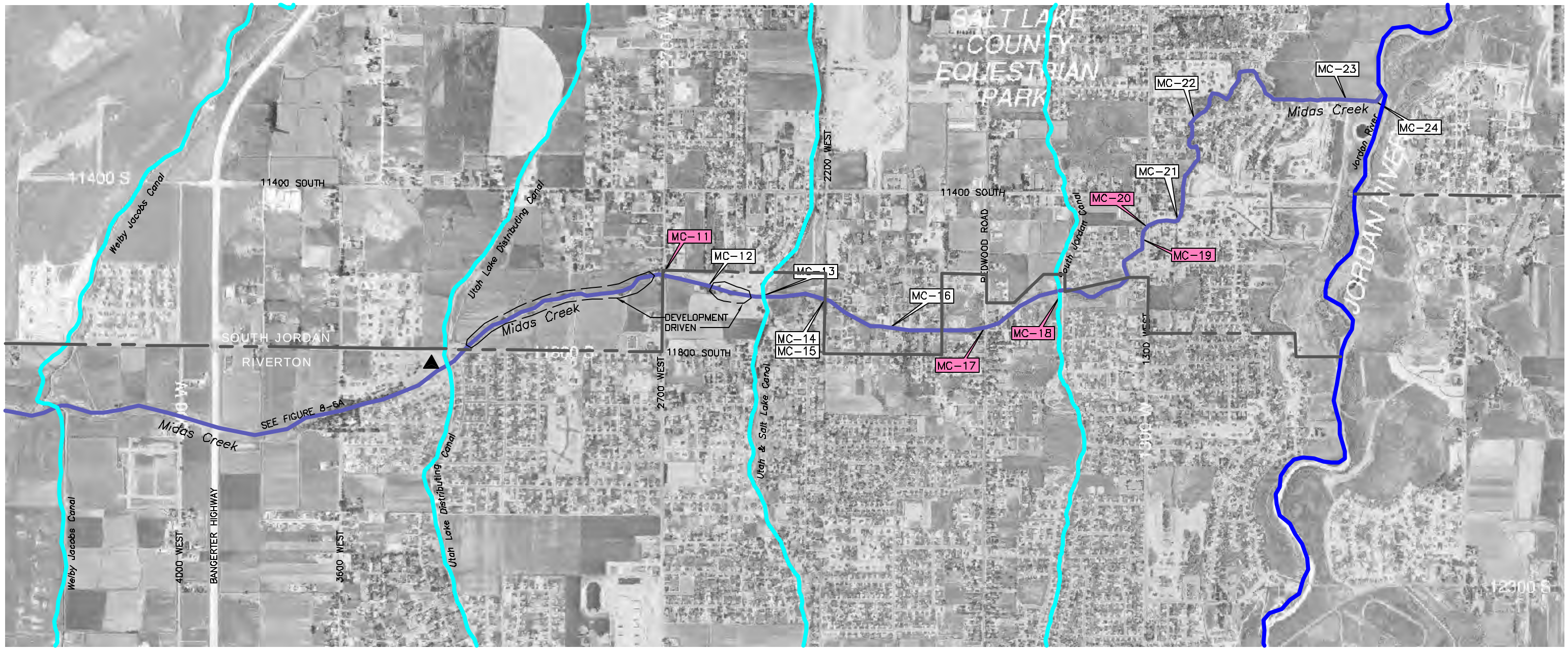

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Facility ID	Existing Development Estimated 100-year Peak Discharge	Future Development Estimated 100-year Peak Discharge	Location	Estimated Hydraulic Capacity	Existing Drainage Facility	Photo	Recommended Improvements	Deficiency Level
MC-11	520 cfs	830 cfs	2700 West	120 cfs	42" CMP	MC_0579.JPG	Replace with 12' x 6' box culvert w/ headwall	I
MC-12	520 cfs	830 cfs	11625 South	1500 cfs	19' x 7' box culvert	MC_0599.JPG		
MC-13	520 cfs	830 cfs	Utah & Salt Lake Canal Crossing	1000 cfs	10' x 6.85' bridge	MC_0600.JPG		
MC-14	520 cfs	865 cfs	Eureka Way - 2150 West	870 cfs	8' x 6' box culvert (2)	MC_0601.JPG		
MC-15	520 cfs	865 cfs	Eureka Way - 2150 West	650 cfs	66" RCP (2)	No photo		IV
MC-16	520 cfs	865 cfs	Gold Dust Drive - 1995 West	780 cfs	9' x 5' box culvert (2)	MC_0602.JPG		IV
MC-17	520 cfs	865 cfs	Redwood Road	200 cfs	7' x 2.4' box culvert	MC_0605.JPG	Replace with 10' x 5' box culvert (2) w/ headwall	I
MC-18	520 cfs	865 cfs	South Jordan Canal Crossing	200 cfs	6' x 1.5' box culvert	MC_0607.JPG	Replace with 12' x 4' box culvert w/ headwall	I
MC-19	520 cfs	865 cfs	11500 South	200 cfs	13.5' x 2.5' bridge	MC_0612.JPG	Replace with 14' x 6' bridge.	I
MC-20	520 cfs	865 cfs	1300 West	200 cfs	60" RCP w/ concrete headwall	MC_0614.JPG	Replace with 14' x 5' box culvert w/ headwall	I
MC-21	520 cfs	865 cfs	11460 South	1500 cfs	21' x 9' bridge	MC_0617.JPG		
MC-22	520 cfs	865 cfs	Park Palisade Drive - 11205 South	1000 cfs	15' x 5' bridge	MC_0621.JPG		
MC-23	520 cfs	865 cfs	River Front Parkway	1500 cfs	13' x7' box culvert (2)	MC_0624.JPG		
MC-24	520 cfs	865 cfs	Jordan River Parkway Trail	1500 cfs	13' x 7' box culvert (2)	MC_0627.JPG		

Notes:

(1) - Not modeled hydraulically. Estimated capacity based on open-channel flow using approximated slope of conveyance.

(2) - Detention basin outlet.

Deficiency Level:

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IV - Minor flooding for 100-yr peak discharge for ultimate development. No recommended improvement.

LEGEND

- CREEK
- CANAL
- CORPORATE CITY BOUNDARY
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL I
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL II AND III
- MC-3 HYDRAULIC STRUCTURE ID – DEFICIENCY LEVEL IV OR NONE
- CHANNEL IMPROVEMENTS
- DETENTION BASIN

N

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SCALE IN FEET

Figure 8-6B
MIDAS CREEK
EXISTING DRAINAGE FACILITIES & RECOMMENDED IMPROVEMENTS
SOUTHWEST CANAL AND CREEK STUDY
Salt Lake County

Bowen Collins & Associates, Inc.

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APPENDIX B
TIME OF CONCENTRATION WORKSHEET

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TR 55 Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Herriman SDMP Designed By: K. Ballentine Date: _____

Location: Herriman City Checked By: C. Bagley Date: _____

Check one: ☐ Present ☑ Developed

Check one: ☑ T_c ☐ T_t ☐ through subarea _____

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to T_c only)	Segment ID				
1. Surface description (Table 3-1)					
2. Manning's roughness coeff., n (Table 3-1)					
3. Flow length, L (total L ≤ 100 ft) ..... ft					
4. Two-year 24-hour rainfall, P_2..... in					
5. Land slope, s ..... ft/ft					
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t ..... hr		+		=	

Shallow Concetrated Flow	Segment ID				
7. Surface description (paved or unpaved)					
8. Flow length, L ..... ft					
9. Watercourse slope, s ..... ft/ft					
10. Average velocity, V (Figure 3-1) ..... ft/s					
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr		+		=	

Channel Flow	Segment ID		
12. Cross sectional flow area, a ..... ft^2			
13. Wetted perimeter, P_w ..... ft			
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r ..... ft			0.4
15. Channel Slope, s ..... ft/ft			
16. Manning's Roughness Coeff., n			
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V ..... ft/s	5.2		5.2
18. Flow length, L ..... ft			
19. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr		+		=	

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19 ..... hr

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APPENDIX C
CONCEPTUAL COST ESTIMATE

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Table C-1
Conceptual Cost Estimate Unit Cost Summary
Herriman Storm Drainage Master Plan

Description	Unit	Unit Cost[1]
Detention Basins		
Property Acquisition	Acre	$115,000
Excavation and Hauling	Cubic Yard	$13
Landscaping (Irrigated Turfgrass)	Square Foot	$3.00
Inlet Structure	Lump Sum	$14,000
Outlet Structure	Lump Sum	$16,000
SCADA & Actuators	Lump Sum	$25,000
Emergency Spillway	Lump Sum	$5,000
Storm Drain Pipelines		
Permanent Easement Acquisition	Acre	$11,500
18-inch RCP	Linear Foot	$90
24-inch RCP	Linear Foot	$100
30-inch RCP	Linear Foot	$120
36-inch RCP	Linear Foot	$145
42-inch RCP	Linear Foot	$180
48-inch RCP	Linear Foot	$215
Manhole	Each	$4,000
Catch Basin	Each	$2,800
Asphalt	Square Yard	$42
Channel Construction		
Excavation and Hauling	Cubic Yard	$13
Riprap	Cubic Yard	$75
Other		
Contingency	20 Percent of Construction Cost	
Engineering, Legal, and Administration	15 Percent of Construction Cost w/ Contingency	

(1) - Costs are in 2012 Dollars

Table C-2
Pipes
Conceptual Cost Estimate Summary
Herriman Storm Drainage Master Plan

Project Identifier	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Asphalt Road Repair (sq yd)[1]	ENG., Legal, Admin. (15%) Contingencies (20%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
P 1	1,182	36	4	4	1,618	$ 93,277	$ 359,785
P 2	131	42	0	1	0	$ 9,623	$ 37,118
P 3	108	36	0	1	0	$ 6,877	$ 26,526
P 4	1,104	48	4	4	0	$ 92,607	$ 357,199
P 5	3,553	42-48	16	12	5,073	$ 330,891	$ 1,276,292
P 6	3,088	36	14	11	0	$ 185,847	$ 716,837
P 7	3,654	48	18	13	0	$ 310,787	$ 1,198,750
P 8	3,338	30	16	12	0	$ 172,672	$ 666,021
P 9	2,805	18	14	10	0	$ 116,065	$ 447,678
P 10	548	24	2	2	0	$ 23,930	$ 92,301
P 11	1,882	18	8	7	0	$ 76,926	$ 296,716
P 12	2,103	18	10	8	0	$ 87,245	$ 336,515
P 13	909	36	4	4	0	$ 55,634	$ 214,590
P 14	1,186	24	4	4	0	$ 51,027	$ 196,819
P 15	1,797	24	8	6	0	$ 79,130	$ 305,216
P 16	649	18	2	3	0	$ 26,607	$ 102,628
P 17	2,069	24	10	7	0	$ 92,000	$ 354,858
P 18	1303	36	6	5	0	$ 79,028	$ 304,821
P 19	1,460	42	6	5	0	$ 104,838	$ 404,377
P 20	1,093	24	4	4	0	$ 47,770	$ 184,255
P 21	1,094	36	4	4	1,498	$ 87,067	$ 335,829
P 22	2,415	36-42	12	9	3,385	$ 157,763	$ 608,514
P 23	956	42	4	4	1,366	$ 89,850	$ 346,562
P 24	2,499	24	12	9	2,915	$ 154,660	$ 596,546
P 25	1,604	30	8	6	1,994	$ 112,901	$ 435,475
P 26	2,514	18	12	9	1,117	$ 119,983	$ 462,793
P 27	1,165	30	4	4	1,449	$ 79,746	$ 307,594
Total Cost	-	-	-	-	-	-	$ 10,972,611

[1] Asphalt is Only Needed On Existing Roads

Table C-3
Detention Basins
Conceptual Cost Estimate Summary
Herriman Storm Drainage Master Plan

CFP ID	Volume (Ac-ft)	Area (acres)	Excavation and Hauling	Landscaping	Inlet Apron	Outlet Structure	Emergency Spillway	SCADA & Actuators	Land Acquisition	Eng, Legal, Admin, Contingency (35%)	Total
DB 1[1]	3.0	1.4	$ 31,533	$ 182,952	$ 14,000	$ 16,000	$ 5,000	$ 25,000	-	$ 96,100	**$ 370,600**
DB 2	11.0	4	$ 300,538	$ 522,720	$ 14,000	$ 16,000	$ 5,000	$ 25,000	$ 460,000	$ 470,100	**$ 1,813,400**
DB 3	23.9	9.0	$ 651,644	$ 1,176,120	$ 14,000	$ 16,000	$ 5,000	$ 25,000	$ 1,035,000	$ 1,023,000	**$ 3,945,800**
DB 4[1]	3.4	1.3	$ 35,728	$ 169,884	$ 14,000	$ 16,000	$ 5,000	$ 25,000	-	$ 93,000	**$ 358,600**
DB 5[1]	7.3	2.8	$ 76,711	$ 365,904	$ 28,000	$ 16,000	$ 5,000	$ 25,000	-	$ 180,800	**$ 697,400**
Total Cost	-	-	-	-	-	-	-		-	-	**$ 7,185,800**

[1] Existing Detention Facility

Table C-4
Open Channels
Conceptual Cost Estimate Summary
Herriman Storm Drainage Master Plan

Project Identifier	Channel Length (ft)	Assumed Bottom Width (ft)[1]	Assumed Channel Depth (ft)[1]	Easement Area (acres)[2]	Excavation (cu yds)	Riprap (cu yd)[3,5]	Landscaping (sq ft)	ENG., Legal, Admin. (15%) Contingencies (20%)	Estimated Project Cost (includes Contingency, Engineering, Admin, and Legal Fees)
OC 1	2,005	3	4	1.8	3,504	1,774	0	$ 69,722	$ 268,929
OC 2	2,158	3	4	1.9	3,773	1,910	0	$ 75,076	$ 289,580
OC 3	1,657	3	4	1.5	2,896	1,466	0	$ 57,623	$ 222,262
OC 4	2,069	3	4	1.9	3,617	1,831	0	$ 71,965	$ 277,581
OC 5[4]	2,735	3	5	2.7	7,091	0	69,361	$ 115,959	$ 447,271
OC 6	2,406	3	4	2.2	4,207	2,129	0	$ 83,704	$ 322,858
OC 7[4]	3,068	3	5	3.0	7,955	0	77,812	$ 130,087	$ 501,762
OC 8	4,364	3	4	3.9	7,629	3,861	0	$ 151,792	$ 585,482
OC 9	2,859	3	4	2.6	4,997	2,529	0	$ 99,427	$ 383,504
OC 10	1,804	3	4	1.6	3,154	1,596	0	$ 62,748	$ 242,027
OC 11	2,023	3	4	1.8	3,536	1,789	0	$ 70,349	$ 271,348
OC 12	544	3	4	0.5	951	482	0	$ 18,930	$ 73,017
OC 13	633	3	4	0.6	1,107	560	0	$ 22,019	$ 84,929
OC 14	677	3	4	0.6	1,183	599	0	$ 23,545	$ 90,818
OC 15	1,343	3	4	1.2	2,347	1,188	0	$ 46,697	$ 180,117
OC 16	3,879	3	4	3.5	6,780	3,432	0	$ 134,909	$ 520,364
OC 17[4]	3,811	5	6	4.3	15,413	0	121,315	$ 214,766	$ 828,385
OC 18	3,185	3	4	2.9	5,567	2,818	0	$ 110,768	$ 427,246
OC 19[4]	2,339	10	6	2.9	12,057	0	86,136	$ 156,970	$ 605,455
OC 20	1,433	3	4	1.3	2,506	1,268	0	$ 49,858	$ 192,310
OC 21	3,058	3	5	3.0	7,929	3,719	0	$ 145,855	$ 562,583
Total Cost	-	-	-	-	-	-	-	-	$ 7,377,827

[1] Minimum Bottom Width is 3 ft, Minimum Channel Depth is 4 ft, Side Slope 2:1

[2] Easement Width is the Width of the Channel with an Additional 20 ft for Access Road.

[3] Riprap Depth is 2 ft

[4] Riprap Not Needed - Maximum Channel Velocities Less Than 4 ft/s

[5] Assumed That No Riprap is place on the Top 2 Feet of Channel Bank

APPENDIX D
TOWNE CENTER REPORT

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HERRIMAN TOWNE CENTER

Utility Master Plan Report

Includes: Storm Drain, Sewer, Culinary & Secondary Water

Prepared for:

ROSECREST

4393 Riverboat Road, #450
Salt Lake City, Utah 84123
(801) 461-9700
(801) 461-9723 fax

Prepared by:

DOMINION
Engineering Associates, L.C.

5684 S. Green Street
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SEPTEMBER 2008

HERRIMAN TOWNE CENTER

UTILITY MASTER PLAN REPORT

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Overview

Scope of Services

Dominion Engineering completed the following scope of services for the Herriman Towne Center Development prepared for Rosecrest Inc. This work was preformed from March 2008 to August 2008. Master Plans where created from Concept Plans, Land Use Plans and Phasing Plans provided by Rosecrest Inc. and included in this report.

Storm Drain Master Plan

Identify storm runoff peak flow & volumes for the 2, 10 and 100 year 24 hour storm events for the Herriman Towne Center development. Coordinate with Herriman City to incorporate the overall development plan into their proposed storm drain master plan. Evaluate proposed discharge points and improvements that will need to be implemented. Evaluate the drainage basins using the SCS and Farmer Fletcher rain fall data method to determine peak flow rates and times of concentration for storm water runoff. Develop a model to evaluate the storm water runoff and the proposed drainage system. Use the developed model to evaluate and verify the proposed size and locations of detention basins, outlet works, and storm drain pipe. Evaluate water quality issues that relate to storm runoff to include erosion control measures during construction and mitigation measures to be in place upon completion of the development that will be as good as or better than existing conditions.

Sewer Master Plan

Calculate sanitary sewer flows based on the State of Utah, Department of Environmental Quality, and South Valley Sewer District (SVSD) requirements. Coordinate with SVSD to incorporate the overall development plan into their proposed sewer master plan. The proposed road alignments from the Conceptual Master Plan will be used to layout a sanitary sewer collection system pipe network. Coordinate with SVSD to obtain their input on the system layout and incorporate their suggestions. Develop a sanitary sewer model that will evaluate the peak day sanitary sewer flows for the Conceptual Master Plan.

Culinary and Secondary Water Master Plan

Culinary:

Calculate indoor and outdoor culinary water peak day and peak instantaneous demands based on the State of Utah, Division of Drinking Water, and Herriman City requirements. Indoor and outdoor water source and storage requirements will also be calculated using the required standards. Coordinate with Herriman City to incorporate the overall development plan into their proposed water master plan. The proposed road alignments from the Conceptual Master Plan will be used to layout a water distribution system pipe network. Coordinate with Herriman City to obtain their input on the system layout and incorporate their suggestions. Develop a water model that will evaluate the peak day indoor and outdoor demands with fire flow and the peak instantaneous indoor and outdoor demands.

Secondary:

Identify secondary water demands for Herriman Town Center. Using the Conceptual Master Plan (landscaped area), develop a proposed secondary water distribution system model. Coordinate with Herriman City to incorporate the overall development plan into their proposed secondary water master plan. The model will evaluate the peak landscape watering demands for the "build out" scenario of the Herriman Town Center development. Peak instantaneous demands will be evaluated to ensure that proposed main trunk line sizes are adequate. It is assumed that the master plan will include areas inclusive of the site and will not address any off-site mains necessary to connect secondary water to the proposed site.

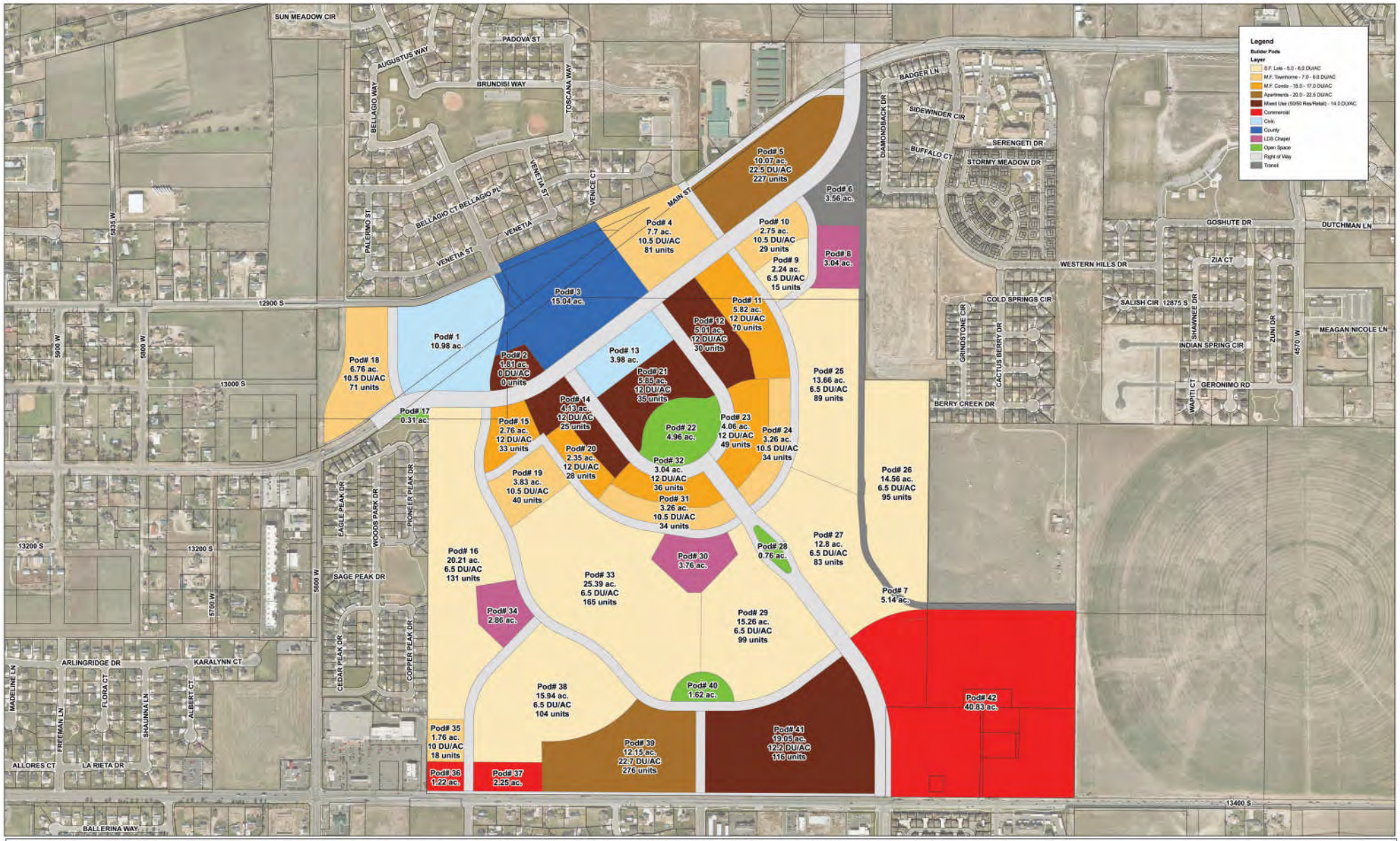
HERRIMAN TOWN CENTER

Conceptual Site Plan
(Yield and Lot Study)
06.23.08

SITE SUMMARY

LAND USE	Ac.	DENISTY	D.U.
Single Family Detached			
35'-40'x100+'	30.0	6 du/ac	180 (8%)
42'-50'x100+'	78.6	4.8 du/ac	377 (18%)
Townhomes	41.6	10 du/ac	416 (20%)
Condo	29.1	14 du/ac	351 (17%)
Apartments	22.8	22 du/ac	501 (25%)
Subtotal	198.1ac*		1825 du
Commercial/Retail	45.25		
Mixed Use (assumes 50/50 split commercial/condo)	31.6	14 du/ac	221 (11%)
Church	10.5		
School	9.1		
Recreation Center	11.8		
Transit	4.6		
Town Center Core	9.0		
Town Center Park	5.75		
Parks/Open Space	6.5		
Misc (Arterial ROW, transit corridor)	45.1		
TOTAL	377.1 ac*		2056 du

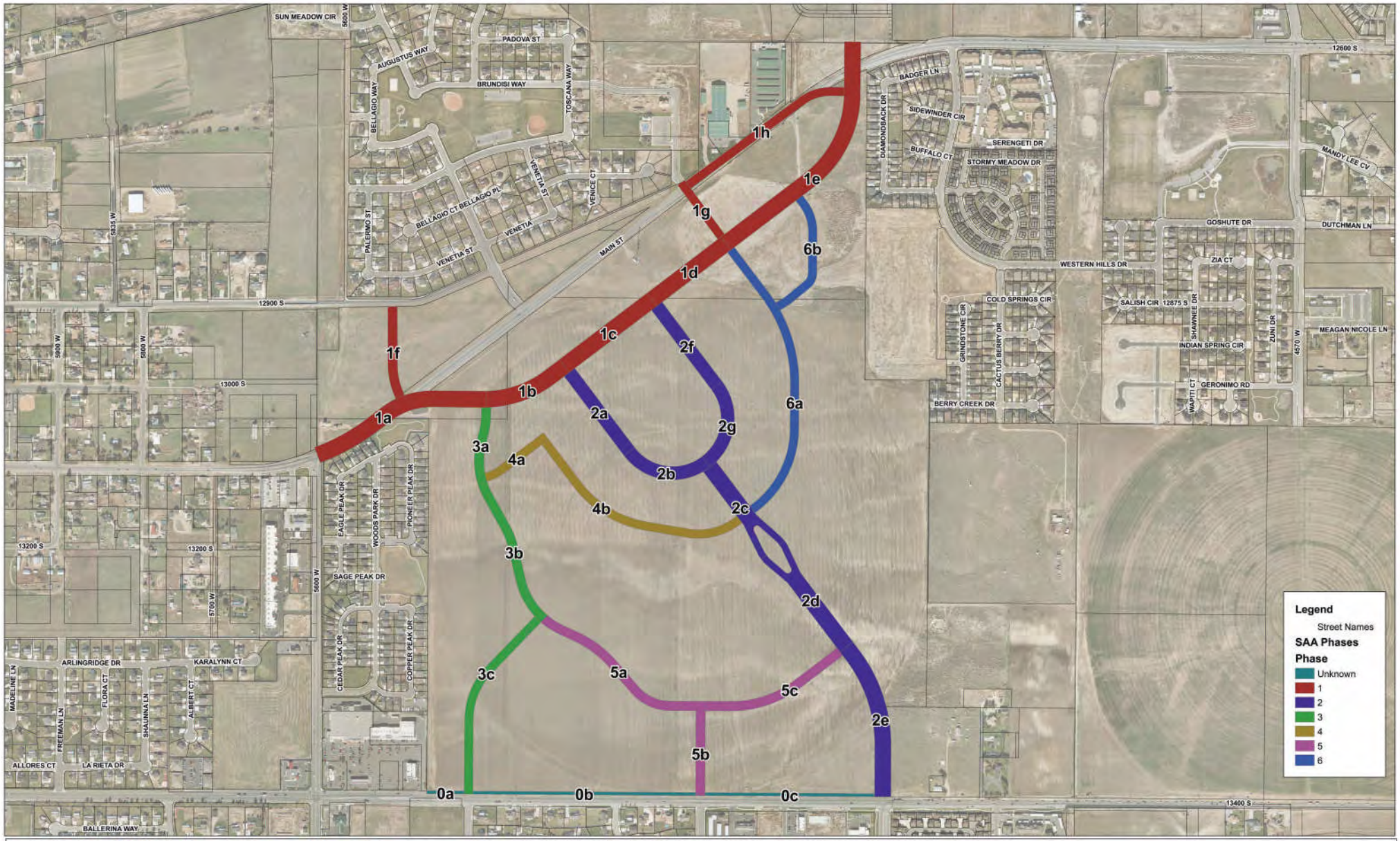
*includes major road ROWs



The Sorenson Group

HERRIMAN TOWNE CENTER

0 500 1,000 2,000 Feet



The Sorenson Group

HERRIMAN TOWNE CENTER

SAA Phasing

0 500 1,000 2,000 Feet

I. Project Description and Location SD-2

II. Existing Physical Conditions SD-3

III. Proposed Development Conditions and Design Criteria SD-4

IV. Methodology SD-5

V. Results SD-8

Exhibit SD-1 (Storm Drain Master Plan) SD-9

Exhibit SD-2 (Storm Drain Master Plan Details) SD-10

Storm Drain Cost Estimate SD-11

Storm Drain Appendix SD-13

I. Project Description and Location

Rosecrest, INC. is proposing to develop approximately 371 acres in Herriman City, Utah in Salt Lake County between 12600 South and 13400 South and 4800 West and 5600 West. The project will ultimately consist of a mixed land use including residential, commercial, publicly-owned buildings and open space.

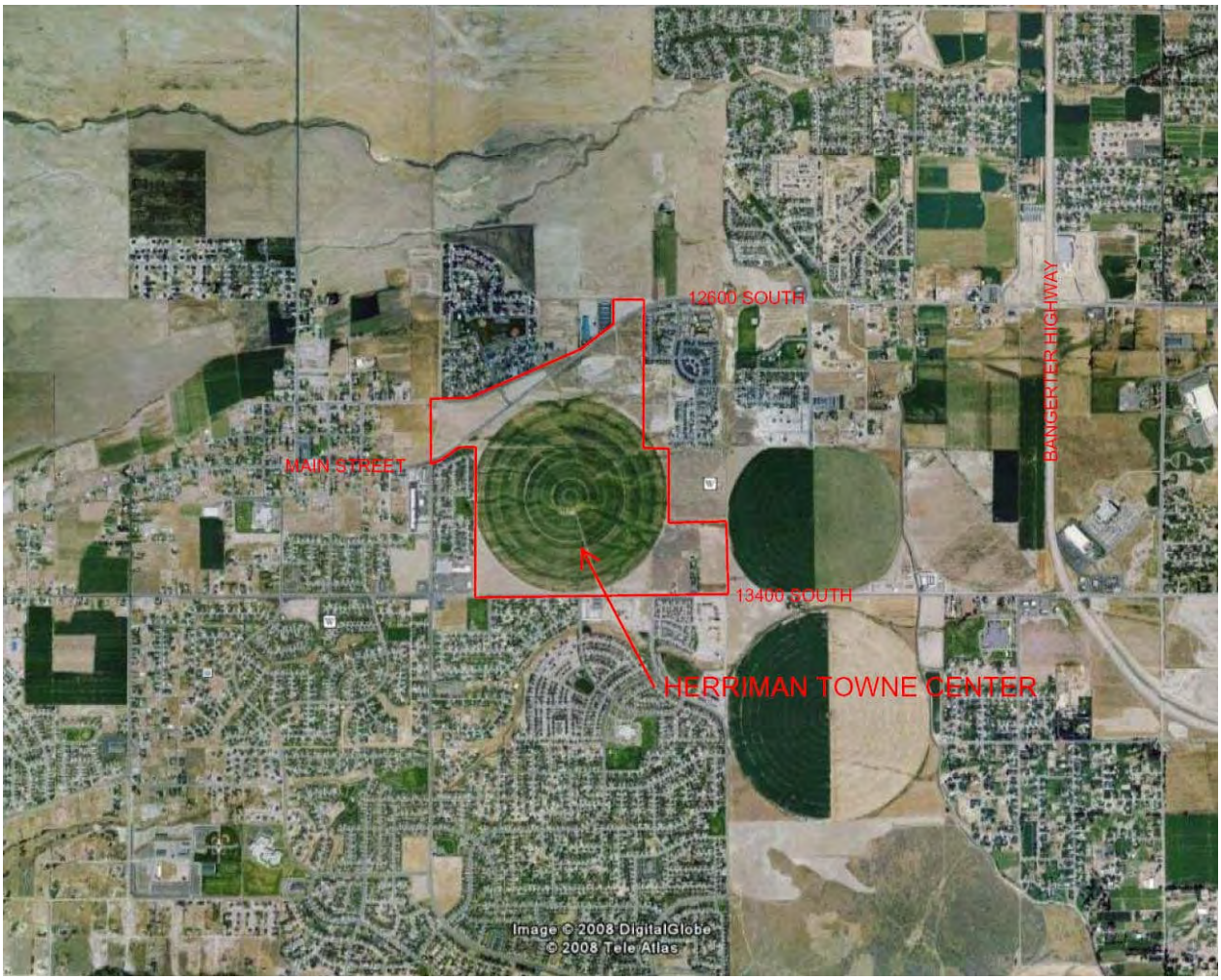


Figure 1: Vicinity Map

II. Existing Physical Conditions

As stated previously the development area for the Herriman Towne Center is approximately 371 acres. The majority of the project area has historically been used for agricultural purposes. A large portion of the project area is covered by active crops irrigated from a well located on property. The remaining portion appears to consist of native grasses and vegetation. Existing drainage patterns flow from the northwest to southeast with the receiving waters being Rose Creek. Storm water flows from the Tuscany Estates subdivision north of Herriman Towne Center currently drains storm water onto the north portion of the Towne Center. All other adjacent properties are planned to route flows away from the Towne Center. The development area ranges in elevation from approximate 4780 feet (USGS datum) near the southeastern portion of the project to approximately 4880 feet near the northwestern portion. There are no existing major drainage ways or existing storm drainage facilities running through the property. It is our understanding that there are no existing irrigation facilities within or running thru this proposed development with the exception of the aforementioned well.

III. Proposed Development Conditions and Design Criteria

The proposed land use for this area will consist of residential, commercial, publicly-owned buildings and open space. Pipe culvert sizing and detention areas were designed for the applicable 10-year storm event as directed by Herriman City. In order to meet Herriman City's storm water release rate criteria, the Herriman Towne Center drainage basin was divided into eight separate sub-basins, with localized detention provided for each sub-basin. (See Exhibit SD-1) Sub-basin delineation was determined by the surface area draining to each localized detention pond. The release rate from each localized detention basin was limited to 0.2 cfs per acre for the 10-year event. A minimum of one-foot of freeboard from the 10-year stage peak was provided on each detention pond.

For storm events greater than the 10-yr storm, minor street flooding is expected to occur. The development master plans included in this report are general and schematic in nature and subject to future modification. As final platting occurs, modeling and design of the drainage system will be updated and submitting to the city for approval. The final design should insure that all future buildings and structures are protected and only minor street flooding for storm events greater than the 10-yr event.

The northern-most 91.1 acre sub-basin labeled as the Midas Creek Sub Basin is designed to have storm flows collected and routed thru a large detention pond located near the northeast corner of the development. From this detention basin flows will outlet into a piped system in 12600 South and continues east with an ultimate outfall to Midas Creek. Storm water generated from the existing Tuscany Estates subdivision that is currently retained near the north portion of the Towne Center property will be collected into a piped system and routed through the Midas Creek Sub-Basin.

The remaining seven southern most sub-basins vary in size from 21.0 acres to 58.7 acres. As depicted on Exhibit SD-2 several of the localized detention ponds are routed in series before leaving the site near the southeastern corner of the Towne Center. From this location the system drains into a piped system in 13400 South and flows east until it discharges into Rose Creek.

IV. Methodology

The Soil Conservation Service TR-55 SCS Curve Number Method was used to determine peak storm flow runoff rates. Rainfall depths for the 10-yr and 100-yr storm events were taken from the Herriman City standards and are presented below.

Herriman City Rainfall Data

Minutes	10-year Depth (in)	100-year Depth (in)
15	0.55	0.89
30	0.7	1.24
60	0.88	1.46
360	1.37	1.90
720	1.64	2.32
1440	1.86	2.57

As directed by Herriman City, the Farmer-Fletcher Rainfall Distribution was used to develop the storm hydrographs. The Farmer-Fletcher Rainfall Distribution was developed to provide a more accurate representation of storm events experienced in Utah. The study found that the storm events in Utah typically exhibit a high intensity rainfall burst. The one hour rainfall burst for a 10-yr storm event is shown in the table below.

1-hr Burst 10-year F/F Distribution

Time (min)	Total Depth (%)	1-hr 10yr Depth (in.)	15-min Inc. (in.)
5	28.5	0.2508	
10	51	0.4488	
15	66.7	0.5870	0.5870
20	76.7	0.6750	
25	82.7	0.7278	
30	87.3	0.7682	0.1813
35	90.7	0.7982	
40	93.3	0.8210	
45	95.3	0.8386	0.0704
50	97.1	0.8545	
55	98.7	0.8686	
60	100	0.8800	0.0414

Pipe and detention ponds were sized from the largest generated flow from evaluating the 10-year 2, 3, 6, 12, and 24-hour storm events. The rainfall distribution for the 12-hr storm event is shown in Figure 2.

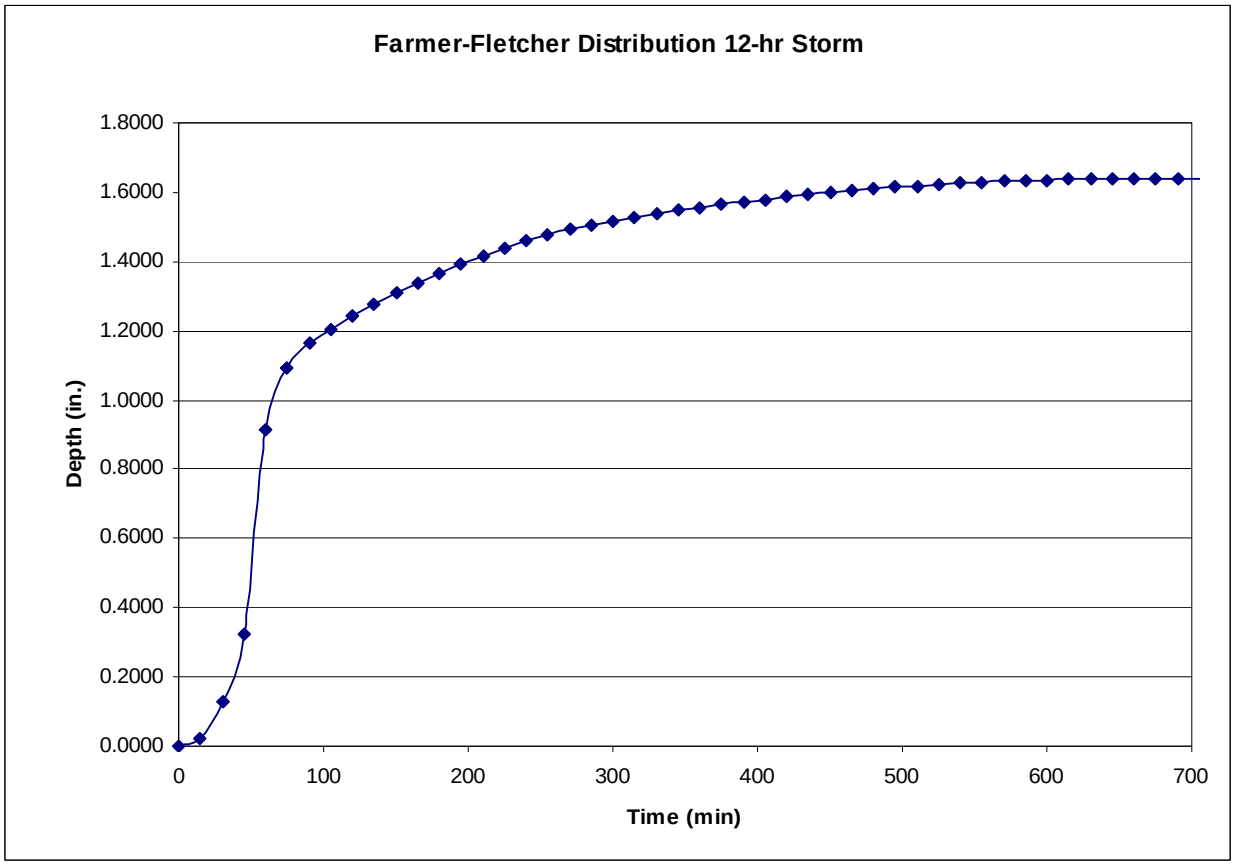


Figure 2: Farmer-Fletcher Rainfall Distribution

The hydrologic soil group maps created by the Natural Resource Conservation Service showed the soils in this area to be broken up into sections of group B, C, and D. GeoStrata Engineering and Geosciences sampled soils throughout the development area and presented their results in an April 30, 2008 report prepared for Rosecrest. Based upon the bore samples, they recommended classifying the soils as Type C soils for all sub-basin curve number determinations. Curve Numbers were developed for each sub-basin considering soil type and future land use as provided by Rosecrest using the following table from TR-55.

Table 2-2a Runoff curve numbers for urban areas [1]

Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94	
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

For sizing the detention ponds, storm flows were routed using the Storage Indication Method. Time of concentrations were calculated following the method as outlines in TR-55. HydroCAD was used to calculate sub basin flows and for detention pond sizing, configuration, and control works. Pipe culvert sizing was accomplished by using StormCAD using the generated peak flows from HydroCAD modeling.

V. Results

Final pipe culvert sizes and detention volumes are presented on Exhibit SD-1. Pipes sizes vary from Herriman's 18-inch minimum up to 42-inches.

The 10-yr 12-hr storm generated the highest peak runoff for both Midas Creek and Rose Creek sub basins. The results of the total peak runoff from the Midas Creek sub basin to the detention pond are demonstrated in the following table.

Midas Creek Sub Basin Peak Flows

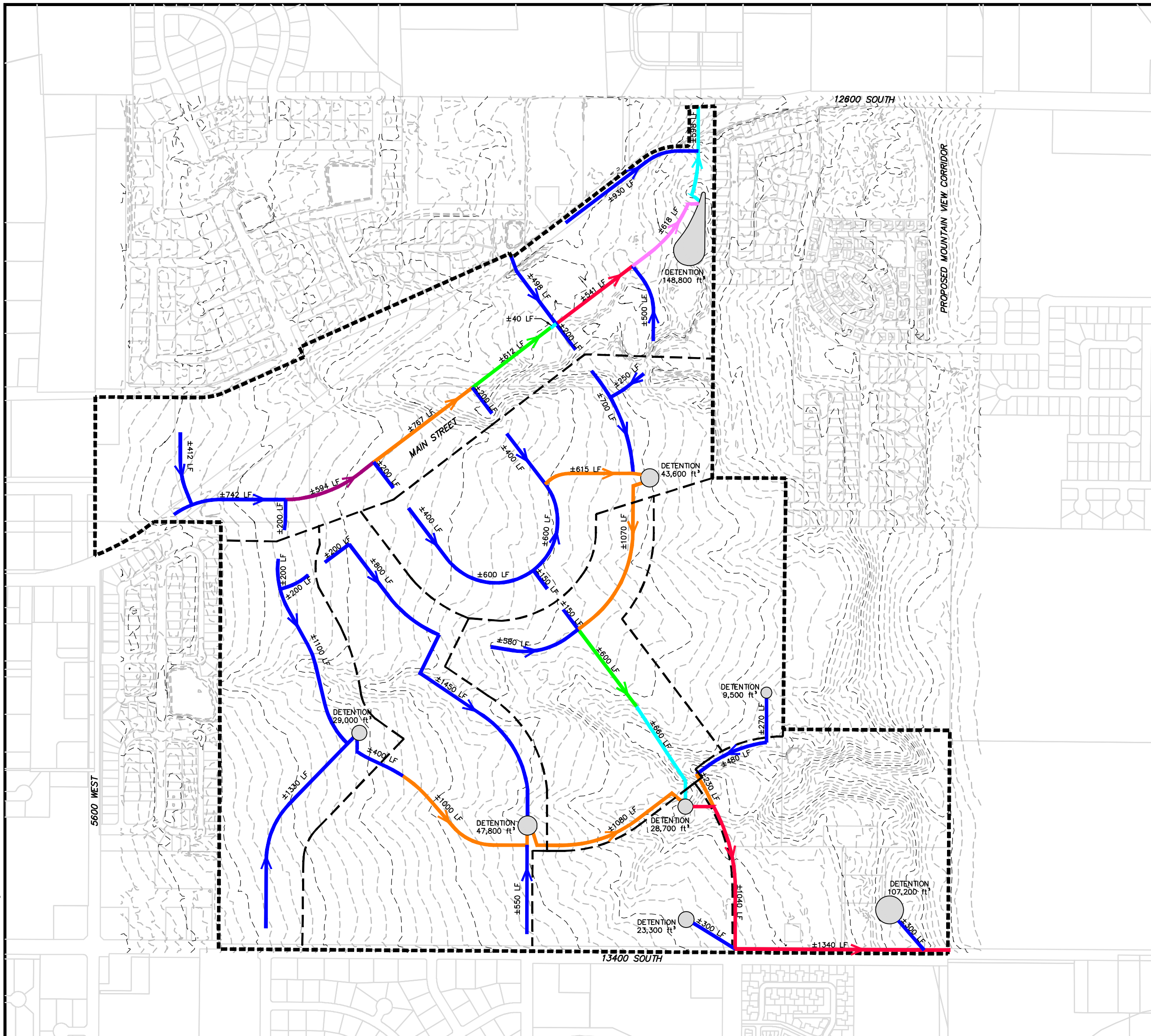
Storm Event (hrs)	Flow (cfs)
2	49.7
3	53.3
6	55.7
12	68.0
24	53.2

The 100-yr storm water event has been evaluated and has shown that minor street flooding should be anticipated for this event.

The HydroCAD modeling results for the detention ponds, the outlet control structures, and the physical characteristics of the ponds are shown in the table below.

Detention Facility	Detention Volume	Bottom of Pond Elevation	10-yr High Water Elevation	Peak Inflow	Peak Outflow	Orifice Size	Orifice Elevation
	(cu-ft)	(ft)	(ft)	(cfs)	(cfs)	(sq-in)	(ft)
MC	148,800	4816	4820.21	68.0	18.2	19.2	4816
RC 1	28,700	4844	4847.95	20.5	8.2	13.0	4844
RC 2	47,800	4822	4825.93	36.8	20.2	21.0	4822
RC 3	43,600	4814	4817.94	27.0	9.4	14.0	4814
RC 4	14,400	4806	4809.76	12.0	5.8	11.0	4806
RC 5	28,700	4802	4806.04	41.9	37.2	29.0	4802
RC 6	32,100	4812	4815.92	17.7	4.0	9.0	4812
RC 7	107,200	4780	4783.92	51.3	5.2	13.0	4780

During final design of each detention facility the modeling will be substantiated and updated as needed based upon actual site conditions and elevations. The modeled 10-yr storm event released rate from the Midas Creek sub basin to the 12600 South piped system is 18.2 cfs, and 56.1 cfs from the Rose Creek sub basin to the 13400 South piped system.



LEGEND

- HERRIMAN TOWNE CENTER OVERALL BOUNDARY
- DRAINAGE SUB BASIN BOUNDRY
- PROPOSED 10–YR DETENTION BASIN
- 18" RCP STORM DRAIN LINE
- 21" RCP STORM DRAIN LINE
- 24" RCP STORM DRAIN LINE
- 27" RCP STORM DRAIN LINE
- 30" RCP STORM DRAIN LINE
- 36" RCP STORM DRAIN LINE
- 42" RCP STORM DRAIN LINE

SEE STORM DRAIN APPENDIX FOR ALL ASSUMPTIONS, METHODS, AND CALCULATIONS

THIS PLAN IS GENERAL AND SCHEMATIC IN NATURE AND SUBJECT TO MODIFICATION AND FINAL DESIGN AND APPROVAL BY THE CITY AT FINAL PLAT DESIGN. ALL IMPROVEMENTS IDENTIFIED HEREIN ARE BACKBONE IMPROVEMENTS.

DRAWN DGG / DATE	CHECKED / DATE		
DESIGNED / DATE	CAB / PROJECT ENGINEER		
APPROVED / DATE	BRW / PROJECT MANAGER		

ROSECREST

HERRIMAN CITY, UTAH

DOMINION Engineering Associates, L.C.
5684 South Green Street
Murray, Utah 84123 801–713–3000

HERRIMAN TOWNE CENTER

STORM DRAIN MASTER PLAN

NO.	REVISIONS	BY	DATE

PROJECT NO. 1434
SHEET NO. SD–1
FILE NAME: HTCSD1A
SCALE: 1"=300'

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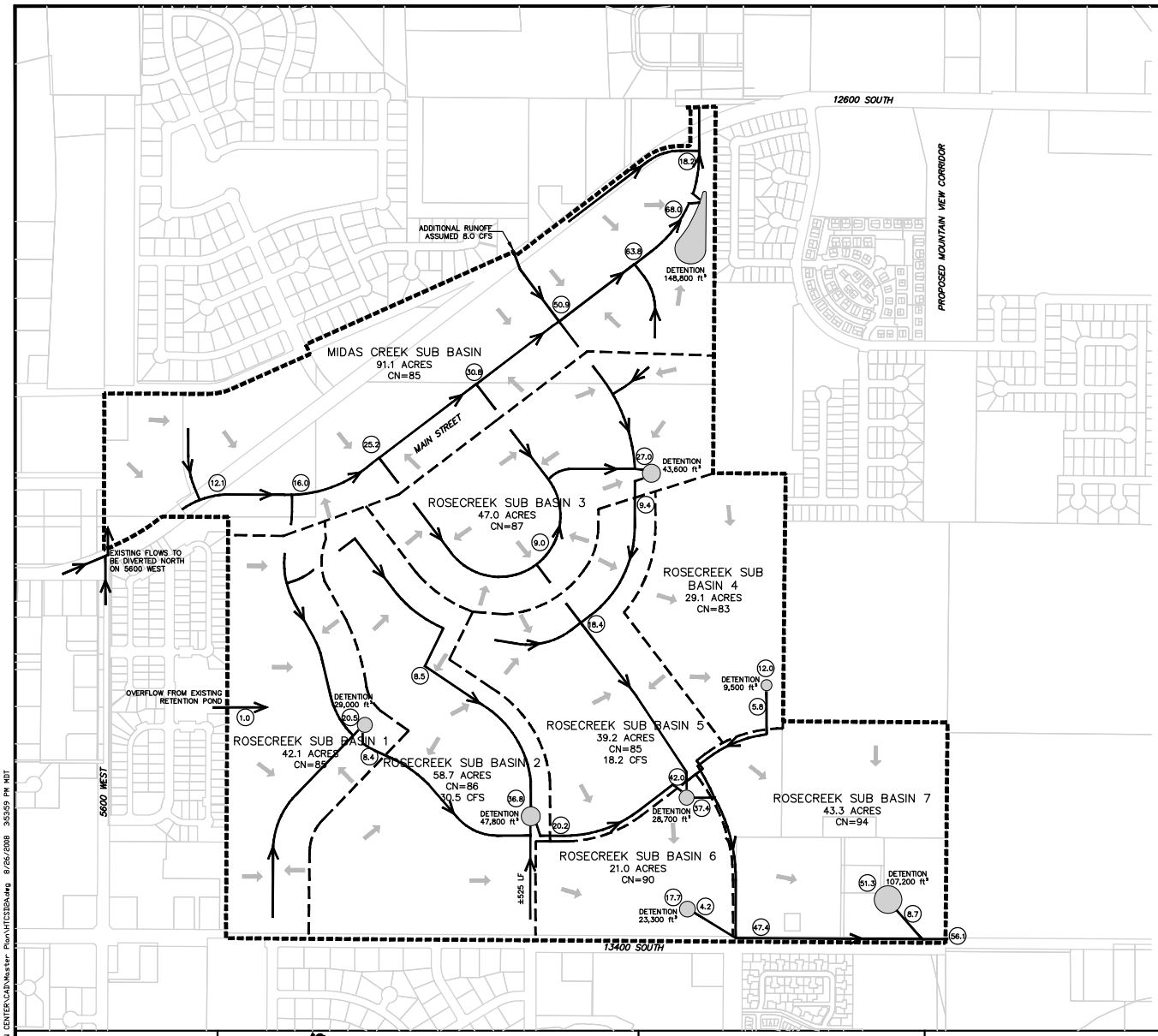

LEGEND

- HERRIMAN TOWNE CENTER OVERALL BOUNDARY
- DRAINAGE SUB BASIN BOUNDRY
- PROPOSED 10-YR DETENTION BASIN
- STORM DRAIN LINE
- FLOW DIRECTION
- (20.0) ACCUMULATED 10-YR FARMER FLETCHER DISTRIBUTION PEAK FLOWS, CFS

SEE STORM DRAIN APPENDIX FOR ALL ASSUMPTIONS, METHODS, AND CALCULATIONS

THIS PLAN IS GENERAL AND SCHEMATIC IN NATURE AND SUBJECT TO MODIFICATION AND FINAL DESIGN AND APPROVAL BY THE CITY AT FINAL PLAT DESIGN. ALL IMPROVEMENTS IDENTIFIED HEREIN ARE BACKBONE IMPROVEMENTS.

N

0 300 600 900
Scale in Feet

CALL BEFORE YOU DIG! IT'S THE LAW BLUE STAKES 1 800 662 4111

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DRAWN DGG DATE	CHECKED DATE	ROSEGREST	DOMINION Engineering Associates, L.C. 5684 South Green Street Murray, Utah 84123 801-713-3000	HERRIMAN TOWNE CENTER
DESIGNED CAB DATE PROJECT ENGINEER		HERRIMAN CITY, UTAH		STORM DRAIN MASTER PLAN DETAILS
APPROVED BRW DATE PROJECT MANAGER				

NO.	REVISIONS	BY	DATE

PROJECT NO. 1434
SHEET NO. SD-2
FILE NAME: HTCSD2A
SCALE: 1"=300'

Storm Drain Cost Estimate $2,388,670.99

Updated: 08/26/08

Storm Drain	Size		Quantity	Units	Unit Price	Total
Phase 1						
Detention Basin A			5,511	YD^3	$5.00	$27,555.56
Class III RCP	18	inch	2,582	LF	$75.00	$193,650.00
Class III RCP	21	inch	594	LF	$80.00	$47,520.00
Class III RCP	24	inch	767	LF	$85.80	$65,808.60
Class III RCP	27	inch	612	LF	$100.20	$61,322.40
Class III RCP	30	inch	638	LF	$114.60	$73,114.80
Class III RCP	36	inch	541	LF	$143.40	$77,579.40
Class III RCP	42	inch	618	LF	$200.90	$124,156.20
Phase 1 Subtotal						**$670,706.96**
Phase 2						
Detention Basin 3			1,615	YD^3	$5.00	$8,074.07
Detention Basin 4			352	YD^3	$5.00	$1,759.26
Detention Basin 5			1,063	YD^3	$5.00	$5,314.81
Detention Basin 6			863	YD^3	$5.00	$4,314.81
Detention Basin 7			3,970	YD^3	$5.00	$19,851.85
Phase 2a						
Class III RCP	18	inch	3,015	LF	$75.00	$226,125.00
Phase 2b						
Class III RCP	18	inch	900	LF	$75.00	$67,500.00
Class III RCP	24	inch	230	LF	$85.80	$19,734.00
Class III RCP	27	inch	600	LF	$100.20	$60,120.00
Class III RCP	30	inch	660	LF	$114.60	$75,636.00
Class III RCP	36	inch	2,380	LF	$143.40	$341,292.00
Phase 2 Subtotal						**$829,721.81**
Phase 3						
Detention Basin 1			1,074	YD^3	$5.00	$5,370.37
Phase 3a						
Class III RCP	18	inch	400	LF	$75.00	$30,000.00
Phase 3b						
Class III RCP	18	inch	1,100	LF	$75.00	$82,500.00
Phase 3c						
Class III RCP	18	inch	1,300	LF	$75.00	$97,500.00
Phase 3 Subtotal						**$215,370.37**
Phase 4						
Phase 4a						
Class III RCP	18	inch	400	LF	$75.00	$30,000.00
Phase 4b						
Class III RCP	18	inch	2,250	LF	$75.00	$168,750.00
Phase 4 Subtotal						**$198,750.00**

Phase 5						
Detention Basin 2			1,770	YD^3	$5.00	$8,851.85
Phase 5a						
Class III RCP	18	inch	400	LF	$75.00	$30,000.00
Class III RCP	24	inch	1,000	LF	$85.80	$85,800.00
Phase 5b						
Class III RCP	18	inch	550	LF	$75.00	$41,250.00
Phase 5c						
Class III RCP	24	inch	1,080	LF	$85.80	$92,664.00
Phase 5 Subtotal						**$258,565.85**
Phase 6						
Phase 6a						
Class III RCP	18	inch	900	LF	$75.00	$67,500.00
Class III RCP	24	inch	1,070	LF	$85.80	$91,806.00
Phase 6b						
Class III RCP	18	inch	750	LF	$75.00	$56,250.00
Phase 6 Subtotal						**$215,556.00**
Storm Drain Total						**$2,388,670.99**

*Includes bedding, manholes, catch basins, combination boxes, and native backfill.