APPENDIX E
Southwest Canal and Creek Study

VOLUME 1 - REPORT

SOUTHWEST CANAL AND CREEK STUDY

SECTION 3 - CANALS, BINGHAM CREEK, BARNEYS CREEK, BEEF HOLLOW, WOOD HOLLOW, AND WOOD HOLLOW SOUTH

Prepared for:

SALT LAKE COUNTY

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CHAPTER 1
INTRODUCTION

BACKGROUND INFORMATION

The previous Southwest Canal and Creek Study (SWCCS) was completed in 2002 (2002 SWCCS). The primary purpose of the 2002 SWCCS was to identify institutional and structural improvements needed to manage storm water runoff conveyed in the creeks and canals located in the southwest quadrant of Salt Lake County in a cost-effective, efficient manner. Since the 2002 SWCCS was completed, the combined population of Salt Lake County has increased from approximately 900,000 to 1.2 million, with most of that growth occurring the southwest portion of the Salt Lake Valley. Significant changes have been made to some of the critical planning and development assumptions used in completing the 2002 SWCCS. Because of those changes, the County is updating the 2002 SWCCS. The County retained Bowen, Collins & Associates (BC&A) to update the SWCCS.

The SWCCS was updated in three phases. This report covers Phase 3. This report includes a capacity evaluation of Bingham Creek, Barneys Creek, Wood Hollow South, Beef Hollow and Wood Hollow and the following canals: Utah Lake Distribution Canal, Utah and Salt Lake Canal, South Jordan Canal, and North Jordan Canal. The study considered recent general plans and identifying needed improvements to the creeks and canals to safely manage storm water.

It is important to note that Barneys Creek was not included in the 2002 SWCCS. A master plan for Barneys Creek had been completed prior to the 2002 SWCCS for Barneys Creek, and that master plan has not been updated. Because the Barneys Creek master plan has not been updated for more than 20 years, it was studied as part of this SWCCS update. A copy of the original Barneys Creek Master Plan could not be found prior to beginning this SWCCS update.

STUDY AREA

The study area for Phase 3 of the SWCCS and the flood control facilities that are the subject of this study (or this project) are shown on Figure 1-1.

RIO TINTO MINING OPERATIONS

Prior to 2013, the collection facilities for storm water runoff from the waste rock along the east side of the Bingham Open Pit Mine, owned by the Rio Tinto Corporation, were sized for the 10-percent-annual-chance-flood (10-year flood). Runoff from the 1-percent-annual-chance-flood (100-year flood) would by-pass those collection facilities and discharge to Bingham Creek. The 2002 SWCC study analyzed the 100-year event and assumed that runoff from the waste rock along the east side of Bingham Open Pit Mine flowed into Bingham Creek.

Over the past 10 years, the capacities of those drainage facilities associated with the mine have been increased to collect and convey runoff from the 100-year design storm event. As a result, the drainage area for Bingham Creek has decreased significantly since 2002 SWCCS. The improved drainage facilities have been designed such that all runoff from the 100-year design storm will be retained on Rio Tinto property. There should be no discharge from that event into any of the natural creek channels. The removed drainage area is identified on Figure 1-1.

BINGHAM CREEK

Bingham Creek is a Salt Lake County flood control facility that is an ephemeral stream that only flows in response to storm events. Bingham Creek receives runoff from multiple storm drain outfalls from South Jordan City and West Jordan City. The Bingham Creek channel traverses about 10.2 miles from the Kennecott retention dam between Copperton and Highway 111 to the Jordan River at about7900 South. Bingham Creek also receives storm water discharges from the canals via canal overflow structures. Those structures are discussed in greater detail Chapter 5.

BARNEYS CREEK

Similar to Bingham Creek, Barneys Creek is an ephemeral stream that only flows in response to storm events. This creek receives storm water discharges from multiple outfalls from West Jordan City. Barneys Creek also receives runoff from four ephemeral tributaries: Clay Hollow, Barneys Wash and two unnamed washes (the unnamed washes are not shown on Figure 1-1). This study includes a hydrologic analysis of the runoff from those tributary areas, but it does not include a hydraulic analysis of those tributaries because they are not designated as County flood control facilities. The only detailed hydraulic analysis performed for the Barneys Creek system was for the reach of the main channel of Barneys Creek from a point west of Highway 111 to the storm water detention facility at the South Valley Regional Airport, which is approximately 7.2 miles in length. Downstream of the detention facility at the airport, runoff is discharged into the West Jordan Storm Drain System in 7800 South which conveys it to the Jordan River. The analysis for the SWCCS update does not extend downstream of the South Valley Regional Airport because Salt Lake County does not own or maintain the storm drain facilities downstream of the South Valley Regional Airport. Only the reach of Barneys Creek upstream of the detention basin is designated as a County flood control facility. The detention basin at the South Valley Regional Airport is also a Salt Lake County Facility.

CANALS

There are five major irrigation canals in the southwest quadrant of Salt Lake County: Welby Jacob Canal, Utah Lake Distributing Canal (ULDC), Utah & Salt Lake Canal (USLC), South Jordan Canal (SJC), and North Jordan Canal (NJC). These five canals generally flow from south to north across the study area. Welby Jacobs Canal is not a Salt Lake County facility and does not receive runoff from urban storm drain outfalls. That canal also does not currently discharge water into County flood control facilities. Therefore, it is not evaluated during this study. This study includes a hydrology and hydraulic analysis for the other four canals.

Utah Lake Distributing Canal

The Utah Lake Distributing Canal (ULDC) begins upstream of Turner Dam in the Jordan Narrows area. Irrigation water is pumped/diverted into an enclosed portion of the canal which flows approximately a half mile north to where the diverted water discharges into an open channel at approximately 1300 West and 17000 South. The ULDC then transverses northwesterly to about 7000 South in West Jordan where the stormwater component of the flow is diverted east to the Jordan River via a West Jordan City storm drain and any irrigation tailwater continues flowing northwest to about 6200 South where the canal terminates, and any remaining water is discharged into a West Jordan storm drain that ultimately conveys it to the Jordan River. The analysis for the ULDC as performed as part of this study ends at the 7000 South diversion, because West Jordan City owns and maintains the channel north of South as a storm drain facility. This canal has 4 stormwater dumpout structures that discharge into creeks, 32 bridge/culvert road crossings, and 6 major control structures. The total length of the ULDC included in this study is 13.5 miles. Urban runoff is discharge into the canal by various storm drain outfalls along the length of the canal.

Utah & Salt Lake Canal

The Utah & Salt Lake Canal (USLC) begins at a gated structure at the Turner Dam in the Jordan Narrows area. The canal traverses northerly to about 7000 South where it turns northwest and traverses in Magna, near the Kennecott smelter. This canal conveys process water to the Kennecott smelter as well as irrigation water for farms. The canal has 7 stormwater dumpout structures that discharge into creeks, 67 bridge/culvert road crossings, and 16 major control structures. The total length of USLC included in the hydraulic model was 27.4 miles.

South Jordan Canal

The South Jordan Canal (SJC) begins at a gated diversion on the Jordan River about 1.4 miles downstream of the Turner Dam. The canal traverses generally northward to approximately 7000 South where it northwest and terminates at 4000 West where it discharges into the Kearns-Chesterfield storm drain system. The canal includes 8 stormwater dumpout structures that discharge stormwater into creeks, 123 bridge/culvert road crossings, and 2 major control structures. The total length of SJC included in the hydraulic model was 18.3 miles.

North Jordan Canal

The North Jordan Canal (NJC) begins at a gated diversion structure on the Jordan River near 9400 South. The canal traverses north generally parallel to the Jordan River until about 5400 South. The canal then flows northwesterly to about 3400 West where the canal splits. The Kennecott Lateral of the canal traverses to the north before turning west and discharging into the Riter Canal. The main branch of the canal, also known as the Granger Lateral, continues west from 3400 West to 4800 West, where it turns north and discharges into the Riter Canal. The detailed analysis for this study follows the Kennecott Lateral north for about half a mile where the canal discharges into an underground pipe at approximately 3600 South. The canal 8 stormwater dumpout structures and 49 bridge/culvert road crossings. The total length of the NJC included in the hydraulic model was 10.5 miles. Urban runoff is discharged into the canal by various pipe outfalls along the length of the canal.

A detailed study was completed in 2017 on the NJC for Salt Lake County (2017 North Jordan Canal Study or 2017 NJC Study). That study analyzed the potential of removing storm water entirely from the canal by constructing new storm drain facilities or converting the NJC to a storm drain facility. Though the 2017 NJC Study had a different focus than that the SWCCS, the visual assessment and hydraulic model developed as part of that 2017 NJC Study were used for this SWCCS update.

BEEF HOLLOW AND WOOD HOLLOW

The Beef Hollow and Wood Hollow are the southernmost County flood control facilities that were studied as part of the SWCCS. The drainage areas for these two ephemeral washes are relatively small compared to the other drainages in the study area. Runoff for each of these washes originates in the lower Oquirrh Mountains. Significant development has occurred in these drainage areas and more development is planned to occur over the next 10 years. The drainage patterns have changed significantly since the 2002 SWCCS. This study (Phase 3) includes hydrologic and hydraulic analyses for Beef Hollow. Wood Hollow and Wood Hollow South were included as part of the Phase 3 of the SWCCS and the analysis, alternatives and results are included in a Technical Memorandum prepared for the County. That technical memorandum is included in the Appendix A of this report.

Beef Hollow

During the 2002 SWCC Study, Beef Hollow crossed the Welby Jacobs Canal siphon and terminated at the ULDC. Since then, additional culverts have been constructed to restore the ability for runoff to be conveyed in the Beef Hollow historic channel east of the canal to the Jordan River, just upstream of the Turner Dam. The total length of Beef Hollow is 1.8 miles.

Wood Hollow

Wood Hollow originates west of Mountain View Corridor and Porter Rockwell Blvd. Wood Hollow is piped over the Welby Jacobs canal and then discharges into a field north of an electrical substation located adjacent to Redwood Road. During the 2002 SWCC Study Wood Hollow terminated at that point. A new channel has since been constructed to extend the Wood Hollow channel east to Redwood Road where it discharges into the Bluffdale City storm drain system. Wood Hollow runoff is then conveyed in a storm drain pipe in Ironhorse Blvd. and to a detention basin that discharges runoff into the Jordan River at approximately 15500 South. The total length of Wood Hollow is 2.4 miles.

Wood Hollow South

Wood Hollow South is not currently a County flood control facility. However, FEMA recently completed a preliminary floodplain study for Wood Hollow South. Wood Hollow South is a relatively short drainage channel. Runoff from this drainage is piped underneath the Welby Jacobs Canal and the ULDC. Wood Hollow South currently terminates at the USLC. There have been discussions in the past between Salt Lake County, Herriman City, and Bluffdale City about the best approach to manage runoff from the Wood Hollow South drainage facilities. Those conversations are still ongoing, and no decisions have been made yet. The total length of Wood Hollow South is 1.2 miles.

MAJOR STUDY TASKS

BC&A performed the following major tasks in completing this study:

- Visual Assessment of Each Creek and Canal
- Developed a Hydrologic Model Each Creek and Canal
- Developed a Hydraulic Model Each Creek and Canal
- Recommended Improvements Based Model Results
- Prepared this Report.

The results of the work associated with completing these tasks are presented in this report. Questions associated with this report may be addressed to Kameron Ballentine P.E., who served as the project engineer or Craig Bagley P.E., CFM, who served as project manager.

CHAPTER 2
REVIEW OF EXISTING CONDITIONS

Several sources of data regarding the existing development and hydrologic conditions of the creek and canal drainage basins were collected and analyzed as part of this project. Some of those data sets included topographic information, master plans, general plans, field survey of bridges and culverts, and field reconnaissance observations. A visual assessment of the general conditions of the study reaches of each of the studied creeks and canals included in Phase 3 of the SWCCS was also completed. The purpose of this chapter is to summarize the general existing conditions that currently exist in the Phase 3 drainage areas and to summarize what other data was collected, reviewed and used to perform the technical analyses.

DATA COLLECTION

This section discusses the data collection and analyses associated with topography, survey, and field reconnaissance. The primary goals of this task were to compile a detailed inventory of the structures on the creeks and canals, and to collect information needed to develop hydrologic and hydraulic models that include those facilities.

Topography and Aerial Photography

Topographic and aerial photographic mapping along the creeks and canals were collected from the Utah Automated Geographic Reference Center (UGRC). The 2020 aerial photography published by Google was utilized and the topography is the bare earth LiDAR data from 2013-14 with 0.5-foot contours. The Google aerial photographs were used for the backgrounds on most of the figures used in this report.

Field Survey

Channel cross sections of the study reaches of the creeks were field surveyed at about 500-foot intervals and about 1000-foot intervals through the open channel section of the canals. The creeks are all ephemeral, so the survey work took place when the creeks were not flowing. The survey of the canals took place during the late fall or winter when the canals were empty. Survey data were also collected for the culverts, bridges, storm water dump-out structures on the canals and other structures.

INVENTORY OF STRUCTURES

This section presents an inventory of the existing structures along the study reaches of the creeks and canals. The inventory of structures is summarized on eight figures, as follows:

Figure 2-1 – Barneys Creek
Figure 2-2 – Bingham Creek
Figure 2-3 – Wood Hollow
Figure 2-4 – Beef Hollow
Figure 2-5 – Utah Lake Distributing Canal
Figure 2-6 – Utah and Salt Lake Canal
Figure 2-7 – South Jordan Canal
Figure 2-8 – North Jordan Canal

Bridges & Culverts & Drop Structure

Table 2-1 identifies the number of existing structures for each of the studied facilities.

Table 2-1
Number of Existing Structures on Phase III Stormwater Facilities

Canal/Creek	Culverts/Bridges	Drop/Control Structures[1]	Stormwater Overflow/Dumpout
Bingham Creek	37	-	3[(2)]
Barneys Creek	18	7	-
Beef Hollow	4	-	-
Wood Hollow	4	-	-
ULDC	32	6	4
USLC	69	13	7
SJC	123	2	8
NJC	49	-	12

[1] Drop/Control structures are typically weirs in the channel to decrease the channel velocities in reaches with steep slopes to minimize erosion.
[2] Stormwater dumpout structures on Bingham Creek receives storm water from the ULDC, USL, and SJC

As can be seen from Table 2-1, most of the structures within the study area are culverts or bridges. Each of the structures are identified on Figure 2-1 through Figure 2-8. Field survey for each structure was collected and used to develop the hydraulic models as described in Chapter 5.

Canal Dump-out Structures

Multiple storm water overflow/dump-out structures have been constructed on the canals at major creek crossings or storm drain crossings to allow storm water that is discharged into the canals from urban storm drains to be released into the creeks or another major storm drain facilities to prevent the canals from overtopping during storm events. The overflow structures are identified on Figures 2-5 through Figure 2-8. As identified in Table 2-1, there are 4 overflow/dump-out structures on ULDC, 7 overflow/dump-out structures on USLC, 8 overflow/dump-out structures on SJC and 12 overflow/dump-out structures on NJC. The overflow structures typically include a gate to manually drain the canal and a weir to allow for an automatic overflow of storm water out of the canal, as shown on Photo 2-1. Tables 2-2 through 2-5 identify the locations of existing storm drain overflow structures by canal as well as if the structure includes an overflow weir and gate.

Photo 2-1: Overflow/Dump-Out Structure Where Utah Lake Distribution Canal Crosses Rose Creek

Table 2-2
Existing Storm Drain Overflow/Dump-Out Structures on Utah Lake Distribution Canal

Creek/Pipeline	Approximate Storm Drain Overflow Structure Location	Structures
7800 South	3800 West	Weir & Gate
Bingham Creek	3400 West	Weir & Gate
Midas Creek	3300 West	Weir & Gate
Rose Creek	3300 West	Weir & Gate

Table 2-3
Existing Storm Drain Overflow/Dump-Out Structures on Utah and Salt Lake Canal

Canal Crossing	Approximate Storm Drain Overflow Structure Location	Structures
8000 West	3700 South	Weir & Gate
4700 South	4050 West	Weir & Gate
5400 South	3200 West	Weir & Gate
7800 South	3100 West	Weir & Gate
Bingham Creek	2700 West	Weir & Gate
Midas Creek	2400 West	Weir & Gate
Rose Creek	2500 West	Weir & Gate

Table 2-4
Existing Storm Drain Overflow/Dump-Out Structures on South Jordan Canal

Canal Crossing	Approximate Storm Drain Overflow Structure Location	Structures
4700 South	3400 West	Weir & Gate
5400 South	2700 West	Weir & Gate
7000 South	2300 West	Weir & Gate
7800 South	2300 West	Weir & Gate
Bingham Creek	2300 West	Weir & Gate
10400 South	1250 West	Weir & Gate
Midas Creek	1500 West	Weir & Gate
Rose Creek	1500 West	Weir & Gate

Table 2-5
Existing Storm Drain Overflow/Dump-Out Structures on North Jordan Canal

Canal Crossing	Approximate Storm Drain Overflow Structure Location	Structures
3800 South	3400 West	Weir & Gate
3200 West	3900 South	Gate Only
3000 West	3900 South	Gate Only
4000 South	2700 West	Weir & Gate
2700 West	4100 South	Gate Only
I-215	4350 South	Weir & Gate
4700 South	Redwood Rd.	Weir & Gate
5400 South	1300 West	Weir & Gates
5600 South	1300 West	Weir & Gate
6500 South	1250 West	Weir & Gate
7200 South	1100 West	Weir & Gate
7800 South	1100 West	Weir & Gate

The Welby Jacob Canal does not have dump-out structures because it does not currently accept any storm water runoff due to its limited capacity. It was not evaluated as part of this study.

SUMMARY OF GENERAL OBSERVED RISKS

A visual assessment of each of the canals and Barneys Creek, Bingham Creek, Wood Hollow and Beef Hollow was completed. The purpose of the visual assessment was to observe general conditions of the canals and creeks and to identify potential hazards, issues and concerns. This section summarizes the observations noted during the visual assessment. Observed issues and concerns are identified on Figure 2-1 through Figure 2-8. Photos from the visual assessment are included in Appendix B.

General Observed Risks

The main channel for the canals different than creek channels in the study area. Canals are typically prismatic and include a man-made earthen embankment on at least one side. They have very mild slopes because they generally follow the topography and they get smaller in the downstream direction. Creek channels traverse more perpendicular to contours, are much steeper, get larger in the downstream direction, and convey water to the Jordan River. As a result, the general observed risks are different based on whether the facility is a creek or a canal.

Creeks

The visual assessments on the creeks took place throughout the summers of 2020 and 2021. The following potential issues and concerns were observed along the creek channels included with Phase 3 of the SWCCS.

- Eroded channel banks
- Excessive vegetation in channel
- Fences that cross the channel
- Poorly defined channel/filled in channel
- Rounded riprap
- Trash racks

Each of items are discussed below.

Eroded Channel Banks. The banks of the creeks in some areas have experienced significant erosion. The eroded banks and the associated bank instability in those areas are not currently adjacent to development and are not currently a major concern. Photo 2-2 identifies an area of bank erosion upstream of Airport Road on Barneys Creek.

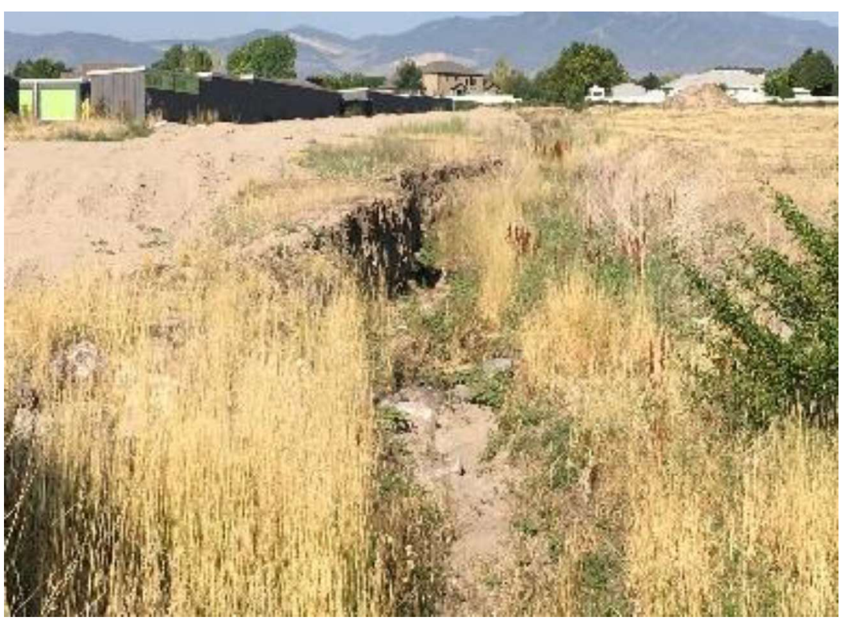

Photo 2-2: Bank Erosion Upstream of Airport Rd. on Barneys Creek

Excessive Vegetation in Channel. Though deep-rooted vegetation is typically allowed to grow on channel banks, woody vegetation in a channel can potentially impact conveyance capacity. Trees and vegetation have the potential to reduce creek capacity by increasing friction losses. Woody vegetation in a creek channel can also be a source of debris that can plug downstream culverts. An example of problem vegetation is shown in Photo 2-3.

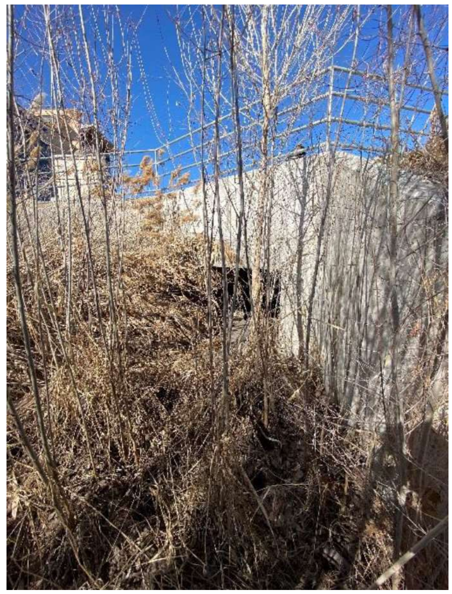

Photo 2-3: Excessive Vegetation in Channel on Bingham Creek near the Jordan Valley Medical Center

Fences that Cross the Channel. There are several locations where fences cross a creek channel. During a large flood it is likely that debris would collect on the fences and restrict flow. Flooding could occur if a fence across a creek channel does not break. It is important that creek channels and floodways remain clear of obstructions and encroachments that could reduce conveyance capacity.

Poorly Defined Channel/Filled in Channel. There are multiple areas along both Barneys Creek and Bingham Creek where the channel is currently poorly defined. There are also areas where the channel has been filled in. Currently most of these areas are in the upstream portion of the drainage areas and there is not much development adjacent to the creek channels in these areas. As these areas develop, the channel should be re-established and armored as part of any development. Examples of this are shown in Photos 2-4 and 2-5.

Photo 2-4: Poorly Defined Bingham Creek Channel Upstream of 5200 West

Photo 2-5: Filled in Barneys Creek Channel in Farm Fields (approximately 6900 West)

Rounded Riprap. There are several stream segments along Barneys and Bingham Creek where rounded riprap has been installed to armor the banks of the Creeks. Riprap channel armoring should be angular so that it can better lock together to provide the required erosion protection. Rounded riprap is likely to fail and roll away during a major runoff event.

Trash Racks. There are a various manually cleaned trash racks at culvert crossings on both Bingham Creek and Barneys Creek. Those trash racks have the potential to plug with debris, trees, woody vegetation, etc. which could lead to the banks overtopping. Consideration should be given to either removing the trash racks or installing automated trash rack cleaners at these locations to reduce the risk of plugging. A photo of an existing trash rack is shown in Photo 2-6. It should also be noted that the culvert in Photo 2-6 is in poor condition and may fail or break off

Photo 2-6: Example of a Trash Rack on Barneys Creek at Airport Rd

Canals

The visual assessments on most of the canals were performed during the falls of 2020 and 2021 (the assessment for the North Jordan Canal was previously done in 2016 as part the 2017 NJC Study). The purpose of the visual assessment was to observe general conditions of the canals and to identify potential hazards, issues and concerns. The following potential issues and concerns were observed along the various canal channels.

- Eroded channel banks
- Embankment piping (internal erosion)
- Excessive vegetation in channel
- Trash racks
- Canal Segment with an Embankment

Each of these potential issues and concerns are discussed below.

Eroded Channel Banks. Small canal sloughs were observed during the visual assessment. These sloughs and other blockages could restrict capacity and backup water sufficiently to cause the embankment to overtop. In addition, if the canal banks erode the canal access road could become inaccessible for maintenance and observational purposes. Examples of eroded banks are shown in Photos 2-7 and 2-8.

Photo 2-7: Recently Sloughed South Jordan Canal

Photo 2-8: Example of Eroded Bank along Utah and Salt Lake Canal

In some areas where the canal bank has sloughed into the canal, concrete liners have been placed to protect from further slope stability issues. In some spots the banks are sloughing into the canal behind the concrete protection. This could lead to the protection failing and increased slope stability problems. An example of this occurring is shown in Photo 2-9.

Photo 2-9: Example of Eroding Bank Protection on Utah and Salt Lake Canal

Embankment Piping. For the purpose of this report, piping is defined as the progressive development of internal erosion of soil particles from seepage, appearing in the downslope embankment as a hole or seam that discharges water containing soil particles. Piping can be initiated by things such as:

- Decaying tree and plant roots
- Animal burrows
- Horizontal drilling, trenchless construction, or open trench construction beneath and/or through the canal alignment to implement the placement of utilities and communication lines.

These potential seepage pathways can continue to erode and eventually create an unstable condition in the embankment that could lead to an embankment failure. No animal burrows were observed during the site visit. However, a more detailed inspection of the embankments is recommended.

Some trees, few tree stumps and other deep-rooted vegetation were observed and noted in several areas on or near canal embankments. Overall, it appears that work has been performed to remove woody, deep-rooted vegetation on the embankment. However, some of the root systems may still remain within the embankment, which means there is still potential for piping. Many small diameter pressurized pipe crossings were identified to private homes. It is assumed that the individual canal operators maintain a list of authorized pipes and their locations. Larger diameter pipes that cross the canal embankments typically appear to have been engineered. However, as the structure headwall erode there is a risk of piping to still occur. Photos 2-10 and 2-11 show examples of potential embankment piping hazards.

Photo 2-10: Tree Stump with Roots in the Utah and Salt Lake Canal Embankment

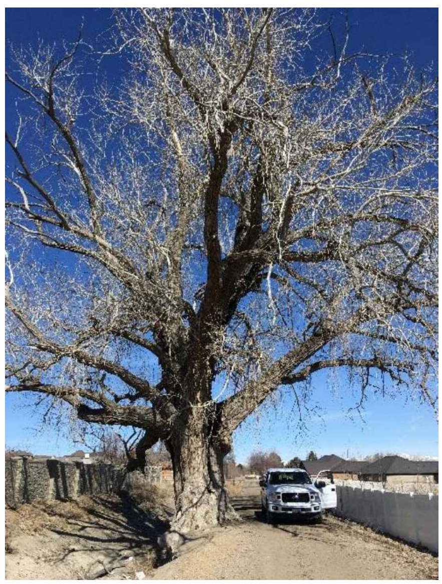

Photo 2-11: Large Tree on Utah Lake Distribution Canal Bank

Excessive Vegetation in Channel. Though deep-rooted woody vegetation is typically removed from the canal banks, there are still trees and heavy vegetation on or near the bank. The trees and vegetation have the potential to plug trash racks, reduce canal capacity, and cause piping the in the embankment. Photos 2-12 and 2-13 show examples of excessive vegetation.

Photo 2-12: Excessive Vegetation Blocking the Storm Water Dumpout on USLC to Midas Creek

Photo 2-13: Vegetation Recently Removed from Bridge Culvert on South Jordan Canal

Trash Racks. There are some manually cleaned trash racks on the ULDC, SJC, and NJC. Those trash racks have the potential to plug with debris, trees, woody vegetation, etc. which could lead to embankment overtopping. Consideration should be given to either remove the trash rack or install automated trash rack cleaners. A photo of a trash rack is shown in Photo 2-14.

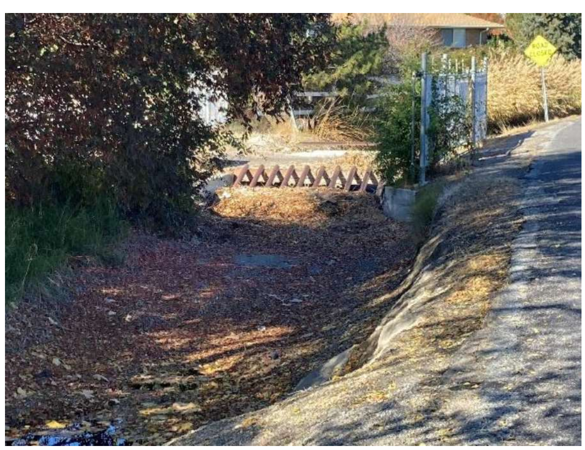

Photo 2-14: Trash Rack on South Jordan Canal

Canal Segment with an Embankment

Canal segments with an embankment that impounds water were identified on the Figures 2-5 through Figure 2-8 for the canals. The areas where the invert of the canal is above the natural ground on the east side of the canal and the embankment is protecting houses and businesses are labeled as areas where an "embankment failure would result in significant property damage." A breach in an east embankment adjacent to development could result in a catastrophic failure of the canal that could drain the canal and cause significant flooding to the properties downhill from the embankment in these areas.

The areas where the embankment is not protecting houses or businesses or where the invert of the canal is below the natural ground on the east side of the canal are labeled as areas where an "embankment failure would result in minimal property damage." A breach in the east embankment in these areas would be less likely to cause significant flooding to the properties downhill from the embankment in these areas then the areas discussed in the previous paragraph.

It is important to note a stability analysis of the embankments and the potential damage an embankment failure could cause was not included in the scope of the study. We would recommend that the County complete a slope stability study on the canal embankments where failure would result in significant property damage to nearby development or critical facilities.

CHAPTER 3
PREVIOUS RELATED STUDIES

Data from previously published reports and studies were used to supplement information collected as part of Phase 3 of this study. In the development of the hydrologic and hydraulic models for this study, previous studies were reviewed, and relevant data from those studies were incorporated into the analysis. Table 3-1 is a summary of previously completed storm drainage studies that were referenced while performing work associated with this study.

Table 3-1
Previously Completed Drainage Studies in the Study Area

Drainage Study	Date Completed	Prepared for	Study Area
Phase 2 of the SWCCS	September 2021	Salt Lake County Flood Control	Midas Creek and Butterfield Creek
South Jordan Storm Drain Master Plan Update	May 2021	South Jordan	South Jordan City
Herriman City Storm Drain Master Plan	September 2020	Herriman City	Herriman City
Phase 1 of the SWCCS	March 2020	Salt Lake County Flood Control	Rose Creek
Preliminary FEMA Floodplain Maps and Models	November 2017	Salt Lake County Flood Control	Midas Creek
Copper Creek Drainage Master Plan	December 2014	Salt Lake County	Copper Creek
South Jordan Storm Drain Master Plan	January 2011	South Jordan City	South Jordan City
UDOT Drainage Design Drawings for Mountain View Corridor	Sept 2010	UDOT	Herriman and Riverton
Riverton City Storm Drain Master Plan Update	July 2010	Riverton City	Riverton City
Southwest Canal and Creek Study (2002)	April 2003	Salt Lake County Flood Control	SWCC Study Area

CHAPTER 4
HYDROLOGIC ANALYSIS

Hydrologic computer models of the creek and canal drainage areas were developed using the Autodesk Storm and Sanitary Analysis (ASSA) computer software. The models were used to estimate storm water runoff volumes and peak discharges generated by a design storm event and to route storm water runoff to the Jordan River for both the existing and full build-out development conditions. This chapter focuses on the process and assumptions used to develop the hydrologic model for the study area. The methods used to estimate the hydraulic capacity of creeks and canals and their related hydraulic structures is discussed in Chapter 5.

PREVIOUS MODELS

ASSA models were developed for the Rose Creek, Midas Creek and Butterfield Creek drainage areas as part of Phases 1 and 2 of the SWCCS. To be consistent, the same hydrologic modeling software was used for Phase 3 (this study). The ASSA software utilizes the same procedures and routines to simulate the rainfall-runoff process as those used by the HEC-HMS software.

The methodology used to develop the hydrologic model parameters was the same as the original 2002 SWCCS, the Herriman City Storm Drain Master Plan, the South Jordan Storm Drain Master Plan, the Riverton Storm Drain Master Plan and Phases 1 and 2 of the SWCCS. The process used to develop the hydrologic model is outlined in the following general steps, with detailed information on each step provided below:

1. Delineate Drainage Basins
2. Develop Hydrologic Modeling Parameters
3. Develop Design Storm Parameters
4. Calibrate Hydrologic Model.

DRAINAGE BASIN AND SUBBASIN DELINEATION

The drainage basin boundaries and related subbasin boundaries were delineated based on storm drain GIS inventory data provided by Riverton City, South Jordan City, West Valley City, Midvale City, Kearns, and Herriman City in conjunction with topographic data. The topographic data used for this study was developed using LiDAR data collected in 2013-2014 available on the Utah Automatic Geographic Resource Center (UGRC) website. Aerial photographs taken in 2020 and published by Google were also used in conjunction with existing storm drain system data and topographic data to develop subbasin boundaries and estimate the amount of directly-connected impervious area (which includes roads, curb and gutter, driveways, parking lots, roof tops, etc.) in each subbasin. The existing conditions model developed is based on the aerial photos from 2020; therefore the existing conditions model represents the year 2020. The drainage basins and subbasin boundaries developed as part of this study are shown on Figure 4-1.

HYDROLOGIC MODEL PARAMETERS

ASSA uses the United States Army Corps of Engineers HEC-HMS hydrologic engine based on SCS Curve Number (CN) methodology to compute runoff for each subbasin. This method requires lag time, CN value, percent impervious, and area for each subbasin as hydrologic input parameters. A description of each of these items is included below. The hydrologic model parameters are summarized in Appendix C.

Curve Number

The Curve Number (CN) was estimated for the pervious portion of the each subbasin based on soil type and vegetative ground cover. The Curve Numbers used in this study do not account for directly connected-impervious land cover, like roads, parking lots or driveways. The methodology used in this study accounted for directly-connected impervious area by inputting that value in the model as a percentage of the area of each drainage subbasin. Using this approach is necessary for Salt Lake Valley's climate and geology, as peak runoff values from the 3-hour design storm would be severely underestimated for areas with Hydrologic Soil Groups (HSG) A and B soils when a "composite" curve number methodology is used instead of entering directly-connected impervious cover separately. The hydrologic soil types for the pervious areas were obtained from the NRCS Soil Survey Geographic (SSURGO) dataset. The vegetative cover data for undeveloped land was obtained from the USGS National Land Cover Database (NLCD). Table 4-1 shows the Curve Numbers used in this study based on soil type and assumed ground cover. The soil types are identified on Figure 4-2 and NLCD are identified on Figure 4-3.

Table 4-1
SCS Curve Numbers Used in This Study

NLCD Number	NLCD Name	Equivalent Land Type Based on TR-55 Manual	CN Value for Hydrologic Soil Type[1]			
			A	B	C	D
11	Open Water	Water	98	98	98	98
12	Perennial Ice/Snow	Water	98	98	98	98
21	Developed Open Space	Open Space (Fair)	49	69	79	80
22	Developed Low Intensity	2 Acres	46	65	77	82
23	Developed Medium Intensity	1 acre	51	68	79	84
24	Developed High Intensity	1/4 acre	61	75	83	87
31	Barren Land	Bare Soil	77	86	91	94
41	Deciduous Forest	Oak-Aspen (Fair)	-	48	57	63
42	Evergreen Forest	Oak-Aspen (Fair)	-	48	57	63
43	Mixed Forest	Oak-Aspen (Fair)	-	48	57	63
51	Dwarf Scrub	Sagebrush (Fair)	-	51	63	70
52	Shrub/Scrub	Oak-Aspen (Fair)	-	48	57	63
71	Grassland/Herbaceous	Sagebrush (Fair)	-	51	63	70
72	Sedge/Herbaceous	Sagebrush (Fair)	-	51	63	70
73	Lichens	Bare Soil	77	86	91	94
74	Moss	Sagebrush (Fair)	-	51	63	70
81	Pasture/Hay	Sagebrush (Fair)	-	51	63	70
82	Cultivated Crops	Sagebrush (Fair to Good)	-	48	59	66
90	Woody Wetlands	Oak-Aspen (Fair)	-	48	57	63
95	Emergent Herbaceous Wetlands	Oak-Aspen (Fair)	-	48	57	63

[1] The values shown in Table 4-1 are from Tables 2-2 in the TR-55 Manual and represent the CN values used in the model.

Drainage and Subbasin Areas

Subbasin areas were calculated using computerized GIS technology and the delineated subbasin boundaries.

Directly-Connected Impervious Area

Directly-Connected Impervious Area only includes impervious surfaces where runoff would flow directly into the storm drain system. This typically includes curb, gutter, inlets, roadways, driveways, roof tops, etc. The amount of directly-connected impervious area for existing development conditions was estimated for each subbasin using the 2020 Google aerial photographs in conjunction with land use and zoning data provided by Salt Lake County and the local municipalities. Each land use type was analyzed based on the aerial photography and the estimated impervious area was recorded. Table 4-2 identifies the percentage of directly-connected impervious area associated with various land uses or zoning for both existing and projected future build-out conditions. The amount of directly-connected impervious area was estimated for full build-out conditions based on projected land-use conditions from the General Plans. For areas that are currently undeveloped, the General Plans for each municipal area was used in conjunction with the data in Table 4-2 to estimate the amount of directly-connected impervious area. Figure 4-4 and Figure 4-5 identify the existing land use and future land use for this study.

Table 4-2
Average Percentage of Directly-Connected Impervious Area Based on Land Use

General Plan Land Use Type	Percent Directly-Connected Impervious Area (Percent)
Medium Density Residential 4-16 units/ac	35%
Low Density Residential 0-3 units/ac	15%
Low Density Residential 2-4 units/ac	20%
Church	75%
Medium Density Residential 4-16 units/ac	35%
Open Space	0%
Industrial	72%
Business/Commercial	85%
Road	100%
High Density Residential 16+ units/ac	70%

Lag Time

Lag time was calculated for mountain watersheds differently than urbanized watersheds. Lag times for urbanized subbasins were estimated using the Worksheet 3 from the TR-55 manual. Lag times for mountain watersheds were estimated using a rain-on-grid model in HEC-RAS. The inputs for the rain-on-grid model was the 2013-14 LiDAR data and the same design storm as the hydrologic model. The cell size ranged from 50 to 100 feet, and the roughness value was 0.06. The results of the rain-on-grid model are consistent with the Watershed Lag Time equation described in NEH 630.1502(a) manual, based on previous studies. Lag times used in the hydrologic model are included in Appendix C.

DESIGN STORM PARAMETERS

The design storm used for Phase 3 of the SWCCS was the same design storm used in Phases 1 and 2 of the SWCCS, 2002 SWCCS, the Herriman Storm Drain Master Plan, and South Jordan Storm Drain

Master Plan: a 100-year, 3-hour storm. This storm was selected because most flooding events in urbanized areas occur as the result of a short cloudburst storm. The 100-year frequency was selected because the creeks and canals are considered to be major storm water conveyance facilities and Salt Lake County uses a 100-year storm as the basis of design for all major drainage facilities. This design storm was selected by Salt Lake County and is the design standard that will be used to identify deficiencies and to size needed capacity improvements. A design storm has a specified depth and temporal precipitation distribution. The design storm was applied to the entire study area using the "nested" Farmer-Fletcher temporal distribution. This distribution is a typical standard for most municipalities along the Wasatch Front.

The following parameters were used to develop the synthetic design storm.

- Storm Duration: 3 hours
- Temporal Precipitation Distribution: Modified Farmer-Fletcher
- Storm Recurrence Interval: 100-year
- Design Storm Depth (From NOAA Atlas 14): (100-Year) 1.92 inches

Areal Reduction of Precipitation Depth

Intense summer cloudburst events typically move across the Salt Lake Valley in relatively small storm cells and rarely cover a large area. Precipitation depth reduction factors for the larger drainage basins were utilized in the hydrologic analysis to adjust point precipitation values for large areas. The NOAA Atlas 2 (1973) recommends a storm-centered areal reduction of 0 to 15 percent for 3-hour storm cells ranging from 0 to 100 square miles in area.

The NOAA precipitation depth adjustment factors, however, are based on data from thunderstorms in the Midwest, rather than those typical to the Salt Lake Valley. The results of a more locally pertinent depth-area precipitation analysis were taken from the Salt Lake City Hydrology Manual. That report recommends the following precipitation depth-area relationship for a thunderstorm of 3-hour duration, with area in square miles:

$$\text{Reduction Factor} = 0.01*(100 - 4.5*\text{Area}^{0.46})$$

The equation above is based on data from *Project Cloudburst,* a study completed by the U.S. Army Corps of Engineers in April 1979 and was used for this analysis. That study involved collection of data from a network of rain gages in Salt Lake City and the vicinity covering an area of roughly 350 square miles. The ARF for this study area is consistent with the previous SWCCS and other studies in the area.

The storm areas used to arrive at these reduction factors were estimated by constructing elliptical thunderstorm cells covering the drainage area contributing to each concentration point. The thunderstorm cell area was used in estimating the ARFs, in the equation listed above. The resulting reduction factors were rounded up to the nearest tenth of an inch, with a threshold reduction of 30 percent (reduction factor = 0.7). The estimated storm cell areas for existing and proposed conditions were the same.

Bingham Creek and Barneys Creek used the areal reduction factors identified in Table 4-3.

If the areal reduction factors are not identified in Table 4-3, then the creek or canal did not use an areal reduction factor (i.e. the areal reduction factor is 1) because the associated drainage areas are too small to require one.

Table 4-3
Areal Reduction Factors

Concentration Point Along Creek[1]	Drainage Area (sq mi)	Areal Reduction Factor
Barneys Creek		
5900 West Detention Basin	16.9	0.85
7900 South and Airport Rd	26.7	0.80
7800 South and Airport Rd	35.6	0.75
Bingham Creek		
Skye Drive	6.0	0.90
8050 South	27.0	0.80

[1] ARFs were not used for the canals, Beef Hollow, Wood Hollow or Wood Hollow South. Those drainage areas were too small to justify an ARF.

EXISTING DETENTION BASINS

Significant portions of the drainage areas are largely developed. Multiple regional and local storm water detention facilities exist in the developed areas. Municipalities provided as-built drawings or design reports for the existing regional detention facilities. For smaller local detention basins or where as-built drawings or design reports were not available, the general assumption was made that detention basins stored enough water to limit the peak design storm discharge to 0.2 cfs/acre for the 100-year storm event, the rate that has been required historically by City and County ordinances for developed land in the study area.

Model Calibration

The final step in the hydrologic modeling process was model calibration. In general, calibration of a hydrologic computer model refers to the process of adjusting model parameters to achieve results consistent with available storm water discharge data in nearby areas. There is no stream gage data on the canals or on Bingham Creek, Barneys Creek, Beef Hollow or Wood Hollow. In areas with no gage data, regional regression equations were used to calibrate the model. Based on the regional regression equation for the area (USGS StreamStats), the runoff rate for undeveloped areas is estimated to be about 0.02 cfs/acre. A detailed description of the regional regression equation and the model calibration process used to develop the runoff rate of 0.02 cfs/ac is included in Section 2 of the SWCCS (the section that discusses Midas Creek and Butterfield Creek). The same unit discharge rate was used for this portion of the SWCCS because the drainage area for Barneys and Bingham Creek are adjacent to the Midas Creek drainage area and drainage and field conditions are similar.

HYDROLOGIC MODELING ASSUMPTIONS

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

1. Rainfall return frequency is equal to associated runoff return frequency.
2. Design storm rainfall has a uniform spatial distribution over each drainage basin.

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

Storm Drain Inlet and System Capacity

The pipes in urban storm drain systems in each of the cities are generally designed to collect and convey runoff from a 10-year design storm. The design storm associated with this study was the 100-year storm, or one that has a one percent chance of occurring in any given year. A cursory analysis of the storm drain inlet and pipe capacities in the developed portions of the local municipal storm drain systems indicated that most of those facilities in the study area do not have capacity to collect and convey runoff from the 100-year design storm. During larger storm events the streets with curb and gutter become the major storm water conveyance facility. Because the creeks are generally at the low point of the drainage system, most of the storm water runoff from a major storm that is being conveyed in the streets will still be conveyed to the creeks and canals, even though it may follow a different path than the storm drain pipe network in getting to the creek.

Future Development Conditions Modeling Considerations

The Utah Department of Environmental Quality in association with the EPA recently made changes to the Municipal Separate Storm Sewer System (MS4) Permit requirements under the Utah Pollution Discharge Elimination System (UPDES). Those changes require that Low Impact Development (LID) practices be implemented with development (where feasible) and that all new development and redevelopment retain onsite runoff produced from the 80th-percentile storm. The 80th-percentile storm occurs quite frequently. The storm depth of the 80th-percentile storm in the study areas have been estimated to be between 0.45 and 0.5 inches, or about 25 percent of the 100-year design storm depth of 1.92 inches. Since this is a large-scale study and since the runoff volume produced from developed areas during the 100-year design storm will far exceed the design capacity of LID facilities that are designed for the 80th-percentile storm, the conservative assumption was made that LID improvements from future development would not have a significant impact on the peak discharge values experienced on the creeks in the study area.

It was assumed that detention facilities will be constructed to attenuate peak runoff discharges from the 100-year design storm associated with future development. This was generally accomplished by simulating a detention facility in each subbasin to limit peak discharge to a desired peak flow rate. Peak allowable discharge rates were evaluated and will be discussed in Chapter 6.

RESULTS & CONCLUSIONS

The estimated peak 100-year design storm discharge rates for Barneys Creek, Bingham Creek, Wood Hollow and Beef Hollow from the existing development conditions hydrologic model are summarized in Table 4-4. Also included in Table 4-4 are the runoff values from the projected full build-out conditions from the 2002 SWCCS and the FEMA Flood Insurance Study.

Table 4-4
Estimated 100-Year Peak Discharge Rates in Creeks (cfs)

Location	City	Preliminary FEMA 100-Year Discharge	2002 Southwest Canal and Creek Study (Full Build-out Conditions)[1]	Existing Development Conditions[2]
Barneys Creek[3]				
Downstream of Detention Basin	West Jordan	10	--	20
Bacchus Highway (U111)	West Jordan	--	--	25
Mountain View Corridor	West Jordan	--	--	120
Downstream of 5900 West DB – Outlet Structure	West Jordan	--	--	10
Clay Hollow Spillway	West Jordan	--	--	0
Downstream of Confluence of Clay Hollow and Barneys Creek	West Jordan	--	--	125
Rio Grande Railroad Culvert	West Jordan	160	--	155
Downstream of Barneys Creek and Barneys Wash (downstream of Airport Road Culvert)	West Jordan	--	--	250
7800 South	West Jordan	--	--	320
Bingham Creek				
Kennecott Retention Ponds	Unincorporated County	100	105	75
Bacchus Highway (U111)	South Jordan	205	300	75
5600 West	South Jordan	360	410	105
4800 West	South Jordan	480	445	105
Welby Jacobs Canal	West Jordan	--	495	120
Utah Lake Distributing Canal	West Jordan	--	560	290
Utah & Salt Lake Canal	West Jordan	--	625	370
South Jordan Canal	West Jordan	--	675	420
Jordan River	West Jordan	--	675	640
Wood Hollow				
Upstream of Welby Jacobs Canal	Herriman	--	115	110
Downstream of Welby Jacobs Canal	Bluffdale/ Herriman	--	115	110
Jordan River	Bluffdale	140	115	130
Beef Hollow				
Upstream of Welby Jacobs Canal	Bluffdale	--	105	90
Downstream of Welby Jacobs Canal	Bluffdale	--	105	90
Wood Hollow South[3]				
Welby Jacobs Canal	Herriman	60	--	23
Utah & Salt Lake Canal	Bluffdale	60	--	25

[1] Assuming Future Development detains peak discharges to 0.2 cfs/acre for the 100-year design storm
[2] Peak discharge includes an Areal Reduction Factor
[3] Barneys Creek and Wood Hollow South were not studied in detail as part of the 2002 Study

There are four key conclusions that can be made from the hydrologic modeling for the creeks. Those conclusions are identified below.

1. **Bingham Creek** - The estimated peak discharge rates associated with existing development conditions identified in Table 4-4 are lower than the projected build-out peak discharge rates identified in the 2002 SWCCS.
2. **Barneys Creek –** The existing conditions flow in Barneys Creek exceeds the FEMA 100-year discharge estimates. This will be discussed in greater detail in Chapters 5 and 6.
3. **Beef Hollow & Wood Hollow –** The 100-year designs storm discharge from existing development conditions in Beef Hollow and Wood Hollow are similar in magnitude to the 2002 SWCCS full build-out conditions flows. This may not be an issue because there is little expected future development within the either drainage area. This is discussed further in Chapters 5 and 6.
4. **Wood Hollow South** - Wood Hollow South was not studied previously and it is not a County flood control facility. The existing conditions flow rate identified as part of this study is lower than the new FEMA 100-year discharge. Capacity of the culverts and bridges will be discussed in future chapters.

The estimated irrigation flows and peak 100-year design storm discharge rates for the canals from the existing development conditions hydrologic model are summarized in Table 4-5. Also included in Table 4-5 are the runoff values from the projected full build-out conditions from the 2002 SWCCS that include both irrigation flows and peak storm drain flows for comparison purposes.

Table 4-5
Estimated 100-Year Peak Discharge Rates in Canals (cfs)

Location	City	Estimated Peak Summer Irrigation Flow	2002 SWCCS Combined Irrigation and Peak Storm Water Flows For Full Build-out Conditions[1]	Combined Irrigation and Peak Storm Water Flows For Existing Conditions[2]
Utah Lake Distributing Canal				
Rose Creek	Riverton	50	140	140
Midas Creek	Riverton	45	235	100
Bingham Creek	West Jordan	30	95	60
7800 South	West Jordan	30	80	65
Utah & Salt Lake Canal				
Rose Creek	Bluffdale	170	140	185
Midas Creek	Riverton	140	220	180
Bingham Creek	West Jordan	130	275	140
7800 South	West Jordan	120	115	90
5400 South	Taylorsville	100	65	140
4700 South	West Valley	70	65	50
8000 West	Magna	60	55	125
South Jordan Canal				
Rose Creek	Bluffdale	80	70	75
12600 South	Riverton	45	270	85
Midas Creek	Riverton	35	65	150
10400 South	South Jordan	30	10	70
Bingham Creek	West Jordan	30	100	120
7800 South	West Jordan	30	135	30
5400 South	Taylorsville	30	115	70
4700 South	Taylorsville	30	55	35
4000 West	West Valley	30	30	35
North Jordan Canal[2]				
Bingham Creek	West Jordan	60	15	100
7800 South	West Jordan	60	15	85
7200 South	West Jordan	52	220	35
6400 South	Murray	52	70	35
5600 South	Murray	52	240	95
5400 South	Murray	52	140	85
4700 South	Taylorsville	47	110	50
I-215	Taylorsville	47	55	85
2700 West	West Valley	47	55	60
3400 West	West Valley	47	55	45
Bangerter Highway	West Valley	47	55	N/A

[1] Assuming Future Development detains peak discharges to 0.2 cfs/ac
[2] Irrigation flows for North Jordan Canal include 42 cfs Kennecott process base flow and irrigation flow

As can be seen from table 4-5, the flow rates in the existing conditions model are either very similar or lower than those identified in the 2002 SWCCS. Chapter 5 and 6 discusses the flow rates further.

CHAPTER 5
HYDRAULIC ANALYSES

Hydraulic models were developed for the channels in the study area using the HEC-RAS computer software. The models included culverts and bridges and were used to estimate existing capacities and to determine existing conveyance capacities and to identify where existing capacity deficiencies exist in the study area. This chapter summarized how the hydraulic analyses were performed.

HEC-RAS hydraulic computer models of the canals and creeks were developed utilizing topographic data, survey data of channel cross sections and hydraulic structures, and aerial photographs. Version 6.0 of the HEC-RAS computer program developed by the United States Army Corps of Engineers was used to perform the hydraulic modeling for this study. The purpose of this chapter is to describe the process used to develop the hydraulic models for the Phase 3 study and to summarize the modeling results associated with the hydraulic analyses.

HYDRAULIC MODEL DEVELOPMENT

This section outlines the general methodology and approach used to complete the hydraulic modeling of the creeks and canals that were studied in detail as part of this project.

Basic Information

Data acquisition and hydraulic model development tasks were completed in accordance with FEMA Guidelines and Specifications.

Topographic Data

Channel cross sections were surveyed at approximately 500-foot intervals on the creeks that generally extended from top of left bank to top of right bank. The surveyed cross sections on the canals were spaced at 1000 feet intervals because the channels are generally prismatic and their slopes are more consistent, and the hydraulic models for the canals do not need as much detail as the creeks. The 2013-14 LiDAR data from UGRC was used to develop cross section data for the creek overbanks outside the surveyed cross section data to develop cross sections for the hydraulic model. Field survey data of hydraulic structures were used to develop the geometry data for hydraulic structures on the creeks.

Downstream Boundary Conditions

The downstream boundary conditions for the hydraulic models were set to be normal depth calculations. Table 5-1 below identifies the downstream boundary condition for each creek and canal in the Phase 3 study.

Table 5-1
Creek and Canal Hydraulic Model Downstream Boundary Conditions (ft/ft)

Creek/Canal	Boundary Condition Slope
Barneys Creek[1]	0.002
Bingham Creek	0.011
Wood Hollow	0.096
Wood Hollow South	0.08995
Beef Hollow[1]	0.003
Utah Lake Distributing Canal	0.0002
Utah & Salt Lake Canal	0.0009
South Jordan Canal	0.0016
North Jordan Canal	0.0044

[1] The hydraulic model terminates at a detention or debris basin. The boundary condition slope represents an approximation of the water surface elevation associated with the detention or debris basin.

Manning's "n" Values and Expansion/Contraction Coefficients

Values for channel overbank roughness coefficients, or Manning's "n" coefficients, were estimated based on field observations, hydraulic modeling literature, aerial photography, and engineering judgment. As a general rule, Manning's "n" values were selected that would result in subcritical flow conditions. Generally, the Manning's "n" value used for the overbank was between 0.040 and 0.080, and a value of 0.035 was used for the main channel. Those Manning's "n" values are within an acceptable range that reflect the channel conditions.

Stream Layout and Cross-section Locations

The creek and canal centerline locations were digitized using the ArcGIS software and the 2020 photographic imagery available from the UGRC website. Channel cross sections were surveyed and entered into the hydraulic model at intervals of about 500 feet for creeks or 1000 feet for canals, as discussed previously. The cross sections included the top of bank, toe of channel banks, flow line and other grade breaks. The geometry data for the overbank areas for the cross sections were collected by extending the cross sections limits across the overbank and floodplain limited using the digital 2013-14 LiDAR data and GIS tools. Survey data of the hydraulic structures were used to develop the geometry data for hydraulic structures.

CALIBRATION

Calibration of a hydraulic computer model generally consists of using actual discharge and water surface measurements in the field and comparing those measurements with the computed by the model. There is no stream gage data for the creeks and canals. Without calibration data, the validity of the model results will be directly tied to the accuracy of the initial, visual assessment of the creek. Since this is the case, a detailed photographic log of the creeks and canals are included in Appendix B of this report.

The calibration process for the hydraulic models for the creeks and canals are described below:

- **Creeks** - Most of the Bingham Creek, Barneys Wash, Wood Hollow, Wood Hollow South and Beef Hollow channels are relatively steep with slopes ranging from 1 to 5 percent. Because the slopes are relatively high, the culverts and bridges will be inlet controlled. The computed capacities of the culverts obtained from the HEC-RAS model were compared to inlet control nomographs from the UDOT Drainage Manual of Instruction (MOI) for the 62 culverts and bridges that were part of the Phase 3 study. Tables that compare the model results to the nomographs can be found in Appendix D.
- **Canals** - The longitudinal slope for the canals ranges from 0.1% to 0.01%. Because of the relatively flat longitudinal slopes, the culverts and bridges along the canals are typically not inlet controlled. The calibration process for the canals included comparing the capacities computed by the model software for the 272 culverts and bridges in the model to Manning's equation. Tables that compare the model results to Manning's equation can be found in Appendix E.

The HEC-RAS model results for the creeks and canals were similar to either the inlet control nomographs or Manning's equation. The structure modeling did not need to be modified as part of the calibration process.

RECOMMENDED CHANNEL FREEBOARD

The recommended minimum channel freeboard for the creeks was set at 2 feet for design and purposes of evaluating maximum safe conveyance capacities. The recommended minimum channel freeboard for canals was set to be 0.5 foot for the purposes of evaluating maximum safe conveyance capacities. The recommended freeboard for the canals is lower than the creeks because the canals are typically prismatic channels, with little sinuosity, lower velocities, and less turbulence, and there is less variability in anticipated maximum discharge because there is much less natural tributary watershed. In performing the detailed hydraulic analyses, channel reaches were considered to have adequate capacity to convey the 100-year design discharge if the hydraulic model indicates that there is more than the minimum recommended freeboard. If an area had less than the minimum desired freeboard, but the channel was not overtopping (i.e. is it not flooding, but has little freeboard), that channel reach was considered to have a potential capacity deficiency but no project would be recommended to increase capacity or freeboard. If the hydraulic computer model predicted that a reach of channel may be overtopped during the estimated 100-year design discharge, that reach would be considered to have a capacity deficiency and a project to mitigate that deficiency would ultimately be identified. Culverts and bridges were considered to be capacity deficient if they overtopped, or if they restricted flow in the channel and created an upstream freeboard deficiency.

The hydraulic models assume clean water conditions, and that modeled hydraulic structures are not obstructed with trees, vegetation or other debris. Areas that have less than the recommended freeboard during the design flow event may have the banks overtop during a large storm event do to plugging or other restrictions in the channel caused by debris or other vegetation. The freeboard recommendations identified in this report are based on previous experience and may need to be adjusted based on the debris potential on the canals.

Irrigation Flows

As part of this project, coordination was performed with key representatives from canal companies to estimate the maximum irrigation flow rates in the canals during the peak growing season. Data from previous studies were used in conjunction with data provided by the irrigation companies to estimate the base irrigation flows that would be included in the hydraulic models. Table 5-2 identifies anticipated maximum irrigation flow rates in the canals obtained from the irrigation companies that were included in the hydraulic models.

Table 5-2
Canal Peak Summer Irrigation Flows Identified by Irrigation Companies

Location	Peak Summer Irrigation Flow (cfs)
Utah Lake Distributing Canal	
Rose Creek	50
Midas Creek	45
Bingham Creek	30
Utah & Salt Lake Canal	
Rose Creek	170
Midas Creek	140
Bingham Creek	130
7800 South	120
5400 South	100
4700 South	70
8000 West	60
South Jordan Canal	
Rose Creek	80
12600 South	45
Midas Creek	35
10400 South	30
North Jordan Canal[1]	
Bingham Creek	60
7200 South	52
4700 South	47

[1] Irrigation flows for North Jordan Canal include 42 cfs Kennecott process base flow and irrigation flow

The peak irrigation flow rates were included in the hydraulic models when evaluating capacities because only canal capacity in excess of the maximum irrigation flows can be relied upon to convey storm water flow. In other words, if a certain reach of a canal has a capacity of 100 cfs and a maximum irrigation flow of 80 cfs, only 20 cfs is consistently available to convey storm water. The month of August is typically when the peak irrigation flows are being conveyed in the canals, and August is also the month when it is typical to have a peak thunderstorm storm event. Therefore, the combined the peak irrigation flows and peak storm water flows were used in the hydraulic analysis.

STORM WATER OVERFLOW STRUCTURES

The canals in the study area were originally constructed primarily to convey irrigation water to farmland, intercepting at some locations the natural drainages and surface storm water runoff. The canals were designed such that their size and conveyance capacities decrease in downstream direction, since irrigation needs also decrease in the downstream direction. As a result, the canals are ill equipped to convey significant amounts of storm water discharges because the sizes of storm drain facilities generally increase in the downstream direction as the amount of conveyed runoff increases. To alleviate potential canal flooding during runoff events, Salt Lake County has installed storm water overflow/dump-out structures at key locations (mostly creek crossings) on the canals that allow storm water in the canals to be released in an effort to keep the canals from overtopping.

Most of the overflow/dump-out structures typically include a weir as well as one or more manually operated gates that can be used to drain the canals. As part of this study, an inventory was performed for each of the overflow structures. This included the total weir length as well as the elevation at the top of any existing stop logs and size of the manual gates. The stop logs are typically present in the overflow structures to keep irrigation flows within the canal and only allow stormwater to pass over the weir. As part of this study, the approximate release capacity of the overflow structure, assuming gates to be closed, was calculated to verify capacity to dumpout storm water from the canal. Table 5-3 summarizes the estimated dump-out capacity and storm water in the canal.

Table 5-3
Canal Storm Water Overflow Structure Inventory and Capacity

Turnout Location	Weir Length (ft)	Total Storm Water in Canal with Future Build-Out (cfs)	Stop Logs Present[1]	
			Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)
Utah Lake Distributing Canal				
Rose Creek	12	95	80	115
Midas Creek	18	55	290	360
Bingham Creek	20	30	280	355
7800 South	24	35	240	170
Utah & Salt Lake Canal				
Rose Creek	18	190	160	220
Midas Creek	18	180	205	265
Bingham Creek	20	145	350	430
7800 South	24	130	185	255
5400 South	15	150	275	340
4700 South	15	50	340	405
8000 West	20	140	605	700
South Jordan Canal				
Rose Creek	15	75	235	290
Midas Creek	15	105	125	170
10400 South	10	35	360	410
Bingham Creek	14	105	100	145
7800 South	28	20	900	1030
7000 South	16	25	295	360
5400 South	10	40	140	175
4700 South	12	5	100	135

Turnout Location	Weir Length (ft)	Total Storm Water in Canal with Future Build-Out (cfs)	Stop Logs Present[1]	
			Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)
North Jordan Canal				
7800 South		85	150	175
7200 South	19	40	125	150
6500 South	15	35	100	130
5600 South	16	125	100	130
4700 South	27	50	100	130
I-215	4.6	90	100	125
2700 West	7.4	65	100	125
4000 South	8	20	100	125

[1] Based on field multiple field visits it appears that stop logs are present year round (based on the ordinary high water mark as well as high water during irrigation season).

As can be seen from the information presented in Table 5-3, generally the overflow structures have capacity sufficient to divert the maximum potential storm water inflow from the upstream canal reach into a creek or a major storm water facility. Multiple overflow structures have been constructed since the 2002 SWCCS was completed.

HYDRAULIC MODELING RESULTS

The hydraulic models of the creeks and canals were run using the 100-year design storm peak discharges associated with existing development conditions identified in Chapter 4. The model was run using steady-state conditions. The results of those runs are included on Figures 5-1 through 5-8.

Canals

Figures 5-1 through 5-4 identify the existing capacity deficiencies along the canals. As can be seen in Figures 5-1 through 5-4, the structures along the canals have capacity for both the peak summer irrigation flow and the storm drain discharges into the canal during the 100-year storm event for existing development conditions. As Figures 5-1 through 5-4 show, the majority of the canal channels have capacity to safely convey runoff from the 100-year design storm and the irrigation flow, with a few notable exceptions discussed below. Recommendations to improve the canals are included in Chapter 6.

ULDC. The ULDC has multiple sections of the east canal bank in an area that is approximately 1.5 miles in length that may overtop during the 100-year storm event between approximately 14900 South and Bangerter Hwy. Most of the developments in this area are residential half acre lots, where storm water discharges into the canal are undetained. Because the large storm water discharges in this area, the canal does not have capacity for the combined peak summer irrigation flows and the 100-year storm water discharge. It is recommended that those segments of the east embankment of the canal in that area be improved to provide minimum freeboard.

SJC. The SJC has multiple sections of the canal in an area that is approximately 3.5 miles in length that may overtop during the 100-year storm event between approximately 10700 South and Bingham Creek. This section of the canal collects storm water runoff from large portions of South Jordan. The canal does not have capacity for the combined peak summer irrigation flows and the

100-year storm water discharge. Portions of the east bank and west bank of the canal in that area will need to be improved.

Miscellaneous Canal Deficiencies. Besides the sections of ULDC and SJC listed above, there are a few isolated areas along the canals where water may overtop the banks of the canals during large storm events, with the potential of flooding nearby developments. Most of those areas are relatively short, ranging in length between 50 feet and 1000 feet. The capacity of the canals in these areas will need to be increased by raising the banks in those areas.

Wood Hollow

Figure 5-5 and Table 5-4 identifies the existing flow rates, existing capacities and existing deficiencies associated with the 100-year design storm on Wood Hollow storm drain facilities. The build-out conditions flow rates from the 2002 SWCCS are included on Table 5-4 to compare existing conditions flow rates to the previous master plan flow rates. When the 2002 SWCCS was completed, Wood Hollow did not reach the Jordan River. Since then, new facilities were constructed to convey runoff from Wood Hollow to the Jordan River. This included a pipe crossing over the Welby Jacobs Canal, new channel to Redwood Road and a pipeline from Redwood Road along Iron Horse Blvd to a regional detention basin that discharges into the Jordan River.

The hydraulic models associated with Wood Hollow indicate that the Welby Jacobs Canal crossing and a 2,600 foot section of the pipeline along Redwood Road and Iron Horse Blvd were not constructed with adequate capacity to convey existing flow rates identified on Table 5-4, or the flow rates identified in the 2002 SWCCS. The existing conditions flow rates on Wood Hollow are similar to the full build-out conditions flow rates identified in the 2002 SWCCS as discussed in Chapter 4.

Wood Hollow South

Figure 5-5 and Table 5-5 identify the existing flow rates, existing capacities and existing deficiencies on Wood Hollow South associated with the 100-year design flow. Wood Hollow South is not a designated Salt Lake County flood control facility at this time, but was recently included by FEMA on the Salt Lake County FIS update. There are no existing capacity deficiencies associated with Wood Hollow South. However, Wood Hollow South does not currently extend to the Jordan River, instead it discharges into the Utah & Salt Lake Canal. Wood Hollow South is further discussed in the next chapter and in a Technical Memorandum included in Appendix A.

Beef Hollow

Figure 5-6 and Table 5-6 identify the estimated flow rates for existing conditions, existing capacities and existing deficiencies on Beef Hollow associated with the 100-year design flow. The build-out conditions flow rates from the 2002 SWCCS are included on Table 5-6 to compare existing conditions flow rates to the previous master plan flow rates. There is only a single deficiency on Beef Hollow, a dirt access road upstream of Redwood Road Based on general plans, this access road will eventually be replaced by Mountain View Corridor (MVC). The culvert will be replaced and improved when MVC is constructed. If the culvert overtops, flooding is unlikely to affect nearby development. Therefore, it is recommended that the culvert be left in place until then, unless it is washed out.

Table 5-4
Estimated 100-Year Peak Discharge Rates in Wood Hollow (cfs)

Location	City	FEMA FIS 100-year Flow Rate	2002 SWCCS Full-Build Conditions	Existing Conditions	Existing Structure Size	Estimated Capacity
Pipe from Detention Basin to the Jordan River	Bluffdale	140	115	130	36” RCP	200
Pipe from Utah & Salt Lake Canal to Overflow Pond	Bluffdale	--	115	130	48” RCP	235
Pipe from Utah Lake Distributing Canal to Utah & Salt Lake Canal	Bluffdale	--	115	130	42” to 48” RCP	155-235
Pipe from Redwood Rd. to Utah Lake Distributing Canal[1]	Bluffdale	--	115	130	30” to 42” RCP	85-120
Pipe under Redwood Rd.	Herriman/Bluffdale	--	115	110	48” RCP	140
Welby Jacob Canal[1]	Herriman	--	115	110	39” CMP	70
Mountain View Corridor	Herriman	--	115	110	48” RCP	280
Gravel Pit Road	Herriman	--	115	100	48” RCP	420

[1] Culverts highlighted in red are capacity deficient in existing conditions.

Table 5-5
Estimated 100-Year Peak Discharge Rates in Wood Hollow South (cfs)

Location	City	FEMA FIS 100-year Flow Rate	Existing Conditions	Existing Structure Size	Estimated Capacity
Utah & Salt Lake Canal	Bluffdale	60	25	--	--
Utah Lake Distributing Canal	Bluffdale	--	25	10’ X 6’ Arch	1100
Trail	Bluffdale	--	25	4’ CMP	170
Redwood Road	Herriman/Bluffdale	--	23	27’ X 11’ Box	3980
Pipe Under Welby Jacobs Canal	Herriman	--	23	2’ CMP	55
Pipe from Start to Welby Jacobs Canal	Herriman	--	23	2’ RCP	30

Table 5-6
Estimated 100-Year Peak Discharge Rates in Beef Hollow (cfs)

Location	City	2002 SWCCS Full-Build Conditions	Existing Conditions	Existing Structure Size	Estimated Capacity
Jordan River Parkway & Utah Lake Distributing Canal	Bluffdale	105	90	48" RCP	160
Dirt Road # 1	Bluffdale	105	90	60" CMP	260
Redwood Rd.	Bluffdale	105	90	42" RCP	115
Dirt Road #2	Bluffdale	105	90	18" CMP	8

Bingham Creek

Figure 5-7 and Table 5-7 identify the existing conditions flow rates, existing capacity and existing deficiencies on Bingham Creek associated with the 100-year design flow. The build-out conditions flow rates from the 2002 SWCCS are included on Table 5-7 to compare to the existing conditions flow rates. The hydraulic model associated with Bingham Creek indicate that the channel has adequate capacity to convey peak 100-year discharges, but there are some culverts on the creek that are currently undersized. The recommended improvements are detailed in Chapter 6 of this report.

Most of the existing conditions flow rates on Bingham Creek are lower than the build-out conditions flow rates identified in the 2002 SWCCS as discussed in Chapter 4. Therefore, most of the deficiencies on Bingham Creek were identified as part of the 2002 SWCCS. The only area on where that is not the case is between 1300 West and the Jordan River. However, the culvert deficiency downstream of 1300 West identified on Figure 5-7 was also identified as a deficiency in the 2002 SWCCS.

The 100-year discharge identified by FEMA are also identified on Figure 5-7. As can been seen from figures, the 100-year discharge rates identified by FEMA (FEMA flow rates) are higher than the flow rates for existing conditions, but the FEMA flow rates are lower than 2002 SWCCS build-out conditions flow rates. This is to be expected because FEMA typically estimates flow rates based on existing conditions, rather than on full build-out conditions. We will discuss the future conditions flow rates in the next chapter for Bingham Creek.

Barneys Creek

Barneys Creek was not studied as part of the 2002 SWCCS, so the existing conditions flow rates cannot be compared to that study. But the existing conditions flows along Barneys Creek can be compared to the FEMA flow rate, which was estimated as part of a LOMR that was submitted in 2007 (LOMR Case Number 07-08-0330P). That LOMR application was completed by BC&A and was approved by West Jordan City and Salt Lake County before it was submitted and approved by FEMA. The 100-year flow rates identified in that LOMR were also consistent with the West Jordan Storm Drain Master Plan completed in 2003 and updated in 2012. The FEMA flow rates for Barneys Creek identified as part of that LOMR were build-out conditions flow rates that can be used for planning purposes, and did not represent existing conditions. The facilities on Barneys Creek were sized based on those FEMA flow rates. The FEMA flow rates are identified on Figures 5-8 with the existing flow rates, existing capacity and existing deficiencies on Barneys Creek.

As can be seen from Figure 5-8 and Table 5-8, Barneys Creek does not have much additional capacity for additional storm water discharge from future development. There are already three required improvements to culverts along Barneys Creek to safely convey the 100-year flow. Additionally, downstream of Welby Park Drive, Barneys Creek is no longer conveyed in an open channel. The culvert crossing at Welby Park Drive discharges into a storm drain system that does not have much capacity for additional storm water runoff from future development. The storm drain system between Welby Jacobs Drive and the detention basin immediately west of Jordan Landing Blvd is owned and maintained by Salt Lake County. Downstream of that detention basin, flow from Barneys Creek is conveyed through a storm drain system in 7800 South owned and maintained by West Jordan City. The storm drain system owned by West Jordan City was not included in this study. Barneys Creek flow rates and recommendations are discussed in greater detail in the next chapter, and the Technical Memorandum included Appendix F.

Table 5-7
Estimated 100-Year Peak Discharge Rates in Bingham Creek (cfs)

Location[1]	City	FEMA FIS 100-year Flow Rate	2002 SWCCS Full-Build Conditions	Existing Conditions	Existing Structure Size	Estimated Capacity
North Jordan Canal	West Jordan	--[2]	675	640	6' X 12' Box	960
Gravel Lane/8050 South	West Jordan	--[2]	675	640	6' X 20' Box	950
No Name Farm Bridge	West Jordan	--[2]	675	640	48" & 32" RCP	105
1300 West / Temple Drive	West Jordan	--[2]	675	540	6' X 12' Box	1070
Redwood Road	West Jordan	--[2]	675	465	5' X 15' Box	800
2200 West / South Jordan Canal	West Jordan	--[2]	625	420	4' X 12' Box	570
2700 West / Utah & Salt Lake Canal	West Jordan	--[2]	560	370	5' X 10' Box	780
3200 West	West Jordan	--[2]	560	370	5' X 8' Box	650
Utah Lake Distributing Canal	West Jordan	--[2]	465	290	4' X 8' Box	400
3400 West	West Jordan	--[2]	495	290	5' X 10' Box	7740
Bangerter Highway	West Jordan	--[2]	495	290	7' X 13' Box	1130
4000 West	West Jordan	--[2]	495	120	5' X 10' Box	560
Welby Jacobs Canal	West Jordan	480	445	120	10' X 4.5' Arch	1100
Skye Drive	South Jordan	360	445	105	4' CMP	130
4800 West	South Jordan	205	410	105	10' X 10' Box	2000
Railroad	South Jordan	205	410	105	14.5' CMP	4000
Mountain View Corridor Northbound	South Jordan	205	410	75	100' Wide Bridge	4000
Bacchus Highway	South Jordan	100	300	75	8' X 6' Box	760
Dirt Access Road	Unincorporated County	100	105	75	2.67' CMP	70

[1] The Table 5-7 does not include all culvert crossings. See Figure 5-7 for all culvert crossings and deficiencies.
[2] Culverts highlighted in red are capacity deficient in existing conditions.
[3] The FEMA FIS for Bingham Creek currently ends at the Welby Jacobs Canal

Table 5-8
Estimated 100-Year Peak Discharge Rates in Barneys Creek (cfs)

Location	City	FEMA FIS 100-year Flow Rate	Existing Conditions	Existing Structure Size	Estimated Capacity
7800 South to Airport Detention Basin	West Jordan	--	320	2 x 48" RCP	390
Airport Rd. to 7800 South	West Jordan	--	250	66" RCP	220
Airport Rd. Crossing	West Jordan	--	155	2 x 42" RCP	185
Railroad Crossing (4600 West)	West Jordan	160	155	66" RCP	290
4660 West	West Jordan	--	155	5' X 3' Box	135
4800 West	West Jordan	--	155	5' X 3' Box	100
Barneys Creek Trail #1 (5200 West)	West Jordan	--	125	5' X 3' Box	65
Barneys Creek Trail #2 (5100 West)	West Jordan	--	75	5' X 3' Box	80
Amethyst Drive (5420 West)	West Jordan	--	75	5' X 3.2' Box	100
Grizzly Way (5300 West)	West Jordan	--	40	2 x 42" RCP	180
5600 West	West Jordan	10	10	36" RCP	105
Mountain View Corridor	West Jordan	--	120	8' X 6' Box	430
Maple Water Drive (5900 West)	West Jordan	--	100	10' X 6' Box	410
Birch Water Lane (5980 West)	West Jordan	--	100	10' X 6' Box	500
Fallwater Drive (6000 West)	West Jordan	--	100	10' X 6' Box	615
6160 West	West Jordan	--	70	8' X 6' Box	475
8600 South	West Jordan	--	50	8' X 6' Box	420
6400 West	West Jordan	--	50	8' X 6' Box	370
Bacchus Highway	West Jordan	--	25	72" RCP	250
Farm Road (7400 West)	West Jordan	--	20	30" RCP	40

[1] Culverts highlighted in red are capacity deficient in existing conditions.

CONCLUSIONS AND RECOMMENDATIONS

The hydraulic analysis of the existing canal and creeks in the study area resulted in the following major conclusions.

- **Canal Structures (ULDC, USLC, SJC & NJC) –** Based on the hydraulic analysis, the structures on the canals have capacity for the peak irrigation flows combine with the estimated 100-year storm water inflow.
- **Canal Channel Capacity (ULDC, USLC, SJC & NJC) –** The majority of the canal channels have capacity for the peak irrigation flows combine with the estimated 100-year storm water inflow, with a few notable exceptions on the SJC and the ULDC discussed previously. There are also a few isolated areas of channel deficiencies on each of the canals. Those areas are identified on Figures 5-1 through 5-4. The recommended improvements associated with the canals are discussed in Chapter 6.
- **Available Canal Capacity (ULDC, USLC, SJC & NJC) –** There is very little capacity available in the canals for future development. However, this is not anticipated to be a major issue. Most of the areas the discharge storm water into the canals are currently fully developed and there is very little open space that has the potential for development. The remaining infill or re-development in the canal drainage areas can detain flows to the peak flow rate associated with the receiving creek. If there is no creek downstream, the maximum allowable discharge will be decided by the local municipality, but should not be higher then 0.2 cfs/ac.
- **Bingham Creek –** Bingham Creek has capacity for additional flows from future development. The hydraulic model associated with Bingham Creek indicate that the drainage channels have adequate capacity to convey peak 100-year discharges, but there are some culverts on the creek that are currently undersized. However, the undersized culverts were identified as deficient as part of the 2002 SWCCS.
- **Barneys Creek –** Some segments of Barneys Creek do not have capacity to safely convey the peak 100-year existing conditions design discharge rate. Three projects will be required to mitigate the capacity deficiencies along the Barneys Creek so it can safely convey the 100-year existing conditions discharge without damaging existing homes and structures. Barneys Creek does not have capacity to receive any additional storm water runoff from future development without making the existing problems worse and creating new problems or deficiencies. Alternative methods that could be implemented to resolve the existing deficiencies and safely manage runoff from future development will be addressed in Chapter 6, and in a technical memorandum in Appendix F.
- **Barneys Creek FEMA Mapping -** The discharges used by FEMA to develop the 100-year floodplain along Barneys Creek are slightly higher than the 100-year discharges associated with existing development conditions. This means that some of the flooding problems shown on the preliminary FEMA Flood Insurance Rate Maps may not be as severe as they are illustrated. In evaluating future improvements, it is recommended that an effort be made to limit the projected future develop discharges to be less than or equal to the existing FEMA 100-year discharge values so that no new flood hazards are created.
- **Bingham Creek FEMA Mapping -** The discharges used by FEMA to develop the 100-year floodplain along Bingham Creek are slightly higher than the 100-year discharges associated with existing development conditions. However, the planning flow rates for Bingham Creek culvert and channel are based on the 2002 SWCCS, and are being updated as part of this study. We would recommend using the flow rates identified in this study as the basis for

planning in the future. Therefore, once the drainage area for Bingham Creek is closer to built-out, we would recommend updating the 100-year discharge rate and FEMA Flood Rate Insurance Maps (FIRMs) associated with Bingham Creek.

- **Wood Hollow –** New facilities installed since the 2002 SWCCS was completed to connect Wood Hollow to the Jordan River are undersized for the existing conditions flow rates. This will require upsizing the facilities to safely convey the flow all the way to the Jordan River. Further analysis and recommendation for Wood Hollow and nearby drainages are part of the Wood Hollow and Wood Hollow South Drainage Alternative Study Technical Memorandum provided in Appendix A.
- **Wood Hollow South –** Wood Hollow South has capacity for additional flow from future development without channel or culver deficiencies. Since Wood Hollow South does not currently reach the Jordan River, alternatives were analyzed as part of a Technical Memorandum provided in Appendix A on how to address runoff within the Wood Hollow South drainage basin.
- **Beef Hollow –** Beef Hollow has capacity to safely convey existing conditions flow to the Jordan River with the exception of a single culvert. This culvert should be replaced when Mountain View Corridor is extended into Utah County or if the existing dirt road is washed out.

CHAPTER 6
FUTURE CONDITIONS AND RECOMMENDATIONS

INTRODUCTION

The previous chapters in this report discussed the results of the hydrologic and hydraulic analyses and the deficiencies associated with the existing development conditions. This chapter will focus on the projected future development conditions model development, results, conclusions, and recommendations for each of the County flood control facilities covered by this study.

Future Model Development

A future conditions model was developed for each of the County flood control facilities included in this study. The future conditions model represents the projected full build-out conditions in the drainage area associated with each facility which was based on the general plan for each municipal area. The hydrologic and hydraulic models were updated to represent full build-out conditions by modifying the hydrologic parameter "directly connected impervious area" (see description in Chapter 4). The drainage areas that discharge storm water runoff into the canals are mostly build-out. Therefore, for the canals, the existing conditions and future conditions models were very similar. For the creeks (Bingham, Barneys, Wood Hollow, Wood Hollow South and Beef Hollow) there are large areas that have the potential to develop in the future, especially in the upstream portion of the drainage areas. For the creeks, the existing conditions and future conditions models were very different due to those areas that have the potential to develop.

In the build-out development conditions hydrologic model, a generic detention basin was generally added to the modeled subbasins to limit the peak discharge rate from the 100-year design storm to a maximum of 0.2 cfs/acre for areas that are anticipated to develop in the future. The 0.2 cfs/acre discharge rate was utilized in the 2002 SWCCS master planning effort and has been the default detention standard throughout most of Salt Lake County for many years.

If the estimated peak flow rates from the full build-out conditions hydrologic model were similar to those from the 2002 SWCCS future conditions estimate, then no additional analysis was completed. If the projected build-out conditions flow rate was significantly higher than the 2002 SWCCS flow rate, then sometimes potential improvement scenarios were analyzed in an effort to identify the best improvement alternative to resolve identified capacity deficiencies. A brief description of hydrologic and hydraulic analyses associated with projected full build-out conditions in the drainage basins associated with each of the creeks and canals is provided below.

Canals (ULDC, USLC, SLC & NJC)

The future conditions flow rates at key locations along the study reaches for the four canals are identified in Table 6-1. A summary of the projected future flow rates for the four canals and associated hydraulic structures is provided in Appendix G.

Table 6-1
Estimated Future 100-Year Peak Discharge Rates in Canals and Existing Culvert Capacities

Location	City	Existing Conditions Combined Storm Water & Irrigation Flow (cfs)	Estimated Future Build-Out Combined Storm Water & Irrigation Flow (cfs)	Existing Structure Size	Estimated Existing Structure Capacity (cfs)
Utah Lake Distributing Canal					
Iron Horse Blvd.	Bluffdale	90	90	60" RCP	190
Bangerter Hwy.	Bluffdale	145	145	17' X 5' Box	320
12600 South	Riverton	75	75	12' X 6' Box	260
9000 South	West Jordan	60	60	10' X 6' Box	205
8070 South	West Jordan	65	65	12' X 6' Box	260
Utah & Salt Lake Canal					
Iron Horse Blvd.	Bluffdale	190	200	20' X 7' Box	650
2200 West	Bluffdale	345	350	20' X 7.75' Box	750
11800 South	Riverton	320	320	22' Wide Bridge	810
2700 West	West Jordan	270	275	18' X 8' Arch	450
Trax Line	West Jordan	130	135	34' Wide Bridge	510
Bastile Dr.	Taylorsville	240	250	22' Wide Bridge	560
4000 West	Kearns	120	120	24' Wide Bridge	320
Valley Forge Rd.	Magna	185	200	20' X 6' Arch	400
South Jordan Canal					
14400 South	Bluffdale	155	155	14' X 6.5' Box	405
12600 South	Riverton	85	85	16' X 6' Box	260
12040 South	Riverton	150	150	14' X 6' Box	364
1300 West	South Jordan	70	70	16' X 6.4' Box	475
8660 South	West Jordan	120	140	17' X 4' Box	160
7800 South	West Jordan	30	30	16' X 3.5' Box	120
5505 South	Taylorsville	70	70	11' X 2.5'	105
3250 West	Taylorsville	35	35	8' X 3' Box	70
3900 West	West Valley	35	35	8' X 5' Box	130
North Jordan Canal[3]					
Trax Line	West Jordan	145	145	20' X 7.7' Arch	400
Valley Water Access	West Jordan	92	97	20' Wide Bridge	545
7000 South	West Jordan	102	102	15.7' Wide Bridge	520
5800 South	Murray	147	177	21' Wide Bridge	305
1300 West	Taylorsville	157	172	12' X 6' Box	315
Access Bridge	Taylorsville	107	107	28' Wide Box	470
I-215	Taylorsville	137	147	18' Wide Bridge	360
4100 South	Taylorsville	62	67	18' Wide Bridge	360
3400 West	West Valley	92	92	5' RCP	90

As can be seen from Table 6-1, the existing conditions flow rates and the future conditions flow rates are generally very similar. The results of the future conditions hydraulic model did not identify any deficiencies on the canals that were not identified and discussed in Chapter 5. Therefore, no additional alternatives restricting future peak flow rates were studied. No culvert or bridge capacity deficiencies were identified on the canals. The Figures 6-1 through 6-4 identify the estimated future conditions flow rates, capacities, and deficiencies. It is important to note that the hydraulic models assume clean water conditions and that structures are not obstructed with trees, vegetation or other debris. Blockages, sediment, and other obstructions may decrease the capacity of culverts and bridges during large storm events and cause flooding issues.

The recommended improvements associated with the canals consists of raising embankment elevations in areas. In most areas, the maintenance road adjacent to the channel can be raised by placing and compacting engineered fill to the required elevation (usually 8 inches to 2.0 feet above the current ground surface elevation). In areas where the banks of the canal will be raised, it is recommended that the embankments be raised to a point where there is a minimum of 6-inches of freeboard. We have assumed that there is enough ROW along the canals for the needed improvements, or that a small retaining wall (1-2 feet tall) can be constructed to keep the improvements within the ROW. The cost estimate for the channel improvements does not include ROW costs. It only includes the costs to raise the embankment heights. Figures 6-5 through 6-8 identifies the recommended improvements to resolve both existing and proposed future capacity deficiencies along the canals and a summary of the conceptual construction cost estimate to make those improvements.

Bingham Creek

The estimated full build-out conditions flow rates for Bingham Creek are identified in Table 6-2. Figure 6-9 identifies the future conditions flow rates, capacities, and deficiencies.

Table 6-2
Estimated 100-Year Peak Discharge Rates and Structure Capacities on Bingham Creek

Location[1]	City	FEMA FIS 100-year Flow Rate (cfs)	2002 SWCCS Full-Build Conditions (cfs)	Existing Development Conditions (cfs)	Future Development Conditions (cfs)	Existing Structure Size	Estimated Existing Capacity (cfs)
North Jordan Canal	West Jordan	--[2]	675	640	950	6' X 12' Box	960
Gravel Lane/8050 South	West Jordan	--[2]	675	640	950	6' X 20' Box	950
No Name Farm Bridge[3]	West Jordan	--[2]	675	640	950	48" & 32" RCP	105
1300 West / Temple Drive	West Jordan	--[2]	675	540	720	6' X 12' Box	1070
Redwood Road	West Jordan	--[2]	675	465	630	5' X 15' Box	800
2200 West / South Jordan Canal	West Jordan	--[2]	625	420	565	4' X 12' Box	570
2700 West / Utah & Salt Lake Canal	West Jordan	--[2]	560	370	500	5' X 10' Box	780
3200 West	West Jordan	--[2]	560	370	500	5' X 8' Box	650
Utah Lake Distributing Canal	West Jordan	--[2]	465	290	450	4' X 8' Box	400
3400 West	West Jordan	--[2]	495	290	450	5' X 10' Box	7740
Bangerter Highway	West Jordan	--[2]	495	290	450	7' X 13' Box	1130
4000 West	West Jordan	--[2]	495	120	320	5' X 10' Box	560
Welby Jacobs Canal	West Jordan	480	445	120	320	10' X 4.5' Arch	1100
Skye Drive[3]	South Jordan	360	445	105	220	4' CMP	130
4800 West	South Jordan	205	410	105	220	10' X 10' Box	2000
Railroad	South Jordan	205	410	105	220	14.5' CMP	4000
Mountain View Corridor Northbound	South Jordan	205	410	75	80	100' Wide Bridge	4000
Bacchus Highway	South Jordan	100	300	75	80	8' X 6' Box	760
Dirt Access Road	Unincorporated County	100	105	75	80	2.67' CMP	70

[1] The Table 6-2 does not include all culvert crossings. See Figure 6-9 for all culvert crossings and deficiencies.
[2] The FEMA FIS report for Bingham Creek currently ends at the Welby Jacobs Canal
[3] Culverts highlighted in red are capacity deficient in future conditions.
[4] The culvert crossing the Utah Lake Distributing Canal is a Detention Basin Outlet and is not considered deficient.

As can be seen in Table 6-2, most of the future conditions flow rates for Bingham Creek are slightly lower the estimated 2002 SWCCS full build-out conditions flow rates. The flow rates for the 2002 SWCCS are included for comparison purposes. The only area where the projected future conditions flows are higher than the 2002 SWCCS future development flows is between 1300 West and the Jordan River. However, it is also important to note that there are no additional deficiencies than those identified in Chapter 5 due to the increased flows downstream of 1300 West caused by projected future development. The only recommended improvement in this area is to replace the private culvert downstream of 1300 West. That culvert was also identified in the 2002 SWCCS as being undersized. The culvert has not been replaced since 2002, and it still needs to be replaced with a larger culvert.

The projected full build-out condition flow rates are based on the assumption that all future development will detain flows from the 100-year design storm to the maximum discharge rate of 0.2 cfs/acre. No additional alternative improvements on Bingham Creek were analyzed as part of this study. It is recommended that all future development in the Bingham Creek drainage detain the peak discharge to a maximum of 0.2 cfs/acre.

If new development is going to be constructed in areas where development is not anticipated by the current general plans, then development on those areas will need to detain peak storm water discharge rates such that the outflow to a county flood control facility will be less than or equal to the pre-development peak runoff rate (approximately 0.02 cfs/ac).

Figure 6-10 identifies the improvements and a conceptual construction cost estimate summary for the recommended improvements on Bingham Creek.

Barneys Creek

The full build-out conditions flow rates and existing culvert capacities for Barneys Creek study reach are identified in Table 6-3. Table 6-4 identifies those same parameters for the Clay Hollow channel, which is the primary conveyance for the 5900 West Detention Basin emergency spillway. The emergency spillway would be activated during the 100-year design storm for projected development conditions unless additional detention facilities are constructed upstream of this facility.

Table 6-3
Estimated 100-Year Peak Discharge Rates and Structure Capacities on Barneys Creek

Location	City	FEMA FIS 100-year Flow Rate (cfs)	Existing Development Conditions (cfs)	Future Build-Out Development Conditions Flow Rate – 0.2 cfs/ac (cfs)	Future Build-Out Development Conditions Flow Rate – 0.02 cfs/ac (cfs)	Existing Structure Size	Estimated Existing Capacity (cfs)
7800 South to Airport Detention Basin[1]	West Jordan	--	320	580	325	2 x 48" RCP	390
Airport Rd. to 7800 South[1]	West Jordan	--	250	600	310	66" RCP	220
Airport Rd. Crossing[1]	West Jordan	--	155	290	215	2 x 42" RCP	185
Railroad Crossing (4600 West)	West Jordan	160	155	290	215	66" RCP	290
4660 West[1]	West Jordan	--	155	290	215	5' X 3' Box	135
4800 West[1]	West Jordan	--	155	290	215	5' X 3' Box	100
Barneys Creek Trail #1 (5200 West)[1]	West Jordan	--	125	285	205	5' X 3' Box	65
Barneys Creek Trail #2 (5100 West)	West Jordan	--	75	75	75	5' X 3' Box	80
Amethyst Drive (5420 West)	West Jordan	--	75	75	75	5' X 3.2' Box	100
Grizzly Way (5300 West)	West Jordan	--	40	40	40	2 x 42" RCP	180
5600 West	West Jordan	10	10	10	10	36" RCP	105
Mountain View Corridor	West Jordan	--	120	225	165	8' X 6' Box	430
Maple Water Drive (5900 West)	West Jordan	--	100	200	140	10' X 6' Box	410
Birch Water Lane (5980 West)	West Jordan	--	100	200	140	10' X 6' Box	500
Fallwater Drive (6000 West)	West Jordan	--	100	200	140	10' X 6' Box	615
6160 West	West Jordan	--	70	185	115	8' X 6' Box	475
8600 South	West Jordan	--	50	175	105	8' X 6' Box	420
6400 West	West Jordan	--	50	175	105	8' X 6' Box	370
Bacchus Highway	West Jordan	--	25	145	95	72" RCP	250
Farm Road (7400 West)	West Jordan	--	20	110	95	30" RCP	40

[1] Culverts highlighted in red are capacity deficient in the 0.02 cfs/ac future conditions scenario.

Table 6-4
Estimated 100-Year Peak Discharge Rates and Structure Capacities on Clay Hollow

Location	City	FEMA FIS 100-year Flow Rate[1]	Existing Development Conditions	Future Build-Out Development Conditions Flow Rate – 0.2 cfs/ac	Future Build-Out Development Condition Flow Rate – 0.02 cfs/ac	Existing Structure Size	Estimated Existing Capacity[2]
Grizzly Way (5300 West)	West Jordan	--	50	275	200	48" RCP	200 [4]
Clay Hollow Trail	West Jordan	--	10	280	200	9' X 5' Box	200 [4]
5600 West	West Jordan	--	10	280	200	10' X 4' Box	200 [4]
Unita View Way	West Jordan	--	0	270	190	42" RCP [3]	190 [4]

[1] The FEMA FIS Flow Rate is for the 100-year inflow into the 5900 West Detention Basin.
[2] The channel on Clay Hollow was not modeled. Estimated capacity was based on inlet nomographs and field reconnaissance
[3] The 42-inch pipe is a low flow pipe and includes an overflow channel on the ground surface that will convey excess runoff downstream without flooding local property. The capacity of the pipe without the overflow channel is identified in the column labeled "Estimated Existing Capacity."
[4] The peak flow rate is governed by the spillway flow from the 5900 West Detention Basin.
[5] Culverts highlighted in red are capacity deficient in the 0.02 cfs/ac future conditions scenario.

As can be seen from the information presented in Table 6-3, the flow rates associated with the projected future conditions are significantly higher than the FEMA 100-year flow rates identified in the 2007 LOMR or in the 2003 and 2012 versions of the West Jordan Storm Drain Master Plan discussed in Chapter 5. There are thousands of acres with the potential to develop within the Barneys Creek drainage area. If future development in the Barneys Creek drainage basin is allowed to discharge at a maximum rate of 0.2 cfs/acre, then several existing culverts and storm drain pipes will need to be replaced with larger facilities or parallel facilities will need to be installed to safely convey the 100-year design flow. Figure 6-11 identifies the future conditions flow rates, capacities, and deficiencies if future development detains to a rate of 0.2 cfs/acre.

An alternatives analysis was completed using the Barneys Creek model that limited storm water runoff from future development to discharge at a maximum of 0.02 cfs/acre to determine if additional detention would resolve the potential future capacity deficiencies. The results of that analysis are also included in Tables 6-3 and 6-4. As can be seen from Table 6-3, even if the future development limited the peak runoff to 0.02 cfs/ac, there would need to be several costly improvements to Barneys Creek and the West Jordan storm drain system because the future flow rate will be significantly higher than was anticipated in previous studies. Figure 6-12 identifies the future conditions flow rates, capacities, and deficiencies if future development detains to a rate of 0.02 cfs/ac.

There are several reasons for the significant increase in peak flow from prior planning flow rates in the future conditions analysis associated with this study. Those reasons are discussed in detail in a Technical Memorandum included in Appendix F. To summarize, the West Jordan Storm Drain Master Plan identified several large regional detention facilities that were going to limit runoff from the mountain watershed areas and development west of Bacchus Highway (SR-111). Those detention basins were either not constructed or were constructed in a location that could not limit the runoff from local development. Because those detention basins were not constructed, the estimated 100-year discharge rate for Barneys Creek in the future conditions model is much higher than originally anticipated in previous planning and design projects.

Salt Lake County has jurisdiction on Barneys Creek upstream of the South Valley Regional Airport at approximately 4000 West. Downstream of that detention basin, Barneys Creek is conveyed in the West Jordan Storm Drain system between 4000 West and the Jordan River. West Jordan City owns and maintains the storm drain system downstream of 4000 West. The discharge requirements for Barneys Creek will have a direct impact on a large portion the West Jordan storm drain system. Various alternatives to manage storm water runoff for Barneys Creek are discussed in that Technical Memorandum. A recommended approach to managing storm water will need to be selected from that Technical Memorandum in Appendix F.

No construction cost estimates for flood control improvement on Barneys Creek were developed as part of this study because the recommended improvements and recommended approach to managing storm water along Barneys Creek have not been selected.

Wood Hollow

The full build-out conditions flow rates for Wood Hollow are identified in Table 6-5. Figure 6-13 identifies the future conditions flow rates, 2002 SWCCS flow rates, capacities, and capacity deficiencies.

Table 6-5
Estimated 100-Year Peak Discharge Rates and Structure Capacities on Wood Hollow

Location	City	FEMA FIS 100-year Flow Rate (cfs)	2002 SWCCS Full-Build Conditions (cfs)	Existing Development Conditions (cfs)	Future Development Conditions - 0.2 cfs/ac (cfs)	Existing Structure Size	Estimated Existing Capacity (cfs)
Pipe from overflow pond to the Jordan River	Bluffdale	140	115	130	150	36" RCP	200
Pipe from Utah & Salt Lake Canal to Overflow Pond	Bluffdale	--	115	130	160	48" RCP	235
Pipe from Utah Lake Distributing Canal to Utah & Salt Lake Canal[1]	Bluffdale	--	115	130	160	42" to 48" RCP	155-235
Pipe from Redwood Rd. to Utah Lake Distributing Canal[1]	Bluffdale	--	115	130	160	30" to 42" RCP	85-120
Pipe under Redwood Rd.	Herriman/Bluffdale	--	115	110	140	48" RCP	140
Welby Jacob Canal[1]	Herriman	--	115	110	140	39" CMP	70
Mountain View Corridor	Herriman	--	115	110	130	48" RCP	280
Gravel Pit Road	Herriman	--	115	100	130	48" RCP	420

[1] Culverts highlighted in red are capacity deficient in the future conditions scenario.

As can be seen from Table 6-5, the flow rates associated with projected future development conditions are significantly higher than the estimates developed as part of the 2002 SWCCS. As discussed in Chapter 5, there is a section of pipe along Wood Hollow that is approximately 2,600 feet long that does not have capacity for the existing conditions flow rates. It is important to note that the majority of that undersized section of pipe along Wood Hollow does not have capacity for the 2002 SWCCS build-out conditions flow rate. A portion of the piped section of Wood Hollow will need to be upsized to convey the 100-year build-out conditions flow rate. Figure 6-14 identifies the improvements and a summary of the cost estimate for Wood Hollow.

Currently there are no canal overflow/dump-out structures that discharge storm water in the canals into Wood Hollow. A study was completed that identified alternatives for overflow/dump-out structures on Wood Hollow or Wood Hollow South. That Technical Memorandum discussed the following alternatives:

1. Installing an overflow/dump-out structure on Wood Hollow
2. Installing an overflow/dump-out structure on Wood Hollow South and extending Wood Hollow South to the Jordan River
3. No overflow/dump-out structures on Wood Hollow or Wood Hollow South (ie. no changes to the drainage patterns)

The Technical Memorandum that discusses those alternatives is included in Appendix A. Salt Lake County will need to review and select one of the alternatives in that Technical Memorandum.

The Wood Hollow drainage area is mostly built-out. Increases in storm water discharged into Wood Hollow due to future development is expected to be minimal. It is recommended that future development continue to discharge at 0.2 cfs/acre. The cost estimate for Wood Hollow is based on the 3rd alternative listed above (no overflow/dump-out structures on Wood Hollow or Wood Hollow South). If a different alternative is selected, the cost estimate for this study will need to be updated. It is important to note that each alternative includes a cost estimate in the Technical Memorandum in Appendix A.

Wood Hollow South

Wood Hollow South was not studied with the 2002 SWCCS. The full build-out conditions flow rates for Wood Hollow South are identified in Table 6-6. Figure 6-14 identifies the future conditions flow rates, 2002 SWCCS flow rates, capacities, and deficiencies.

Table 6-6
Estimated 100-Year Peak Discharge Rates and Structure Capacities on Wood Hollow South

Location	City	FEMA FIS 100-year Flow Rate (cfs)	Existing Development Conditions (cfs)	Future Development Conditions - 0.02 cfs/ac (cfs)	Existing Structure Size	Estimated Existing Capacity (cfs)
Utah & Salt Lake Canal	Bluffdale	60	25	35	--	--
Utah Lake Distributing Canal	Bluffdale	--	25	35	10' X 6' Arch	1100
Trail	Bluffdale	--	25	35	4' CMP	170
Redwood Road	Herriman/Bluffdale	--	23	35	27' X 11' Box	3980
Pipe Under Welby Jacobs Canal	Herriman	--	23	30	2' CMP	55
Pipe from upstream end of study to Welby Jacobs Canal	Herriman	--	23	30	2' RCP	30

Currently Wood Hollow South discharges into the Utah & Salt Lake Canal which discharges into Rose Creek. The Rose Creek discharge requirement is 0.02 cfs/ac. Unless the drainage patterns along Wood Hollow South change, the discharge requirements for Wood Hollow South drainage area is also 0.02 cfs/ac.

As can be seen from Table 6-5, the channel and the culverts on Wood Hollow South have the required capacity to convey future build-out conditions flow to the Utah and Salt Lake Canal.

Currently there are no overflow/dump-out structures that discharge storm water from the canals into Wood Hollow South. As discussed previously, a study was completed that identified alternatives to install overflow/dump-out structures that would discharge into Wood Hollow South. That Technical Memorandum is included in Appendix A.

It is important to note that Wood Hollow South is not a County flood control facility, so no recommended improvements are included in this study.

Beef Hollow

The full build-out conditions flow rates for Beef Hollow are identified in Table 6-7. Figure 6-15 identifies the future conditions flow rates, capacities, and deficiencies.

The Beef Hollow drainage channel was extended to the Jordan River as recommended by the 2002 SWCCS. The Beef Hollow channel and most of the existing culverts have the required capacity to convey future build-out conditions flow to the Jordan River. As discussed in Chapter 5, the Dirt Road #2 culvert does not have adequate capacity to convey the 100-year flow. However, this road is within a UDOT ROW and the culvert need to be replaced when Mountain View Corridor is extended south into Utah County. The capacity of that culvert should be increased at that time by UDOT to convey a minimum of 90 cfs. A cost estimate for that improvement was not included in this report.

Table 6-7
Estimated 100-Year Peak Discharge Rates in Beef Hollow

Location	City	2002 SWCCS Full-Build Conditions (cfs)	Existing Development Conditions (cfs)	Future Development Conditions - 0.2 cfs/ac (cfs)	Existing Structure Size	Estimated Existing Capacity (cfs)
Jordan River Parkway & Utah Lake Distributing Canal	Bluffdale	105	90	105	48" RCP	160
Dirt Road # 1	Bluffdale	105	90	100	60" CMP	260
Redwood Rd.	Bluffdale	105	90	100	42" RCP	115
Dirt Road #2 [1]	Bluffdale	105	90	90	18" CMP	8

[1] Culverts highlighted in red are capacity deficient in the future conditions scenario.

RECOMMENDATIONS

The following are recommendations for this study.

Detention Requirements

The results of the hydrologic and hydraulic analyses for the future full build-out development scenario were reviewed with Salt Lake County and the local municipalities. To maintain capacity in the channels and creeks, updated detention requirements for all future development were developed and recommended based on available capacity in each of the flood control facilities that were studied as part of this Phase 3 of this report. The following peak discharge limits are recommended:

1. All new development in the SWCC Study should be required to detain storm water discharges from the 100-year storm event such that the peak discharge rate into a county flood control facility is equal to or less than the rates identified on Table 6-8. It is important to note that the peak discharge requirements for the 100-year design storm include all roads (both public and private) and public and private development. Plan reviewers and those that issue permits from cities and Salt Lake County will need to make sure that the aggregate runoff from an area (not just the local development) meets the requirements identified in Table 6-8 before approving the development plans for construction.

Table 6-8
Discharge Requirements

Creek or Canal	Detention Requirement (cfs/ac)
Bingham Creek	0.2
Barneys Creek	Less than 0.2[1]
Beef Hollow	0.2
Wood Hollow	0.2
Wood Hollow South	0.02[2]
ULDC, USLC, SJC & NJC	Limit to downstream receiving creek.[3]

[1] The discharge requirement for Barneys Creek has not been decided yet.
[2] Currently Wood Hollow South is part of the Rose Creek drainage basin.
[3] If there is no downstream receiving creek identified in this study for an area that is to develop, then the peak discharge requirement that discharges in the County flood control facility should not exceed 0.2 cfs/acre based on the total area to be developed, including roads.

2. All new development in areas where development is not anticipated as part of this study shall detain storm water runoff from the 100-year design storm such that the discharge into a county storm drain facility is less than or equal to the undeveloped natural condition, which is approximately 0.02 cfs/ac.

General Recommendations for Creeks

The following general recommendations are made for creeks facilities that are the subject of this study:

1. The hydraulic models developed as part of this study should be updated periodically to reflect improvements.
2. New creek crossings should be designed to convey a flow greater than or equal to the projected 100-year peak flow based on full-built out development conditions.
3. All new culverts or bridges and associated channel improvements to existing creek channels should include riprap upstream and downstream of the culvert to mitigate scour and erosion hazards to the channel bank and to protect the culverts or bridges.

General Recommendations for Canals

The following general recommendations are made for canal facilities that are the subject of this study:

1. In general, no new storm water outfalls should be permitted under present canal operation and canal capacity conditions.
2. The hydraulic models developed as part of this study should be updated periodically to reflect improvements.
3. New culvert or bridge crossings over the canals should be designed to convey a minimum of the sum of the estimated peak irrigation flow and the estimated 100-year build-out conditions peak flow. A minimum of 6 inches of freeboard should be maintained in the canals for during the estimated 100-year design flow event. Sizing of a canal crossing should be coordinated with the corresponding canal company and Salt Lake County Engineering.

Recommended Improvements Based on Field Reconnaissance

Based on field reconnaissance performed as part of this study, some problems and deficiencies not related to capacity were discovered. Those issues are identified in Chapter 2. Recommendations to address those problems are summarized below.

1. Monitor areas where creek channels have been armored with rounded rock riprap. Rounded riprap has a high potential to fail as it can easily be pushed downstream by the velocity of flowing water. If the armoring fails, those areas should be repaired as needed.
2. Consider charging a fee for Salt Lake County Flood Control Permits for projects that include the installation of riprap or other significant channel improvements. The fee could be used to pay for more County oversight and inspection during construction. This could allow more quality control and reduce the potential for rounded or undersized riprap from being installed or avoid other potential problems that could fail during a significant runoff event.
3. Coordinate and work with private property owners that have constructed fences across the creek channel to facilitate the removal of fencing that is obstructing flow in creek channels.
4. Monitor sections of the creek channels that are experiencing bank erosion and lateral channel migration. Continue to repair and armor the channel adjacent to new developments as they occur so that the future structures can be protected.
5. Areas with a poorly defined creek channel should have the channel restored or improved and armored as funds become available. Most sections of poorly defined channels are in undeveloped areas. Salt Lake County may be able require development in these areas to restore the channel prior to construction.

Summary of Cost Estimates

Table 6-9 summarizes the total conceptual construction cost estimates in 2022 dollars for each of the creeks and canals discussed in this Phase 3 report. The locations and individual cost estimates for the recommended improvements are identified on Figure 6-5 through Figure 6-9 and Figures 6-11 and 6-15.

Table 6-9
Summary of Costs for Recommended Improvements

Alternative	Construction Cost	Engineering, Legal, Administration, ROW Acquisition, & Contingency	Total Cost
Bingham Creek [1]	$ 1,789,000	$ 704,000	$ 2,493,000
Wood Hollow [2]	$ 1,035,500	$ 444,500	$ 1,480,000
Beef Hollow [1]	Construct culvert with a minimum capacity of 90 cfs[3]		
ULDC [1]	$ 435,000	$ 162,000	$ 597,000
USLC [1]	$ 136,000	$ 51,000	$ 187,000
SJC [1]	$ 1,829,000	$ 792,000	$ 2,621,000
NJC [1]	$ 204,000	$ 77,000	$ 281,000
Totals[4]	**$ 5,428,500**	**$ 2,230,500**	**$ 7,659,000**

[1] The cost estimates are in 2022 dollars.
[2] Cost estimates for Wood Hollow were developed in 2020. Construction costs have almost doubled since that cost estimate was developed. The County will need to account for the significant increase in costs during the planning and design stage of the project. The Wood Hollow improvements represents the Alternative 3 (no new overflow/dump-out structures).
[3] A culvert will need to be constructed with a capacity of a minimum of 90 cfs. We have assumed that UDOT will design and construct the culvert, and that Salt Lake County will not pay for it.
[4] Total does not include Barneys Creek because recommended improvements have not been identified. The technical memorandum in Appendix F of Section 3 of this report identifies alternatives for Barneys Creek.

A detailed breakdown of the cost estimate can be found in Appendix H.

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