2002
SOUTHWEST CANAL AND CREEK STUDY

Volume 1 of 2

Prepared for:

Salt Lake County Engineering Division

SALT LAKE COUNTY

Prepared by:

Bowen Collins & Associates, Inc.
Consulting Engineers

April 2003

FOR INFORMATION REGARDING THIS PROJECT CONTACT:

Craig Bagley
756 East 12200 South
Draper, Utah 84020
(801) 495-2224

FINAL REPORT

2002 SOUTHWEST CANAL AND CREEK STUDY

VOLUME 1 OF 2

Prepared for:

Salt Lake County Engineering Division

REGISTERED PROFESSIONAL ENGINEER
No. 11060
CRAIG R. BAGLEY
STATE OF UTAH
4-28-2003

Prepared by:

Bowen, Collins & Associates, Inc.
756 East 12200 South
Draper, Utah 84020

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EXECUTIVE SUMMARY

INTRODUCTION

A significant portion of the land historically used for agricultural purposes in Salt Lake County has been urbanized during the past 50 years. The southwest quadrant of Salt Lake County is currently one of the fastest developing areas in the State of Utah. The ongoing urbanization in the southwest quadrant of Salt Lake County has and continues to result in flood control problems in areas that have not previously experienced flooding problems.

Developing and implementing a plan to properly manage flood hazards is one of the key responsibilities of governmental agencies and planners. The Engineering Division of the Salt Lake County Public Works Department is responsible for operation and maintenance of the major flood control facilities in Salt Lake County (often referred to as "County-wide" facilities,) including selected natural streams and some irrigation canals in cooperation with the associated canal companies. Salt Lake County maintains joint-use agreements with some canal companies, allowing for limited use of canals for storm water conveyance. The Engineering Division also provides programs designed to reduce and prevent storm water pollution in the incorporated and unincorporated areas of the County. The Engineering Division is also responsible for the planning, engineering design, and construction of flood control improvements on County-wide flood control facilities. The County-wide flood control facilities located in the southwest quadrant of Salt Lake County are listed in Table ES-1.

Table ES-1
Salt Lake County Flood Control Facilities
in the Southwest Quadrant of the County

Natural Streams	Irrigation Canals
Beef Hollow	Utah Lake Distributing Canal
Wood Hollow	Utah and Salt Lake Canal
Rose Creek	South Jordan Canal
Butterfield Creek	North Jordan Canal
Midas Creek	
Bingham Creek	

A master drainage study for the southwest quadrant of Salt Lake County was last completed in 1985. The primary purpose of that study was to develop a master plan that identified the most cost effective, efficient method to utilize the County flood control facilities to provide needed flood protection for the area as it developed. At that time, most of the study area was not yet urbanized and assumptions were made for planning purposes with respect to the type and density of future development. Since the southwest quadrant of the County has experienced a high rate of growth during the past 18 years and the area is currently experiencing widespread development pressure, Salt Lake

County retained Bowen, Collins & Associates (BC&A) to update the Southwest Canal and Creek (SWCC) Study prepared in 1985. This report presents the updated study results.

STUDY OBJECTIVES

The primary purpose of this study is to identify institutional and structural improvements needed to manage storm water runoff conveyed in the creeks and canals located in the southwest quadrant of the County in a cost effective, efficient manner. To accomplish this primary objective, the conveyance capacities of culverts, bridges, and open channel sections of the canals and creeks were estimated so that available conveyance capacities could be optimized in each County-wide facility. Personnel from the Engineering Division of the Salt Lake County Public Works Department and BC&A coordinated with officials from the cities and canal companies included in the study area to collect and discuss existing planning data. Current land use and zoning maps and current storm drain master planning documents were obtained and referenced from Salt Lake County, the Cities of West Jordan, South Jordan, Riverton, Bluffdale, Taylorsville, West Valley, and the Town of Herriman. Meetings were also held with canal company representatives to project how the canals will be utilized in the future, after the area is mostly urbanized. It appears that the joint-use canals in the southwest quadrant of Salt Lake County will be in service for an indefinite period into the future. This study addresses how available canal conveyance capacity may be utilized with the natural streams in the area to best manage storm water runoff.

BACKGROUND

Development and Growth

As development in the Salt Lake Valley has spread from east to west and north to south, the southwest portion of Salt Lake County has undergone a gradual transition from primarily agricultural land use to a mix of residential and commercial development. The majority of urban development in the study area to date has occurred east of 4000 West. Increased accessibility provided by the Bangerter Highway and other major east/west roadway improvements, however, has facilitated increased west-area development in Herriman, Riverton, South Jordan, and West Jordan.

General Flood Control Concerns: Canals

Until recent years, the general strategy for handling increased runoff resulting from urban development in the Salt Lake Valley has been to convey storm water discharges to the nearest available waterway, without particular regard for the suitability of the waterway as a storm water conveyance. This has resulted in numerous storm drain outfalls to the irrigation canals located in the study area.

Utilizing the irrigation canals to collect and convey storm water creates some challenging flood control issues:

1. **Canal Construction:** The irrigation canals in the study area were constructed such that their conveyance capacities are greatest near their headwaters and gradually decreasing in the downstream direction due to irrigation diversions. This is the reverse of conventional storm drain system design, where conveyance capacity generally increases in the downstream direction. In addition, the canals were constructed with very mild slopes, nearly parallel to the contours. As a result, no natural floodplain exists along the canals.

2. **Canal Operation:** The canals convey their largest irrigation flows during the hottest months of the growing season, particularly July and August. The Salt Lake Valley is prone to intense cloudburst thunderstorms during this same period. This means that little storm water capacity is available in the canals when it is most needed. The period of greatest potential for large storm water discharges to the canals coincides with periods of peak irrigation, when the canals are operating at or near full capacity.

3. **Development:** Since there is no natural floodplain along the canals, homes (many with basements) have been and continue to be constructed on lots adjacent to the canals throughout the study area. Canal susceptibility to flooding during intense thunderstorm events makes the homes next to the canals and at the downstream end of nearby cul-de-sacs prone to flood damage.

4. **Sediment Deposition:** The mild slopes at which the irrigation canals were constructed make them highly susceptible to sediment deposition from storm water discharged into the canals. This sediment deposition gradually decreases the capacity of the canals, further compromising their utility as storm drainage conveyances.

To alleviate problems arising from storm water discharges to the canals in the study area, a series of canal overflow structures has been constructed to divert storm water out of the canals. Most of these overflow structures include a weir designed to discharge excess storm water accumulations in the canals to the nearest natural drainage or storm drain trunkline, as well as a manually-operated gate which allows an authorized operator to divert all or most of the total canal flow into a major storm water conveyance facility.

General Flood Control Concerns: Creeks

The natural steams evaluated as part of this study are typically dry for a significant portion of the year. Early agricultural and residential developments gave little consideration to these channels and floodplains. As a result, the natural drainage corridors have in many cases been rerouted or obscured, leading to more and more pronounced flooding problems as development creeps west. Some effort has been made in recent years to restore continuous natural drainage corridors, such as Rose Creek, from their headwaters in the Oquirrh Mountains to a discharge point at the Jordan River.

Salt Lake County personnel identified the area along the Bingham Creek channel, between Redwood Road and 1500 West (location of a trailer park), as the only known existing major flooding problem along the natural major drainages in the study area. Other historic hydraulic deficiencies of the major storm water conveyance facilities have been or are currently being addressed with improvement projects.

GENERAL RECOMMENDATIONS

Institutional/ Management Policies

The results of the ultimate development scenario hydrologic analysis completed as part of this study are based on several general assumptions regarding new development. In accordance with these assumptions and in order to preserve the relevance of model results the following recommendations are made:

1. All new development in areas where development was anticipated as part of this study shall detain storm water discharge such that the outflow to a county storm drainage facility is less than or equal to 0.2 cfs per acre.

2. All new development in areas where development was not anticipated as part of this study shall detain storm water discharge such that the outflow to a county storm drainage facility is less than or equal to the undeveloped natural condition discharge.

3. All storm drain improvement projects constructed in the study area should be designed and constructed to manage runoff for projected full build out conditions. The design storms and evaluation criteria used in this study should serve as the basis of design of these new facilities.

Operating Criteria

The following are recommended general criteria for the operation of the integrated canal and creek storm drainage system:

1. All storm water collected by the canals should ultimately discharge to a creek or major storm drain via a canal overflow structure.

2. All creeks and major storm drains should ultimately discharge to the Jordan River.

3. Runoff from all mountain and undeveloped drainage basins not flowing to the Jordan River shall be detained. This should particularly be the case for the mountain drainages near Beef and Wood Hollows, west of the Welby Jacobs Canal. Detained flows shall be routed to the nearest major creek that ultimately discharges to the Jordan River.

General Recommendations for Creeks

The following general recommendations are given for the natural drainages:

1. The size, invert elevation, and low chord elevation for new creek crossings should be determined using the hydraulic models developed as part of this study. These models should be updated periodically to reflect improvements. Locations and elevations for new creek crossings should be established using the survey benchmarks given in the Technical Appendix.

2. New creek crossings should be designed to convey a flow greater than or equal to the 100-year peak flow based on ultimate development conditions.

3. All new creek crossings and improvements to existing conveyance facilities should be riprapped upstream and downstream to maintain channel integrity at velocities associated with the design flow.

4. All improvements or other channel modifications involving restriction of the natural channel should incorporate riprap upstream and downstream as well as along the length of the restriction.

General Recommendations for Canals

The following general recommendations are made for canal conveyances and canal storm drainage facilities:

1. In general, additional storm water discharges to the canals should not be permitted under present canal operation and canal capacity conditions.

2. Any new storm drain trunklines which cross the canals and drain to the Jordan River should include canal storm water overflow facilities.

3. The size, invert elevation, and low chord elevation for new canal crossings should be determined using the canal hydraulic models developed as part of this project. These models should be periodically updated. Locations and elevations for new canal crossings should be established using the survey benchmarks given in the Technical Appendix.

4. New canal crossings should be designed to convey a minimum of the peak irrigation flow in addition to the 10-year peak flow (future development conditions) with six inches of freeboard. Sizing of a canal crossing should be coordinated with the corresponding canal company.

5. New canal storm water overflow structures should include both an automatic weir and a manually operated gate. The weir should be

designed with a stage-discharge relationship consistent with the canal, and should have a capacity greater than or equal to the 10-year peak flow (future development conditions).

6. Concrete weir crest elevations should be set at or slightly below maximum irrigation flow elevations. Stop logs should be used to allow adjustments based on field observations of canal response to storm water events.

7. Installation of new overflow structures and modifications to existing facilities should be closely coordinated with and must be approved by the canal companies.

8. Canal storm water overflow structures should be inspected and associated gates exercised yearly.. Maintenance should be performed as determined by these inspections.

RECOMMENDED CAPITAL IMPROVEMENTS

An extensive survey of existing canal and creek drainage facilities was completed as part this study. Field investigations and storm drainage facility inventories were also conducted in an effort to gain an understanding of the overall integrated nature of the canals and creeks in the study area. The information gathered in these surveys and investigations was used to develop hydrologic models of the drainage basins within the study area as well as hydraulic models of the corresponding canal and creek channels. The information collected was also used to create a storm drainage GIS database.

The results of the hydrologic and hydraulic analyses were used to identify storm drainage facilities that have the potential for flooding during high intensity cloudburst events. Forty-three projects with a total estimated cost of $7.5 million were recommended to alleviate potential flooding problems. These improvements, summarized in Tables ES-2 and ES-3, were also assigned a priority ranging from one (highest) to three (lowest) based on whether the needed improvements are to correct existing deficiencies or associated with future development and other criteria developed with County personnel.

Table ES-2
Summary of Recommended Improvements - Canals

Canal	Facility ID	Location	Existing Storm Drainage Overflow Facility	Recommended Improvements	Priority	Cost
Utah Lake Distributing Canal	ULDC-1 (A & B)	South of Bangerter Highway	No existing facility	(A) Raise approximately 1,200 feet of east bank by 1' (B) Raise approximately 300 feet of northeast bank by 2'	2	$30,000
Utah Lake Distributing Canal	ULDC-3	Midas Creek	No existing facility	Add overflow structure	3	$132,000
Utah Lake Distributing Canal	ULDC-5	7800 South	No existing facility	Overflow structure expected as part of 7800 South storm drain improvements.	1	$132,000
Utah & Salt Lake Canal	USLC-2	Rose Creek	18' weir with stop logs, 48" gate (2)	Remove 12" to 18" of stop logs	1	$1,000
Utah & Salt Lake Canal	USLC-4	Midas Creek	18' weir with stop logs, 48" gate (2)	Remove 10" to 14" of stop logs	1	$1,000
Utah & Salt Lake Canal	USLC-6	7800 South	No existing facility	Overflow structure expected as part of 7800 South storm drain improvements.	1	$132,000
Utah & Salt Lake Canal	USLC-7	5400 South	15' weir with stop logs, 50" gate	Remove 3" to 6" of stop logs	1	$1,000
Utah & Salt Lake Canal	USLC-9	7800 West	12' weir with stop logs	Remove all stop logs	1	$1,000
South Jordan Canal	SJC-2	South of 12800 South	No existing facility	Raise approximately 1,000 feet of east bank by 2'	2	$40,000
South Jordan Canal	SJC-3	12600 South	No existing facility	Overflow structure expected as part of 12600 South road widening project	3	$132,000
South Jordan Canal	SJC-6	South of Bingham Creek	No existing facility	Raise approximately 1,500 feet of both banks by 2'	2	$118,000
South Jordan Canal	SJC-7	Bingham Creek	15' weir with stop logs, 50" gate	Remove all stop logs	1	$1,000
South Jordan Canal	SJC-8	7800 South	No existing facility	Overflow structure expected as part of 7800 South storm drain improvements.	1	$132,000
South Jordan Canal	SJC-9	5400 South	10' weir with stop logs	Remove all stop logs	1	$1,000
North Jordan Canal	NJC-2	South of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	2	$20,000
North Jordan Canal	NJC-4	North of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	2	$20,000
North Jordan Canal	NJC-6	South of 5600 South	No existing facility	Raise approximately 1,500 feet of east bank by 1'	1	$30,000
North Jordan Canal	NJC-8	5400 South	60" gate, no weir	Install weir structure	3	$132,000
					TOTAL:	**$1,056,000**

Table ES-3
Summary of Recommended Improvements - Creeks

Stream	Facility ID	Location	Existing Drainage Facility	Recommended Improvements	Priority	Cost
Beef Hollow	BH-3	Utah Lake Distributing Canal	No existing facility. Currently drains to ULDC. Future drainage to Jordan River.	48" RCP under 2 canals, ~ 700 feet of channel improvement to Jordan River.	3	$250,000
Wood Hollow	WH-1	Welby Jacobs Canal	No existing facility. Currently drains to Welby Jacobs Canal. Future drainage to Jordan River.	48" RCP under Redwood Road and 4 canals, ~ 5500 feet of channel improvements to the Jordan River	1	$645,000
Rose Creek	RC-1	Rose Canyon near 8000 West	36" CMP	60" RCP	3	$90,000
Rose Creek	RC-7	Welby Jacobs Canal Crossing	6' x 1.45' box culvert	Canal to be realigned and crossing replaced as part of development. 14' x 4' box culvert w/ headwall	3	$144,000
Rose Creek	RC-8	4000 West	6' x 5' box culvert	Add 6' x 5' box culvert w/ headwall. Improve approximately 1600 feet of channel from Welby Jacobs Canal to 4000 West.	2	$312,000
Rose Creek	RC-9	Field east of 4000 West	Approximately 150' of 48" CMP in poor condition.	Remove pipe and restore channel. Riprap channel from 4000 West to Bangerter Highway (approximately 1100 feet).	1	$80,000
Rose Creek	RC-11	3600 West	8' x 5' box culvert. Currently effectively 8' x ~ 3' with capacity ~ 100 cfs.	Clean existing box. Replace with 10' x 5' box culvert w/ headwall	3	$114,000
Rose Creek	RC-13	3160 West	10' x 3.7' box culvert.	Replace with 14' x 5' box culvert w/ headwall	2	$136,000
Butterfield Creek	MC-1	Butterfield Creek - 6000 West	No existing storm drainage facility	Improve approximately 3500' of channel from 6400 West to 6000 West. Install approximately 2800' of 60" RCP along 6000 West to Copper Creek. Improve approximately 5700' of channel along Copper Creek from 6000 West to Midas Creek	2	$1,970,000
Midas Creek	MC-5	Welby Jacobs Canal Crossing	3.5' x 2.5' arch	Replace with 14' x 4' box culvert w/ headwall	3	$153,000
Midas Creek	MC-6	4000 West	48" RCP w/ headwall	Replace with 14' x 6' box culvert w/ headwall	2	$142,000
Midas Creek	MC-11	2700 West	42" CMP	Replace with 12' x 6' box culvert w/ headwall	1	$149,000
Midas Creek	MC-17	Redwood Road	7' x 2.4' box culvert	Replace with 10' x 5' box culvert (2) w/ headwall	1	$151,000
Midas Creek	MC-18	South Jordan Canal Crossing	6' x 1.5' box culvert	Replace with 12' x 4' box culvert w/ headwall(1)	2	$359,000
Midas Creek	MC-19	11500 South	13.5' x 2.5' bridge	Replace with 14' x 6' bridge.	1	$134,000
Midas Creek	MC-20	1300 West	60" RCP w/ concrete headwall	Replace with 14' x 5' box culvert w/ headwall	1	$157,000
Bingham Creek	BC-1	Skye Drive	48" CMP	Replace with 66" RCP w/ headwall	3	$194,000
Bingham Creek	BC-3	4000 West	48" CMP	Replace with 72" RCP w/ headwall	3	$161,000
Bingham Creek	BC-16	1650 West	48" CMP	Replace with 16' x 5' box culvert w/ headwall	1	$246,000
Bingham Creek	BC-17	1500 West	48" CMP	Replace with 12' x 5' box culvert w/ headwall; Improve approximately 1000' of channel between 1650 West and 1500 West	1	$459,000
Bingham Creek	BC-18	1300 West	8' x 5.5' box culvert	Replace with 10' x 6' box culvert w/ headwall; Improve approximately 1300' of channel between 1500 West and 1300 West	3	$403,000
					TOTAL:	$6,449,000

Notes:
(1) - Includes replacement of canal overflow structure

SECTION 1
INTRODUCTION

BACKGROUND INFORMATION

A significant portion of the land historically used for agricultural purposes in Salt Lake County has been urbanized during the past 50 years. The southwest quadrant of Salt Lake County is currently one of the fastest developing areas in the State of Utah. The ongoing urbanization in the southwest quadrant of Salt Lake County has and continues to result in flood control problems in areas that have not previously experienced flooding problems.

Developing and implementing a plan to properly manage flood hazards is one of the key responsibilities of governmental agencies and planners. The Engineering Division of the Salt Lake County Public Works Department is responsible for operation and maintenance of the major flood control facilities in Salt Lake County (often referred to as "County-wide" facilities, including selected natural streams and some irrigation canals in cooperation with the associated canal companies. Salt Lake County maintains joint-use agreements with these canal companies, allowing for limited use of canals for storm water conveyance. The Engineering Division also provides programs designed to reduce and prevent storm water pollution in the incorporated and unincorporated areas of the County. In addition to their operating and maintenance responsibilities, the Engineering Division is responsible for the planning, engineering design and construction of flood control improvements on these County-wide facilities. The County-wide flood control facilities located in the southwest quadrant of Salt Lake County are listed in Table 1-1.

Table 1-1
Salt Lake County Flood Control Facilities in the Southwest Quadrant of the County

Natural Streams	Irrigation Canals
Beef Hollow	Utah Lake Distributing Canal
Wood Hollow	Utah and Salt Lake Canal
Rose Creek	South Jordan Canal
Butterfield Creek	North Jordan Canal
Midas Creek	
Bingham Creek	

In 1985 Salt Lake County retained the engineering consulting firm of Forsgren-Perkins Engineering to prepare a master drainage study for the southwest quadrant of the County. The primary purpose of that study was to develop a master plan that identified the most cost effective, efficient method to utilize the County flood control facilities to provide needed flood protection for the area as it developed. At that time, most of the study area was not yet urbanized and assumptions were made for planning purposes with respect to the type and density of future development. Since the southwest quadrant of the County experienced a high rate of growth during the past 18 years and the area is currently experiencing widespread development pressure, the Engineering Division retained Bowen, Collins & Associates to update the Southwest Canal and Creek (SWCC) Study that was prepared in 1985. This report presents the updated study results.

It should be noted that the Barney's Creek watershed was included in the 1985 SWCC study, but was not evaluated as part of this study. Salt Lake County opted not to include the Barney's Creek drainage in this study because a detailed drainage study for that watershed was recently completed as part of a separate project for West Jordan City. Evaluation of the Welby Jacobs Canal was also not included in this study because it has little or no storm water capacity and is not used as a County flood control facility.

PURPOSE OF STUDY

The primary purpose of this study is to identify institutional and structural improvements needed to manage runoff conveyed in the creeks and canals located in the southwest quadrant of the County in a cost effective, efficient manner. To accomplish this primary objective, the conveyance capacities of culverts, bridges, and open channel sections of the canals and creeks were estimated so that available conveyance capacities could be optimized in each County-regulated facility. Personnel from the Engineering Division of the Salt Lake County Public Works Department and Bowen, Collins & Associates coordinated with officials from the cities and canal companies included in the study area to collect and discuss existing planning data. Current land use and zoning maps and current storm drain master planning documents were obtained and referenced from Salt Lake County, the Cities of West Jordan, South Jordan, Riverton, Bluffdale, Taylorsville, West Valley City, and Herriman. Meetings were also held with canal company representatives to project how the canals will be utilized in the future, after most of the remaining agricultural areas have become urbanized. It appears that the joint-use canals in the southwest quadrant of Salt Lake County will be in service for an indefinite period into the future. This study addresses how available canal conveyance capacity may be utilized with the natural streams in the area to manage storm water runoff.

SCOPE OF WORK

The flood control facilities that were evaluated as part of this project are identified in Table 1-2. Hydrologic analyses were completed for the natural drainages and canals listed in Table 1-2, and hydraulic analyses were performed for the specified study reaches.

Table 1-2
Study Area for 2002 Southwest Canal and Creek Study

Natural Streams/Drainages	Study Reach
Beef/Wood Hollow	Hydrology only (no hydraulic analysis)
Rose Creek	6400 West to Jordan River
Butterfield Creek	Hydrology only (no hydraulic analysis)
Midas Creek	5600 West to Jordan River
Bingham Creek	4800 West to Jordan River

Table 1-2
Study Area for 2002 Southwest Canal and Creek Study
(continued)

Canals	Study Reach
Utah Lake Distributing Canal	Jordan River at Turner Dam to Bingham Creek Overflow
Utah and Salt Lake Canal	Salt Lake County Line to 8000 West Overflow
South Jordan Canal	Jordan River Diversion near Turner Dam to Kearns-Chesterfield Overflow (near Bangerter Highway and 4500 South)
North Jordan Canal	Jordan River Diversion near 9400 South to Overflow near Bangerter Highway and 3700 South

The major tasks that were performed in completing this study are summarized below.

TASK 1: COLLECT AND REVIEW EXISTING INFORMATION

This task was accomplished to collect information that was required to complete the study.

TASK 2: PLANNING COORDINATION

This task was completed to coordinate with officials from the following agencies: West Jordan City, South Jordan City, Riverton City, Bluffdale City, Taylorsville City, West Valley City, the Town of Herriman, the Utah Lake Distributing Canal Company, the Utah and Salt Lake Canal Company, the South Jordan Canal Company, and the North Jordan Canal Company. Coordination meetings were held to discuss the long-term plans for operation of each of the canals, existing canal company agreements with the County and Cities, existing maintenance practices, and the potential to utilize the canals as storm drain facilities in the future. Drainage master plans and land use information were obtained from each of the cities for the purpose of incorporating this information in the study. Meetings were also held to review the results of this study and to coordinate other storm drain master planning efforts with those of this study.

TASK 3: INVENTORY EXISTING FLOOD CONTROL FACILITIES

Information obtained from Tasks 1 and 2 was utilized in conjunction with field reconnaissance to develop an inventory of existing and proposed major storm water management facilities in the study area. This inventory includes size, location, and estimated capacity of major storm drain trunk lines, open channels, culverts, bridges, flow directions, and detention facilities. GIS maps summarizing this information were created.

TASK 4: DEVELOP HYDRAULIC MODELS OF THE CANALS AND CREEKS IN THE STUDY AREA

Each bridge structure on the canals and creeks in the study area was field inventoried and surveyed and channel cross sections were surveyed at select locations. This data was then used to develop hydraulic computer models for the portions of the major canals and creeks that serve as major storm water conveyance facilities in the study area. These models were calibrated and utilized to estimate conveyance capacities of the culverts, bridges, and open channel sections and to identify hydraulic deficiencies as well as needed improvements.

TASK 5: DEFINE DRAINAGE BASIN/SUBBASIN BOUNDARIES

Existing topographic mapping and existing storm drain system inventories were utilized to define and delineate hydrologic drainage basin and subbasin boundaries. This information was utilized in developing the hydrologic model of the study area.

TASK 6: IDENTIFY SYSTEM EVALUATION CRITERIA

Evaluation criteria were developed for use as a baseline to determine the adequacy of existing drainage facilities and to identify deficiencies in drainage facilities. The criteria included: design storm, recommended minimum open channel conveyance capacities, and acceptable canal freeboard.

TASK 7: DEVELOP A HYDROLOGIC COMPUTER MODEL OF EXISTING LAND USE CONDITIONS

A GIS database containing the existing hydrologic characteristics of the study area was developed. Information from this database was transferred to hydrologic modeling software to simulate the rainfall-runoff process for existing land use conditions. The area that was modeled as part of this study included all drainage areas in Salt Lake County that are west of the Jordan River and south of Bingham Creek. Hydrologic model results were used in the hydraulic model to identify existing drainage system deficiencies.

TASK 8: DEVELOP A COMPUTER MODEL OF PROJECTED FULL BUILD-OUT LAND USE CONDITIONS

A GIS database of the projected future hydrologic characteristics of the study area was developed. Information from this database was used in conjunction with hydrologic modeling software to simulate the rainfall-runoff process for projected full build-out land use conditions. Hydrologic model results were used in the hydraulic model to identify existing drainage system deficiencies.

TASK 9: EVALUATE ALTERNATIVE SYSTEM IMPROVEMENTS

The computer models developed in Tasks 4 and 8 were utilized to evaluate alternative system improvements that, if implemented, would resolve the storm drain system deficiencies identified in Tasks 7 and 8. Recommended improvements were then identified.

TASK 10: DEVELOP COST ESTIMATES FOR RECOMMENDED IMPROVEMENTS

Cost estimates for recommended storm drain system improvements were developed.

TASK 11: PRIORITIZE RECOMMENDED IMPROVEMENTS

The recommended storm drain/flood control improvements were prioritized for planning purposes based on whether the needed improvements are to correct existing deficiencies or associated with future development and other criteria developed with County personnel.

TASK 12: REPORT PREPARATION

A draft report was prepared to summarize the results of the study and present the recommended storm system capital improvements. The report summarizes the results and recommendations of the study. Review comments were obtained from County personnel and representatives from West Jordan City, South Jordan City, Riverton City, Bluffdale City, West Valley City, Taylorsville City, and the Town of Herriman, as well as representatives from the Utah Lake Distribution, the Utah and Salt Lake, the South Jordan, and the North Jordan Canal companies, before the report was finalized.

SECTION 2
DESCRIPTION OF STUDY AREA

LOCATION

The SWCC Study area is located in the southwest quadrant of the Salt Lake Valley. The study area, shown in Figure 2-1, is generally bounded by the North Jordan Canal and the Jordan River on the east, the Salt Lake County line on the south and the west and by a line extending roughly from the County line along 7000 South east to 4000 West, north along 4000 West to the North Jordan Canal. As shown in Figure 2-1, two additional urban drainages north of 5400 South and west of 4000 West were also included in the project area. (All figures are included in Volume 2 of this report.)

The study area includes all or portions of several cities and towns, as well as a large section of unincorporated Salt Lake County. The cities included in the study are listed in Table 2-1.

Table 2-1
Cities Located Within the SWCC Study Area

Cities
Bluffdale
Town of Herriman
Riverton
South Jordan
West Jordan(1)
Taylorsville(1)
West Valley(2)

(1) Study does not include area east of the North Jordan Canal.
(2) Study only includes small areas on the south side of West Valley.

Climate and Elevation

Elevations in the study area range from approximately 4250 feet above M.S.L. at the Jordan River on the east to approximately 9350 feet above M.S.L. in the Oquirrh Mountains to the west. The average elevation in the valley portion of the study area is approximately 4,400 feet. The climate in the Salt Lake Valley is characterized as semi-arid, with annual mean relative humidity of 55 percent (ranging from 22 to 79 percent). Average temperatures range from 59° to 88° F in the summer, 40° to 65° F in the spring and fall, and from 22° to 40° F in the winter. Average annual precipitation in the valley is approximately 15.4 inches, more than half of which comes in the form of snow during the winter months.

Land Use Conditions

As development in the Salt Lake Valley has spread from east to west and north to south, the SWCC study area has undergone a gradual transition from primarily agricultural land use to a mix of residential and commercial development. The majority of urban development in the study area to date has occurred east of 4000 West. Increased accessibility provided by the Bangerter Highway and other major east/west roadway improvements, however, has facilitated increased west-area development in Herriman, Riverton, South Jordan, and West Jordan.

EXISTING CANALS

As discussed in Section 1, there are five irrigation canals which generally flow from south to north across the study area. Four of these canals (see Table 1-1) collect runoff from urbanized areas. As mentioned previously, the Welby Jacobs Canal has no storm water capacity and is not utilized as a county flood control facility.

Utah Lake Distributing Canal

The Utah Lake Distributing Canal begins at a gated diversion structure on the Jordan River at Turner Dam, in the Jordan Narrows area. The canal traverses northwesterly from its headwaters to the intersection of 3200 West and Bangerter Highway. From this point, the canal traverses north between 2700 West and 4000 West to 6200 South. The canal continues east along 6200 South, where irrigation tailwater is discharged into an underground storm drain system.

Utah & Salt Lake Canal

This canal also has its headwaters at Turner Dam. The canal traverses from this point northwest to approximately 2500 West, where it continues traversing north, between 2700 West and Redwood Road, to Bingham Creek. From Bingham Creek, the canal flows north approximately two miles, roughly along 3000 West, and then turns east for approximately one mile before rounding to the northwest and continuing to its terminus west of Magna.

South Jordan Canal

The South Jordan Canal begins at a gated diversion on the Jordan River, downstream of Turner Dam and traverses northward, between 1300 West and 2200 West, to Bingham Creek. From Bingham Creek the canal traverses north along a line just west of 2200 West to approximately 6400 South. Here the canal traverses east for about a mile before turning northwest and discharging into the Kearns-Chesterfield storm drain near 4100 South.

North Jordan Canal

The North Jordan Canal begins at a gated diversion structure on the Jordan River near 9400 South. The canal traverses north to approximately 4500 South, generally paralleling the Jordan River. From that point the canal continues in a northwest-west direction to approximately 3400 West, where the canal splits. The Kennecott Lateral of the canal flows north from this point for approximately one and a half miles before turning west and discharging into the Riter Canal, which flows through the Lake Park Golf Course. 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 dischargers into the Riter Canal.

EXISTING MAJOR DRAINAGE SYSTEMS (CREEKS)

There are seven primary natural drainage basins within the SWCC study area. Six of these were studied as part of this project. Hydrologic and hydraulic analyses of the Barney's Creek watershed were completed as part of separate drainage studies performed for West Jordan City. The results of the Barney's Creek studies will be used by Salt Lake County as a basis for storm water drainage evaluation and design within that drainage basin. A brief description of each of the drainage basins studied in the SWCC study is provided below.

Beef Hollow and Wood Hollows

Beef Hollow and Wood Hollow are the southernmost drainage basins studied as part of the SWCC study. As compared with the other major drainages in the study area, both of these basins are relatively small. Storm water runoff from these basins originates in the lower Oquirrh Mountains above the Jordan Narrows area and flows east to the Welby Jacobs Canal. Beef Hollow crosses the Welby Jacobs Canal siphon and terminates at the Utah Lake Distributing Canal. Wood Hollow is piped across the Welby Jacobs Canal and is dispersed in the fields north of the electrical substation located adjacent to Camp Williams Road. Little development currently exists in these two drainage basins.

Rose Creek

The Rose Creek drainage basin begins in the high Oquirrh Mountains at the southwest end of the study area. Runoff collects in Rose Canyon and is conveyed northeast along a well-defined natural channel to approximately 6400 West. The channel continues east from this point, generally between 13800 South and 13400 South. The channel has been flattened and incorporated into farm fields west of the Welby Jacobs Canal. East of this point, various improvements have been made to route the channel across highways and through residential developments. Rose Creek discharges into the Jordan River at about 14200 South.

Butterfield Creek

The Butterfield Creek drainage originates in the Oquirrh Mountains just south of the main Kennecott Copper Pit. The drainage channel runs along Butterfield Canyon Road. From the canyon mouth, drainage is conveyed east via a ditch along approximately 13000 South. Near the City of Herriman, the channel becomes less and less defined and eventually disappears in the fields north of Herriman and west of 6000 West.

Midas Creek

The Midas Creek drainage basin begins in the Oquirrh Mountains on the east side of the Kennecott Copper Pit. Runoff from the mountains collects in several natural channels that continue west of Oquirrh Boulevard (an extension of U-111). The channel continues east from this point along the natural channel to approximately 4800 West. From this point east to the Jordan River, Midas Creek is routed through multiple highway crossings, canal crossings, and residential developments. The channel turns to the northeast near 1300 West and 11800 South before traversing to the east again near the River Front Parkway and discharging into the Jordan River at about 11200 South.

Bingham Creek

All runoff originating in the Oquirrh Mountain portion of the Bingham Creek drainage as well as all runoff from the Kennecott Copper Pit and associated mining facilities is retained in several ponds near the mouth of Bingham Canyon and south of Copperton. These retention ponds are owned and maintained by Kennecott Copper Corporation. Consequently, the Bingham Creek drainage area as it pertains to the SWCC Study, originates at the downstream end of these retention ponds. The Bingham Creek channel traverses from this area to the east-northeast to approximately 4800 West, roughly paralleling the Old Bingham Highway. East of 4800 West, improvements have been made to route the channel through both residential and commercial development, as well as across multiple highways and canals. Bingham Creek discharges into the Jordan River at approximately 7900 South.

It should be noted that excavation and grading at the Salt Lake Welby Pit Facility in the Bingham Creek drainage corridor (approximately 5200 West to 4800 West) have effectively created a retention pond at the west end of the Welby Pit. Salt Lake County personnel employed at the Welby Pit indicated that significant runoff has only accumulated at this location once in the past 20 to 30 years. During the particular flood year, accumulated water is reported to have risen to a level at which there was concern that the dike might be overtopped.

For the purpose of the SWCC Study, it was assumed that retention storage at the Welby Pit Facility would not be sufficient to contain runoff from a 100-year storm. Design flows for downstream facilities were estimated based on discharge accumulating beginning downstream of the Kennecott retention ponds.

It should further be noted that storm water quality for runoff generated west of the Welby Pit could become an issue should the drainage corridor ever be restored. This is due to the presence of present and former landfill operations adjacent to Bingham Creek in this area.

SECTION 3
PREVIOUS STORM DRAINAGE STUDIES

One of the purposes of updating the SWCC study was to develop general planning and design criteria for managing storm water runoff in the southwest quadrant of the Salt Lake Valley. Drainage studies conducted for municipalities, new developments, and other agencies, often have discrepancies in the following areas:

- Design storm magnitude, distribution, and return period used in hydrologic modeling
- Hydrologic modeling method
- Loss rate and routing parameters utilized in hydrologic calculations.

In the process of completing this study, an attempt was made to develop standards that could be used for future drainage studies conducted within the study area. A number of resources were consulted during this process. Among these were several storm drainage master plans completed for cities within the study area as well as parts of unincorporated Salt Lake County.

Data from previously published reports and studies were used to supplement information (such as surveys and field observations) collected as part of this study. In the development of the hydrologic and hydraulic models for the SWCC study, significant effort was made to achieve results consistent with the existing studies, while preserving the elements of analysis based on the most current data. Table 3-1 is a summary of previously completed storm drainage studies that were referenced as part of this study.

Table 3-1
Previously Completed Drainage Studies
SWCC Study Area

Drainage Study	Date Completed	Prepared for	Prepared by	Study Area
Storm Drain Collection System Master Plan	November 1998	South Jordan City	EWP Engineering	South Jordan City
West Area Storm Drainage Master Plan	May 1997	West Jordan City	Thompson-Hysell Engineers	West Jordan City; Barney's Creek, Barney's Wash, Clay Hollow, and Dry Wash Drainages

Table 3-1 (continued)
Previously Completed Drainage Studies
SWCC Study Area

Drainage Study	Date Completed	Prepared for	Prepared by	Study Area
Storm Drain Master Plan	1996	City of Taylorsville	Sunrise Engineering	Taylorsville City
Storm Drainage Master Plan	March 1996	Salt Lake County Development Services	EWP Engineering	Herriman Area/ Butterfield Drainage
Storm Drain Master Plan	January 1994	Riverton City	Gilson, McKellar, McWhorter & Associates	Riverton City
Rose Creek Drainage Study with Regional Detention Basin (Update to Rose Creek Portion of 1985 SWCC Study)	March 1991	Salt Lake County Flood Control	Salt Lake County Flood Control	Rose Creek Drainage
Hydrologic and Hydraulic Analysis of Barney's Creek and Barney's Wash	November 1991	West Jordan City	Sear-Brown Group	Barney's Creek and Barney's Wash Drainages
Southwest Canal and Creek Study	June 1985	Salt Lake County	Forsgren-Perkins Engineering	SWCC Study Area (see Figure 2-1)

SECTION 4
CURRENT STORM DRAINAGE STUDIES

As discussed in the previous section, an attempt was made as part of the SWCC study to develop standards that could be used for the current study, as well as for future drainage studies within the study area. In addition to utilizing information from previously completed drainage studies, efforts were made to coordinate concurrent drainage-related projects with the SWCC study.

The studies listed in Table 4-1 are either currently in the process of completion, or were completed during the course of the SWCC study. All of the studies listed in Table 4-1 are updates to existing drainage master plans, with the exception of the Bluffdale study.

Coordination meetings were held with individuals involved with these drainage studies, either from the agency funding the project or, where possible, from the engineering firm performing the study. Efforts were made in these meetings to ensure, to the extent possible, that the assumptions and results from these drainage studies would be consistent with those from the SWCC study. Where possible, copies of draft or final reports for these studies were obtained and provided to Salt Lake County.

Table 4-1
Pending and Recently Completed Drainage Studies
SWCC Study Area

Drainage Study	Expected Date of Completion	Prepared for	Prepared by	Study Area
Storm Drainage Master Plan	April 2003	Bluffdale City	Caldwell Richards Sorensen	Bluffdale City; Beef and Wood Hollow Drainages
Storm Drainage Master Plan	October 2002	Riverton City	Hansen Allen & Luce	Riverton City
Storm Drainage Master Plan	May 2003	West Jordan City	Bowen, Collins & Associates	West Jordan City

SECTION 5
FIELD INVESTIGATION AND DRAINAGE FACILITY INVENTORY

An extensive field survey of existing canal and creek drainage facilities was completed as part the SWCC study. Field investigations and storm drainage facility inventories were also completed in an effort to gain an understanding of the overall integrated operation of the canals and creeks in the study area. The information gathered in these surveys and investigations was used to develop hydrologic models of the drainage basins within the study area as well as hydraulic models of the corresponding canal and creek channels.

CANAL SURVEY, FIELD INVESTIGATION, AND DRAINAGE FACILITY INVENTORY

Canal Channel Survey

Field reconnaissance and survey work were performed along the Utah Lake Distributing Canal, the Utah & Salt Lake Canal, the South Jordan Canal, and the North Jordan Canal. Information collected in this survey is listed in Table 5-1:

Table 5-1
Description of Canal Survey Data

Item	Survey Data Collected
Channel Crossing Structures (i.e. road crossings)	Culvert size, invert, bridge deck elevation, bottom chord elevation (all data collected for both upstream and downstream ends of structure)
Channel Cross Sections Upstream and Downstream of Structures	Detailed elevation data for channel cross sections immediately upstream and downstream of crossing structures
Intermediate Channel Cross Sections	Detailed channel elevation data for cross sections at intervals no greater than 1000 feet
Other Appurtenant Facilities (i.e. check structures and storm water overflow structures)	Check structure elevations and geometry, sizes and elevations of weirs, gates, and associated structures

The Utah Lake Distributing Canal was surveyed from the headwaters at Turner Dam to Bingham Creek. The Utah & Salt Lake Canal was surveyed from Turner Dam to 8000 West. The South Jordan Canal was surveyed from the headwaters to 4000 West.

The North Jordan Canal was surveyed from the headwaters near 9400 South to approximately 3800 West.

Canal Storm Drain Outfall Inventory

In addition to the survey work on the structures and channels, an inventory of visible storm drain pipes that discharge into each of the canals was completed. Information including the location, size, and pipe material was collected for each apparent storm drain outfall that discharges into a canal. This information was recorded in a GIS database, a digital copy of which is provided with this report. Figure 5-1 shows the location and estimated size of apparent storm drain outfalls along the canals. It should be noted that for some canal reaches, particularly along the South Jordan Canal, bank access is only possible via private property. Storm drain outfall inventory information through some of these less accessible reaches may not be complete. Table 5-2 summarizes the size and number of storm drain inflow pipes observed in each canal reach. Also provided in the table are rough estimates of the combined capacity of the inventoried pipes discharging to the canals. These outfall capacity estimates are based on assumed full pipe flow at a slope of 0.5 percent, with assumed roughness factors based on pipe material. The purpose of these estimates is to provide a conservative capacity-based approximation of the maximum storm water inflow potential for each canal reach.

Table 5-2
Summary of Storm Drain Outfalls that Discharge into Canals

Reach	Storm Drain Outfall Pipes		Combined Estimated Storm Drain Outfall Capacity (cfs) (1)	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) (1)
	Number of Pipes	Outfall Pipe Diameter (inches)		
Utah Lake Distributing Canal				
Point of Diversion to Rose Creek	1	10	2	32
	5	12	11	
	2	15	9	
	1	21	10	
Rose Creek to Midas Creek	1	8	2	18
	4	15	16	
Midas Creek to Bingham Creek	3	12	7	27
	2	15	10	
	1	18	10	
Bingham Creek to 7800 South	0	0	0	0

Table 5-2
Summary of Storm Drain Outfalls that Discharge into Canals
(continued)

Reach	Storm Drain Outfall Pipes: Number of Pipes	Storm Drain Outfall Pipes: Outfall Pipe Diameter (inches)	Combined Estimated Storm Drain Outfall Capacity (cfs) (1)	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) (1)
Utah & Salt Lake Canal				
Point of Diversion to Rose Creek	1	8	2	**22**
	4	12	10	
	1	21	10	
Rose Creek to Midas Creek (2)	1	6	1	**141**
	1	8	2	
	3	12	8	
	4	15	20	
	6	18	36	
	1	21	15	
	4	24	51	
	1	36	8 (3)	
Midas Creek to Bingham Creek	1	8	2	**124**
	1	9	2	
	11	12	26	
	5	15	20	
	2	18	17	
	1	30	16	
	1	36	41	
Bingham Creek to 7800 South	2	12	5	**25**
	2	15	8	
	1	27	12	
7800 South to 5400 South	2	6	1	**142**
	1	9	1	
	13	12	29	
	14	15	52	
	6	18	40	
	1	21	10	
	1	24	9	

Table 5-2
Summary of Storm Drain Outfalls that Discharge into Canals
(continued)

Reach	Storm Drain Outfall Pipes: Number of Pipes	Storm Drain Outfall Pipes: Outfall Pipe Diameter (inches)	Combined Estimated Storm Drain Outfall Capacity (cfs) (1)	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) (1)
Utah & Salt Lake Canal				
5400 South to 4700 South	2	6	1	**69**
	1	9	2	
	3	12	6	
	2	15	5	
	6	18	36	
	1	21	10	
	1	24	9	
4700 South to 7800 West	2	10	3	**67**
	9	12	18	
	10	15	30	
	4	18	16	
7800 West to 8000 West	0	0	0	**0**
South Jordan Canal				
Point of Diversion to Rose Creek	1	15	3	**13**
	1	21	10	
Rose Creek to 12600 South	1	6	1	**80**
	1	8	2	
	1	10	2	
	2	12	5	
	1	15	3	
	2	18	13	
	2	24	28	
	1	30	26	
12600 South to Midas Creek	1	8	2	**40**
	3	12	5	
	3	15	12	
	1	18	7	
	1	24	14	
Midas Creek to 10400 South	2	15	7	**7**

Table 5-2
Summary of Storm Drain Outfalls that Discharge into Canals
(continued)

Reach	Storm Drain Outfall Pipes: Number of Pipes	Storm Drain Outfall Pipes: Outfall Pipe Diameter (inches)	Combined Estimated Storm Drain Outfall Capacity (cfs) [(1)]	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) [(1)]
South Jordan Canal				
10400 South to Bingham Creek	1	12	4	**66**
	3	15	8	
	2	24	28	
	1	36	26	
Bingham Creek to 7800 South	1	12	4	**22**
	1	15	4	
	1	18	14	
7800 South to 5400 South	1	8	1	**90**
	1	10	2	
	6	12	14	
	12	15	30	
	3	18	20	
	2	24	23	
5400 South to 4700 South	2	12	3	**37**
	3	15	11	
	2	18	13	
	1	21	10	
4700 South to 4000 West	1	12	2	**70**
	2	15	9	
	4	18	24	
	1	24	9	
	1	36	26	
North Jordan Canal				
Point of Diversion to Bingham Creek	0	0	0	**0**
Bingham Creek to 7800 South	1	12	2	**8**
	1	15	6	

Table 5-2 (continued)
Summary of Storm Drain Outfalls that Discharge into Canals

Reach	Storm Drain Outfall Pipes: Number of Pipes	Storm Drain Outfall Pipes: Outfall Pipe Diameter (inches)	Combined Estimated Storm Drain Outfall Capacity (cfs) (1)	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) (1)
North Jordan Canal				
7800 South to 7200 South	2	6	1	**60**
	1	10	1	
	2	15	7	
	1	18	10	
	1	36	41	
7200 South to 6400 South	1	6	1	**18**
	1	12	3	
	1	24	14	
6400 South to 5600 South	3	12	7	**142**
	4	15	16	
	2	18	13	
	1	24	14	
	2	30	51	
	1	36	41	
5600 South to 5400 South	0	0	0	**0**
5400 South to 4700 South	1	10	2	**61**
	5	18	25	
	2	24	18	
	1	30	16	
4700 South to I-215	1	15	6	**26**
	1	18	4	
	1	30	16	
I-215 to 2700 West	0	0	0	**0**
2700 West to 3400 West	2	15	5	**51**
	2	18	11	
	1	24	9	
	1	36	26	
3400 West to Bangerter Highway	1	18	4	**4**

Table 5-2 (continued)
Summary of Storm Drain Outfalls that Discharge into Canals

Reach	Storm Drain Outfall Pipes		Combined Estimated Storm Drain Outfall Capacity (cfs) (1)	Total Estimated Storm Drain Outfall Capacity for Reach (cfs) (1)
	Number of Pipes	Outfall Pipe Diameter (inches)		
Bangerter Highway to Lake Park	1	18	4	**13**
	1	24	9	

(1) Estimated capacity based on full pipe flow at an assumed slope of 0.5 percent.

(2) The following pipes, not observed in the field inventory, were added at the request of Riverton City personnel: one 6-inch, one 8-inch, three 18-inch, and three 24-inch pipes. These pipes are not included in the GIS inventory.

(3) The capacity of this 36-inch outfall was revised based on a contributing area of 12 acres, as estimated by Riverton City personnel.

As stated previously, the intent of the storm drain outfall capacity estimates for each canal reach is to approximate the maximum potential storm water discharge to the canals. These estimates do not account for orifice plates or other flow restrictions on the storm drain outfalls. It should also be noted that additional storm water flows might enter the canals through catch basins at bridges, and via overland flow. These estimates will be compared with hydrologic modeling results (Section 6) to assess the potential of the existing storm drain system to convey design storm runoff to the canals.

Canal Overflow Structure Inventory

The canals in the study area were originally constructed solely for irrigation purposes, intercepting at some locations the natural drainages and surface storm water runoff. The canals were designed with decreasing downstream capacity, since flows in the canals decrease as irrigation water is taken from the canal. As a result, the canals are ill equipped to handle storm water discharges which generally accumulate in the downstream direction. To alleviate potential canal flooding during runoff events, Salt Lake County has installed storm water overflow structures on the canals to allow for the release of storm water during runoff producing events.

An inventory of the canal overflow structures was completed as part of this project. This inventory was completed during the summer, when irrigation flows were at or near their peak. The majority of these overflow structures include an overflow weir as well as one or more manually operated gates. The information collected in this inventory included overflow weir length and measurements from the top of the structure (roughly equivalent to top of bank) down to: the weir crest, the top of the stop logs, and the water surface. The width or diameter of the gate was also measured. Information collected in the canal storm water overflow structure inventory is summarized in Table 5-3. Photographs of inventoried canal overflow structures are included in Volume 2 of this report.

Table 5-3
Canal Storm Water Overflow Structure Inventory

Turnout Location	Weir Length (ft)	Measurements from Top of Structure Down to: Weir Crest (in)	Top of Stop Log (in)	Water Surface(3) (in)	Gate Width/Dia. (in)
Utah Lake Distributing Canal					
Rose Creek	12	29.5	7.5	NA (5)	NA
Bingham Creek	20	40	16	20	60
Utah & Salt Lake Canal					
Rose Creek	18	43.5	22	47	48 (2)
Midas Creek	18	47	17	37	48 (2)
Bingham Creek (1)	19.5	44	NA	53	80
5400 South	15	42	30	41	50
4700 South	15	53	30	36	72
Utah & Salt Lake Canal					
7800 West(4)	11.4	17	6	20	NA
8000 West	20	54	41	53	72
South Jordan Canal					
Rose Creek	13.5	44	11.5	NA (5)	42 (2)
Midas Creek (1)	5.8	48	NA	51	70
10400 South	10	74.5	47.5	NA (5)	48
Bingham Creek	14.8	31	17	41	50
5400 South	10	48	44	56	50
4700 South (1)	12	53	NA	56	66
North Jordan Canal					
7800 South (2)	NA	NA	NA	NA	42 (2)
7200 South (1)	19	30.5	NA	NA (5)	42 (2)
6400 South	15	18	16	15	56
5600 South 1300 West (1)	16	24	NA	23	40
5400 South (2)	NA	NA	NA	NA	60
4700 South	27	34	25	29	41
I-215 (1)	4.6	48	NA	50	55
2700 West	7.4	25.5	21.5	20	42
Bangerter Highway	8	31.5	22.5	37.5	42

(1) No stop logs present at these locations.
(2) No overflow weir present.
(3) All water surface elevations measured on 6/21/02, except North Jordan Canal at 2700 West and at Bangerter Highway, measured on 8/13/02, and as noted otherwise.
(4) No gate at these locations.
(5) These locations were inventoried on 4/10/03, at which time the Utah Lake Distributing, Utah & Salt Lake, and South Jordan Canals were dry.

The information summarized in Table 5-3 was used to develop estimates of overflow weir capacity for each of these structures. These estimates are included in Section 7 of this report.

Operating Criteria and Historic Flooding Problems for Canals

Coordination meetings were held with each of the canal companies as part of the SWCC study. The purpose of these meetings was to verify the information used to develop the hydraulic models of the canals, as well as to verify the results obtained from these models. Personnel from the canal companies were also asked to identify historic problem areas. Their comments are summarized here.

Utah Lake Distributing Canal

The Utah Lake Distributing Canal currently has a maximum irrigation flow at the headwaters of 73 cfs. The canal was originally designed to convey a peak irrigation flow of approximately 130 cfs at the headwaters. Personnel from the Utah Lake Distributing Canal Company identified three areas of concern along the canal:

- The canal runs close to bank-full for approximately half a mile north of the headwaters at the south end.
- There is a low spot in the canal bank at approximately 10800 South.
- During storm events, the canal has overtopped north of Jordan Valley Hospital in the past. The canal banks in this area have been built up and a ditch added alongside to alleviate this problem. Since these improvements there have been no further problems in this area.

Canal company personnel indicated that the canal sits relatively low with respect to the ground level along its eastern and western banks. For this reason, problem areas along the canal have only minor potential for flooding. In general, they seldom experience problems with flooding along this canal.

Utah & Salt Lake Canal

Canal company personnel indicated that there have been no problems with storm water-related flooding along this canal in the past decade. The canal companies have water rights for 172.5 cfs, and currently operate at peak irrigation flows of 160 cfs at the headwaters. The entire canal was dredged in the past to provide additional capacity for Kennecott. The resulting lower water levels in the canal necessitated the installation of numerous check structures for the purpose of supplying irrigation turnouts.

South Jordan Canal

The South Jordan Canal Company originally had water rights to 142 cfs of irrigation water. The canal currently operates at a peak irrigation flow of approximately 80 cfs at the headwaters. Canal company personnel identified three locations where storm water-related flooding problems have occurred in the past. These were areas with low bank elevations at or near 8100 South, 8300 South, and at 1900 West.

North Jordan Canal

The North Jordan Canal carries water rights for approximately 125 cfs, 30 cfs of which is owned by the North Jordan Canal Company (the remaining 90 cfs is owned by Kennecott). The peak irrigation flow in the canal during the summer months generally ranges from 75 to 80 cfs at the headwaters. The North Jordan Canal is the only canal of the four considered as part of this study that operates in the winter. Winter canal flows typically range from 35 to 40 cfs at the headwaters. Canal company personnel did not identify any historic storm water-related flood problem areas along the North Jordan Canal.

CREEK SURVEY, FIELD INVESTIGATION, AND DRAINAGE FACILITY INVENTORY

A survey of the bridge structures and culverts along the Rose Creek, Midas Creek, and Bingham Creek drainage channels was performed as part of this study. Rose Creek and Midas Creek were surveyed from approximately 6000 West to the Jordan River. Bingham Creek was surveyed from approximately 4800 West to the Jordan River. The information collected in this survey included culvert size, invert, bridge deck elevation, and bottom chord elevation for the upstream and downstream ends of all bridges and culverts along the creek channels. This survey data was combined with channel cross-section information taken from topographic maps provided by Salt Lake County to develop hydraulic models of the creek channels. The inventory of storm drainage facilities for each of these channels is summarized in Section 8 of this report.

In addition to the creek survey, field investigations were conducted in the Beef Hollow, Wood Hollow, Rose Creek, Butterfield Creek, Midas Creek, and Bingham Creek drainages. The purposes of these investigations were as follows:

- To observe general vegetation and overland flow characteristics in these watersheds. These observations formed the basis for hydrologic modeling of these drainages
- To observe channel characteristics for use in hydraulic model development
- To inventory regional detention facilities
- To observe drainage basin response to storm events.

Included in Volume 2 of this report are photographs of all storm drainage facilities along the six major drainages in the study area.

Historic Creek Storm Drainage Deficiencies

Salt Lake County personnel identified the area along the Bingham Creek channel, between Redwood Road and 1500 West (location of a trailer park), as a present flood concern. All other locations along the major drainages considered as part of this study where flooding has been a concern in the past have been or are currently being addressed with improvement projects.

The Wood Hollow drainage as well as the other mountain drainages between Wood Hollow and Rose Creek have historically created flood problems, because the majority of storm water runoff from these areas drains directly into the Welby Jacobs Canal. This canal has no significant capacity for storm water conveyance during the irrigation season. Storm water drainage from Wood Hollow and adjacent mountain basins has caused flooding at multiple locations along the Welby Jacobs Canal, as recently as September 6-8, 2002. Runoff generated during cloudburst events on these days, especially in the foothills north of Wood Hollow, overtopped and in some locations washed out the banks of the Welby Jacobs Canal and flooded a residential development. Storm water runoff in this case was intensified by the fact that a recent wildfire had destroyed much of the vegetation.

SECTION 6
HYDROLOGIC ANALYSIS

INTRODUCTION

A hydrologic analysis of the SWCC study area defined in Figure 2-1 was performed to estimate peak design flows for the County-wide canal and creek storm water drainage facilities. Runoff calculations were performed for existing and projected ultimate build-out land use conditions. The results of this analysis were compared with the results of the hydraulic analysis of storm drainage facilities along the canals and creeks to identify deficiencies and recommend necessary improvements.

DRAINAGE BASIN DELINEATION

Runoff generated in the study area generally flows from the west to east, toward the Jordan River. Runoff is conveyed toward the Jordan River by seven primary drainage channels in the study area. The associated drainage basins are listed along with their respective watershed areas and the abbreviations used for hydrologic modeling purposes in Table 6-1. The upper end of each drainage basin was delineated using topographic information for the study area. Drainage basin delineations for existing land use conditions are shown in Figure 6-1.

Table 6-1
Areas of Existing Southwest Canal and Creek Drainage Basins

Drainage Basin	Hydrologic Model Abbreviation	Drainage Area (square miles)
Beef Hollow	BH	4.46
Wood Hollow	WH	5.74
Rose Creek	RC	25.65
Butterfield Creek	BU	13.36(1)
Midas Creek	MC	20.75(2)
Bingham Creek	BI	38.30
Barney's Creek	BA	23.54

(1) Ultimately drains to Midas Creek

(2) Includes the Butterfield Creek Drainage

A significant portion of storm water generated in the urbanized portions of the study area is discharged into irrigation canals that cross the natural drainages. These canals are listed in Table 6-2.

Table 6-2
Southwest Area Canals

Canals listed from west to east:
1. Welby Jacobs Canal
2. Utah Lake Distributing Canal
3. Utah & Salt Lake Canal
4. South Jordan Canal
5. North Jordan Canal

Water in all five canals flows from south to north. The headwaters of the first four are in the Jordan Narrows area, near Turner Dam. The Welby Jacobs Canal is supplied by the Provo Reservoir Canal, while the Utah Lake Distributing, Utah & Salt Lake, and South Jordan Canals obtain water from the Jordan River. The North Jordan Canal also takes water from the Jordan River, with headwaters near 9400 South. The westernmost canal, the Welby Jacobs, operates near bank full during the irrigation season and does not have the capacity to convey significant amounts of storm water. All five canals were originally designed to operate solely as irrigation facilities, and therefore decrease in conveyance capacity in the downstream direction, as opposed to storm water facilities, which are designed to provide increased conveyance capacity in the downstream direction. The strategy utilized by Salt Lake County for managing storm water flows in addition to irrigation baseflows in the canals has been to install storm water overflow structures at points where the canals intersect natural drainage channels and large storm drain pipelines. The purpose of these overflow structures is to discharge storm water accumulations in the canals into storm water conveyance facilities with adequate capacity that will ultimately discharge to the Jordan River.

For the purposes of the hydrologic analysis, it was assumed that all storm water that discharges into the four joint-use canals would be conveyed to the next downstream overflow structure and released to the corresponding natural stream or major storm drain pipeline. For storm water modeling purposes, the Welby Jacobs Canal was assumed not to exist. The delineation of the drainage basins was completed in adherence to these assumptions.

Existing storm drainage facility information was obtained from engineering personnel from each of the cities within the study area, as well as from Salt Lake County. This information was used along with topographic information to delineate drainage basins and subbasins.

The seven major drainage basins listed in Table 6-1 were further divided into 213 drainage subbasins with areas generally between 0.5 and 0.75 square miles (larger subbasin areas were used in the undeveloped mountain region of the study area). The delineation of these subbasins was performed using topographic information as well as storm drain inventories and expected development scenarios provided by the cities in the study area and Salt Lake County. The drainage basin and subbasin delineations were reviewed with engineering personnel from the agencies involved and modified as necessary.

PRECIPITATION

The design storms for the SWCC study were developed using the report, *Rainfall Intensity Duration Analysis, Salt Lake County, Utah*, prepared for Salt Lake County by TRC North American Weather Consultants (1999). Information provided in that report was used to develop design storms with 10-year and 100-year return periods.

Previous storm drainage and floodplain studies (Rollins, Brown and Gunnell, 1980; U.S.A.C.E., 1984) for the western portion of the Salt Lake Valley determined that the east-facing drainages of the Oquirrh Mountains do not accumulate sufficient snowpack to produce design magnitude flood events. In general, runoff events of large magnitude west of the Jordan River are associated with short-duration, high-intensity cloudburst storms during the summer months. Based on information from these studies as well as a study completed by Sear-Brown for the Barney's Creek drainage (1991), a 3-hour cloudburst storm was selected as the design storm for this study.

The temporal distribution of rainfall for the design storms used in the SWCC study was developed using a Farmer-Fletcher distribution modified by Salt Lake County. Based on variations in point rainfall intensities presented in the TRC report, three regions of differing rainfall intensity were identified for the project area. These areas are shown in Figure 6-2. The 10-year and 100-year 3-hour design storm depths for these three portions of the study area are shown in Table 6-3.

Table 6-3
Design Storm Depths for the SWCC Study Area

Rainfall Area	Description	10-year 3-hour Storm Depth (in)	100-year 3-hour Storm Depth (in)
Mountain	Higher elevation subbasins in the mountains and foothills	1.31	1.97
Valley South	Mid and low elevation subbasins south of Old Bingham Highway	1.20	1.77
Valley North	Mid and low elevation subbasins north of Old Bingham Highway	1.13	1.61

These values can be compared with the more general 10-year and 100-year 3-hour storm depths of 1.2 and 1.7 inches, respectively, from the NOAA Atlas 2 (1973).

Areal Reduction of Rainfall

As Table 6-1 indicates, the areas of the seven major drainage basins in the study area range in size from approximately 4.5 to 40 square miles. Since intense summer cloudburst events typically move across the valley and are rarely distributed over a large area, precipitation depth reduction factors for the larger drainage basins were utilized in the hydrologic analysis.

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. These 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 (1983). That report recommends the following precipitation depth-area relationship for a thunderstorm of 3-hour duration, with area in square miles:

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

This relationship is based on data from *Project Cloudburst,* a study completed by the U.S. Army Corps of Engineers in April 1979. This study involved collection of data from a network of rain gages in Salt Lake City and vicinity covering an area of roughly 350 square miles.

The given depth-area relationship was used to estimate areal reduction factors for downstream concentration points along Rose Creek, Midas Creek, and Bingham Creek. Table 6-4 shows the areal reduction factors and their points of application for each of the creeks. 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 resulting reduction factors were rounded up to the nearest tenth, with a threshold reduction of 30 percent (reduction factor = 0.7). The Beef and Wood Hollow drainages were not large enough to justify areal reduction of precipitation.

Table 6-4
Areal Reduction Factors for Study Area Creeks
Existing Land Use Scenario

Location	Areal Reduction Factor
Rose Creek	
Welby Jacobs Canal	0.8
Utah Lake Distributing Canal	0.8
Utah & Salt Lake Canal	0.7
Jordan River	0.7

Table 6-4
Areal Reduction Factors for Study Area Creeks
Existing Land Use Scenario
(continued)

Location	Areal Reduction Factor
Midas Creek	
Welby Jacobs Canal	0.7
Utah Lake Distributing Canal	0.7
Utah & Salt Lake Canal	0.7
Jordan River	0.7
Bingham Creek	
Welby Jacobs Canal	0.9
Utah Lake Distributing Canal	0.7
Utah & Salt Lake Canal	0.7
Jordan River	0.7

MODELING METHODOLOGY

The hydrologic analysis of the SWCC study area was performed using the HEC-HMS software package developed by the U.S. Army Corps of Engineers. HEC-HMS uses the HEC-1 Flood Hydrograph Package algorithms in a Windows environment, with additional pre- and post-processing capabilities. A complete description of HEC-HMS modeling methods and capabilities is present in the U.S.A.C.E. HEC-HMS User's Manual. The model input parameters were assembled using multiple data sources, including drainage basin delineations, soil surveys, land use maps, recent aerial photography, and model input data used in similar hydrologic studies within or in the vicinity of the study area.

Primary Hydrologic Modeling Assumptions

The following 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 the watershed with a Farmer-Fletcher temporal distribution.

3. Normal (SCS Type 2) antecedent soil moisture conditions exist at the beginning of the design storm.

4. The hydrologic computer model adequately simulates watershed response to precipitation.

5. All storm water runoff generated by the model is conveyed through downstream model elements (the hydrologic model does not account for storm drain inlet or conveyance deficiencies).

HEC-HMS Input Parameters

The HEC-HMS software offers a variety of alternatives for both the hydrologic modeling of subbasins and the routing of subbasin runoff. Two methods for subbasin hydrology were used to model the undeveloped mountain and agricultural portions of the study area, as well as the urban developed drainage subbasins. These methods are described below.

SCS Curve Number Method for Undeveloped Drainages

The mountain and agricultural subbasins in the study area were modeled using the SCS (U.S. Department of Agriculture Soil Conservation Service) Curve Number Method. The assigned curve number dictates the amount of precipitation that will be lost to infiltration and abstraction. Table 6-5 shows the average curve numbers applied to subbasins within the SWCC study area. These curve numbers were assigned using values for arid and semiarid climates from SCS TR-55 (1986). Ground cover in the mountains and foothills of the study area generally consists of sagebrush and scrub oak; the predominant ground cover for each subbasin was chosen based on aerial photographs. Typical soils in the study area are well-drained sand and gravel loams. Hydrologic soil type distributions for each subbasin were determined based on the SCS Soil Survey of Salt Lake Area (1974). Figure 6-3 is a map of hydrologic soil types for the study area. Hydrologic soil group A is sandy and well drained, group B is sandy loam, group C is clay loam or shallow sandy loam, and group D is a poorly drained heavy plastic clay. Areas shown as soil type O had soil properties too varied to be classified. An average watershed vegetation condition was assumed for this study rather than a poor or burned watershed.

Table 6-5
SCS Curve Numbers for Undeveloped Drainage Areas

Drainage Type	Average SCS Curve Number	Range of SCS Curve Numbers
Mountain and Foothill	74	72 – 76
Agricultural	64	57 – 72

Drainage basin lag times were calculated based on approximate collection channel lengths and slopes using the Corps of Engineers version of Snyder's equation for lag time (Flood Hydrology Manual, 1989). Typical subbasin lag times for the study area ranged from 16 minutes to just under two hours depending on basin slope and geometry.

Kinematic Wave Routing Method for Urban Drainages

The kinematic wave method was used to model storm water runoff in developed portions of the study area. Each urban subbasin was divided into impervious and pervious areas, with separate loss rate and overland flow routing parameters. The percentages of impervious area for each subbasin were assigned based on land use maps obtained from Salt Lake County, as well as recent aerial photographs. The estimated percentages of impervious area for urban subbasins ranged from two percent for minimally developed predominantly agricultural subbasins to 30 percent for subbasins with a significant amount of commercial development. It should be noted that these ranges represent subbasin averages. Smaller scale subbasins would have yielded much higher percentages of impervious area in commercial and industrial areas. Precipitation infiltration and abstraction losses were modeled using initial and constant loss rates, as shown in Table 6-6.

Typical overland flow roughness parameters of 0.1 for impervious concrete or asphalt areas and 0.3 for lawns and other pervious surfaces were used, based on values recommended by Crawford and Linsley (1966). Representative collection channel routing parameters used in the kinematic wave method were approximated for each subbasin based on storm drainage inventories from the cities within the study area as well as from Salt Lake County.

Table 6-6
Kinematic Wave Parameters for SWCC Urban Drainage Areas

Area	Initial Abstraction Loss (in)	Constant Infiltration Loss (in)	Average Percentage of Subbasin Area	Range of Percentage of Subbasin Area	Overland Flow Roughness N
Impervious	0.063	0.02	16 %	2 % – 30 %	0.1
Pervious	1.0	1.0	84 %	70 % – 98 %	0.3

The initial and constant loss rates used for pervious areas were based on values previously determined for the Salt Lake Valley in the aforementioned studies completed by Rollins, Brown and Gunnell and the Corps of Engineers (1980 and 1984, respectively). The initial abstraction for impervious areas of one-sixteenth of an inch was taken from the previous Southwest Canal and Creek Study (1985), while the constant infiltration parameter was selected to be nearly negligible.

Channel and Storage Routing

The Muskingum-Cunge channel routing method was used for routing runoff from subbasins to and through the primary drainage conveyance. Detailed information on channel geometry, slope, and roughness collected during surveys of the canals and creeks was used where appropriate. In areas where this information was not collected, typical routing parameters were assigned based on field observations. A Manning's channel roughness value of 0.035 was used for typical natural channels, while a value of 0.015 was used for concrete-lined channel sections and culverts. Channel lengths were estimated from maps of the study area. Channel slopes not included in survey data collection were estimated based on topography.

Storage routing elements were included in the model to simulate the effect of detention basins. In general, only large detention basins, with volumes greater than 10 acre-feet, were included in the model. Where available, volume-discharge relationships for these large detention facilities were collected from Salt Lake County and the cities within the study area. In cases where this information was not available, a volume-discharge relationship was approximated based on the total volume of the detention basin and the size of the outlet conveyance. Large-scale areas of complete retention were identified and addressed accordingly in the development of the hydrologic model.

MODEL CALIBRATION

There are no existing streamflow records of useful length for the streams in the study area that could be referenced for model calibration. It was therefore necessary to reference on regional regression equations, streamflow records from other gaged drainages in Utah, and previous storm drainage and flood insurance studies for the study area in calibrating the computer model. It should be noted that the term "calibration" in this case refers to the process of adjusting parameters to achieve results consistent with available reference information, rather than adjusting for actual stream flow observations from the Study area.

Regression Equations

A U.S. Geological Survey (U.S.G.S.) report for urban drainages (1989) in the Salt Lake Valley was used to develop an acceptable range of 10-year discharge to drainage area ratios for the urban basins within the study area. Data from eight Salt Lake Valley urban drainage basins were used, the result being an estimated range of 0.1 to 0.8 cfs per acre for the 10-year peak discharge from small urban drainages, with an average of 0.4 cfs per acre. Data from a U.S.G.S. flood frequency report for the Southwestern United States (1994) was too general to be applicable to the natural drainage in the SWCC study.

Streamflow Records from Salt Lake Valley Drainages

Salt Lake Valley streamflow records were evaluated to develop a viable range of peak flow to drainage area ratios for the undeveloped drainage subbasins in the study area. Peak flood records for seven east-side drainages with long periods of record were consulted. Streamflow information from the Little and Big Cottonwood Creek drainages, as well as the Mill Creek and City Creek drainages were included. Discharge records from these seven drainages result in a range of ratios of 100-year peak flow to drainage area of 7 to 30 cfs per square mile, with an average of 14 cfs per square mile. It should be noted that the peak discharge mechanism for the east-side drainages (spring snowmelt) differs from the peak discharge mechanism for the west-side creeks (cloudburst events).

In general, it is inappropriate to calibrate modeled peak stream flow from a cloudburst event to observed peak stream flow for a snowmelt event; however, data from a Jordan River hydrology study completed in the 1984 by the Corps of Engineers suggest close correspondence between 100-year peak snowmelt discharge rates and 100-year peak cloudburst discharge rates for east-side drainages. In particular, peak stream flow discharge rates for the Big and Little Cottonwood Canyon drainages during the 100-year magnitude rainfall event which occurred on September 26-27, 1982, are close to the magnitude of the 100-year peak snowmelt discharge for these drainages. For Big Cottonwood Canyon, the rainfall-generated peak is approximately 15 percent lower than the snowmelt-generated peak. For Little Cottonwood Canyon, the rainfall generated peak differs from the snowmelt-generated peak by less than one percent.

Based on this apparent relationship (understood to be restricted to peak flow rate only, and not peak flow volume for the two different runoff generation mechanisms) available data from the east-side drainages were used to calibrate the SWCC model.

The curve number estimates for the undeveloped drainages in the study area were adjusted to produce 100-year peak model results consistent with the streamflow records from these seven east-side drainages. This calibration is considered conservative based on the more ephemeral nature of the west side drainages as compared with the east side. The model results stemming from this further calibration are consistent with the results of the previous SWCC Study, as well as other west-side drainage studies.

Butterfield Creek Streamflow Records

There is a 7-year record of runoff from Butterfield Creek; however, the record begins in 1995 and therefore does not include any significantly wet years. The Butterfield Creek 10-year peak discharge model result from the final calibration (15 cfs) is fairly consistent with an estimate of the 10-year peak discharge for Butterfield Creek based on the available 7-year record (10 cfs).

FUTURE DEVELOPMENT CONDITIONS

The southwest quadrant of Salt Lake County is quickly transitioning from a predominantly agricultural and rural setting to a more urban condition. For the purposes of this study, it was assumed that this trend would continue. Future development conditions were estimated and a corresponding hydrologic model was constructed based on zoning and land use maps provided by the cities within the Study areas and Salt Lake County. It should be noted that while the assumptions made may not actually reflect detailed future development scenarios, the general forecast should be reasonably representative of an ultimate build-out condition.

Drainage basin configurations for existing land use were revised for future development conditions based on storm drainage master plan information gathered from the cities within the study area and information provided by Salt Lake County. Plans for additional canal overflow structures were also considered. The drainage basin boundaries for projected future land use conditions are shown in Figure 6-4. Table 6-7 shows the contributing areas associated with the expected drainage basins.

Table 6-7
Areas of Future Southwest Canal and Creek Drainage Basins

Drainage Basin	Hydrologic Model Abbreviation	Existing Drainage Area (square miles)	Future Area (square miles)
Beef Hollow	BH	4.46	4.46
Wood Hollow	WH	5.74	5.74
Rose Creek	RC	25.65	34.42
Butterfield Creek	BU	13.36(1)	13.36(1)
Midas Creek	MC	20.75(2)	39.03(2)
Bingham Creek	BI	38.30	16.25
Barney's Creek	BA	23.54	23.54

(1) Ultimately drains to Midas Creek
(2) Includes the Butterfield Creek Drainage

Drainage area changes can be attributed to planned additional canal overflow structures, projected future storm drain trunk lines, and significant areas of projected storm water retention such as the Kennecott Sunrise development. In accordance with instructions from Salt Lake County, it was assumed that storm water generated from all new development (in areas zoned for future development) within the study area would be detained to peaks less than or equal to 0.2 cfs per acre, which is a common standard among many of the cities within the study area. Numerous storage routing elements were added to the future development hydrologic model to reflect this. A map showing general assumed future development and land use conditions for the study area is shown in Figure 6-5.

Areal Reduction of Rainfall – Future Development Conditions

Due to changes in the configuration of the drainage basins reflecting ultimate buildout conditions, it was necessary to revise the areal reduction factors applied at concentration points along the creek drainages. Table 6-8 is a summary of the areal reduction factors used for modeling runoff from projected future land use conditions.

Table 6-8
Areal Reduction Factors for Study Area Creeks
Future Land Use Scenario

Location	Areal Reduction Factor
Rose Creek	
Welby Jacobs Canal	0.8
Utah Lake Distributing Canal	0.7
Utah & Salt Lake Canal	0.7
Jordan River	0.7
Midas Creek	
Welby Jacobs Canal	0.7
Utah Lake Distributing Canal	0.7
Utah & Salt Lake Canal	0.7
Jordan River	0.7
Bingham Creek	
Welby Jacobs Canal	0.9
Utah Lake Distributing Canal	0.8
Utah & Salt Lake Canal	0.8
Jordan River	0.8

HYDROLOGIC MODELING RESULTS

The hydrologic modeling results for the canal 10-year and 100-year peak flood events are summarized in Table 6-9. For reasons previously described, there is a relatively small amount of storm water conveyance capacity in the canals. Since canal capacities are generally insufficient to convey the 100-year peak flow, it was recommended that the projected future 10-year peak flow be used for storm water design purposes, such as the automatic weir element of overflow structures. Ten-year peak discharges into the canals under ultimate buildout conditions generally range from 10 to 150 cfs. In some cases, proposed overflow structures along the canals resulted in future development flow estimations which are less than existing development flow estimations.

The peak 100-year discharge estimates for the creeks are summarized in Table 6-10. Since the creeks are the major conveyance facilities for storm water flowing from the drainage basins to the Jordan River, it is recommended that the design flow for storm drainage facilities along these channels be the 100-year peak flow under future development condition. Hydrologic model output is included in the Technical Appendix.

The hydrologic modeling results were used with hydraulic modeling results to identify deficiencies in existing storm drain facilities. These problems will be identified in subsequent sections of this report.

Table 6-9
Estimated Peak Canal Storm Water Flows by Reach

Reach	Existing Development		Future Development		Estimated Storm Drain Outfall Capacity (cfs)(1)
	10-Year Peak Storm Water Flow (cfs)	100-Year Peak Storm Water Flow (cfs)	10-Year Peak Storm Water Flow (cfs)	100-Year Peak Storm Water Flow (cfs)	
Utah Lake Distributing Canal					
Point of Diversion to Rose Creek	50	130	70	140	32
Rose Creek to Midas Creek	170	355	120	235	18
Midas Creek to Bingham Creek	110	270	40	95	27
Bingham Creek to 7800 South	45	80	45	80	0
Utah & Salt Lake Canal					
Point of Diversion to Rose Creek	80	180	75	140	22
Rose Creek to Midas Creek	95	205	95	220	141
Midas Creek to Bingham Creek	145	275	145	275	124
Bingham Creek to 7800 South	60	100	70	115	25
7800 South to 5400 South	80	105	45	65	142
5400 South to 4700 South	70	95	45	65	69
4700 South to 7800 West	60	85	40	55	67
7800 West to 8000 West	60	85	40	55	0
South Jordan Canal					
Point of Diversion to Rose Creek	30	60	35	70	13
Rose Creek to 12600 South	125	270	125	270	80
12600 South to Midas Creek	90	195	25	65	40
Midas Creek to 10400 South	5	10	15	10	7
10400 South to Bingham Creek	45	100	50	100	66
Bingham Creek to 7800 South	35	95	70	135	22
7800 South to 5400 South	50	125	40	115	90
5400 South to 4700 South	40	65	35	55	37
4700 South to 4000 West	20	35	20	30	70
North Jordan Canal					
Point of Diversion to Bingham Creek	5	10	10	15	0
Bingham Creek to 7800 South	5	10	10	15	8
7800 South to 7200 South	95	220	95	220	60
7200 South to 6400 South	30	70	30	70	18
6400 South to 5600 South	95	240	95	240	142
5600 South to 5400 South	90	140	90	140	0
5400 South to 4700 South	70	110	70	110	61
4700 South to I-215	35	55	35	55	26
I-215 to 2700 West	35	55	35	55	0
2700 West to 3400 West	35	55	35	55	51
3400 West to Bangerter Highway	35	55	35	55	4

(1) See Table 5-2.

Table 6-10
Estimated Peak Creek Storm Water Flows by Reach

Reach	Existing Development 100-Year Peak Storm Water Flow (cfs)	Future Development 100-Year Peak Storm Water Flow (cfs)
Beef Hollow		
Upstream of Welby Jacobs Canal	105	105
Welby Jacobs Canal to Jordan River	105	105
Wood Hollow		
Upstream of Welby Jacobs Canal	115	135
Welby Jacobs Canal to Jordan River	115	135
Rose Creek		
Upstream of 7600 West (Rose Canyon)	155	155
7600 West to 6400 West	300	420
6400 West to 5600 West	315	485
5600 West to 4800 West	235	380
4800 West to Welby Jacobs Canal	350	500
Welby Jacobs Canal to Utah Lake Distributing Canal	350	520
Utah Lake Distributing Canal to Utah & Salt Lake Canal	385	575
Utah & Salt Lake Canal to Jordan River	385	585
Butterfield Creek		
Upstream of 7600 West (Butterfield Canyon)	135	135
7600 West to 7200 West	190	190
7200 West to 6000 West	200	200
6000 West at Copper Creek (includes Copper Creek)	425	425
Midas Creek		
Upstream of 7400 West	230	230
7400 West to 7200 West	235	240
7200 West to 6000 West	345	500
6000 West to 4800 West (includes Butterfield and Copper Creek)	520	620
4800 West to Welby Jacobs Canal	520	805
Welby Jacobs Canal to Utah Lake Distributing Canal	520	810
Utah Lake Distributing Canal to Utah & Salt Lake Canal	520	830
Utah & Salt Lake Canal to Jordan River	520	865
Bingham Creek		
Kennecott Retention Ponds to Oquirrh Boulevard	55	105
U-111 to 5600 West	160	300
5600 West to 4800 West	175	410
4800 West to Welby Jacobs Canal	370	445
Welby Jacobs Canal to Utah Lake Distributing Canal	445	495
Utah Lake Distributing Canal to Utah & Salt Lake Canal	445	560
Utah & Salt Lake Canal to South Jordan Canal	495	625
South Jordan Canal to Jordan River	600	675

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SECTION 7
HYDRAULIC ANALYSIS

METHODOLOGY

Major storm water conveyance facilities in Salt Lake County's southwest quadrant were evaluated using a hydraulic modeling computer program. A hydraulic computer model is a mathematical representation of the geometry and flow characteristics of a drainage channel, pipe, or culvert. The software used in this study was HEC-RAS, a hydraulic computer model developed by the U.S. Army Corps of Engineers. This program was developed to calculate water surface profiles in channels with irregularly shaped cross sections. A complete discussion of the methodology used by HEC-RAS can be found in the U.S. Corps of Engineers HEC-RAS User's Manual.

HEC-RAS Input Parameters

Each HEC-RAS model is composed of two components, geometric data and flow data.

Geometric Data

Geometric data consists of the physical attributes of the drainage channel. This includes channel size, depth, shape, and roughness characteristics. The physical attributes of the drainage channels are represented in HEC-RAS as a series of cross sections. Each cross section in the computer model uses a series of data pairs to describe the station and elevation of the ground surface across the drainage channel. The stationing of the cross section data is oriented looking downstream and is defined from left to right. In addition to defining the ground surface, the cross section data defines the roughness coefficient for that portion of the channel.

Cross section data was assembled based on survey information and topographic aerial mapping. On all of the drainage channels, survey information was collected at all major hydraulic structures. This includes bridges, culverts, and major storm water turnouts. The surveyed data at these structures would include culvert dimensions, channel invert, elevation of top of road, etc. In addition to surveyed information at the structures themselves, surveyed cross sections were also collected on the drainage channel immediately upstream and downstream of all bridges and culverts.

In some locations, the survey information collected at the major hydraulic structures is sufficient to develop the computer model. In other locations, the structures are sufficiently far apart to justify intermediate cross sections. The information used to assemble these intermediate cross sections was collected using different methods for the creeks and the canals. The creeks were generally large enough that cross sections could be assembled from two-foot digital contours based on aerial mapping. Conversely, the canals are small enough that digital contours do not capture their geometry sufficiently to create an accurate model. Where additional cross sections were needed on the canals, survey information was collected. For both the creeks and the canals, additional cross sections were assembled until the maximum distance between any two cross sections was approximately 1,000 feet.

Roughness coefficients for the drainage channels were originally estimated based on a visual assessment of the condition of the channel. Canals were generally assigned a Manning's roughness coefficient of between 0.020 and 0.035, while creeks received a coefficient of between 0.030 and 0.060. Each creek generally received different coefficients for the main creek channel and the overbank areas. The coefficients for both the creeks and the canals were further refined during the calibration process as discussed below.

Flow Data

Flow data consists of all information required to describe the flow in the channel. This includes the total amount of flow in the channel, information regarding the boundary conditions at the ends of the channel, and any fixed water surface elevations that may exist along the channel.

Flow rates in the drainage channels were varied to determine the capacity of the channels. At least five different model runs with varying flow rates were performed for each of the canals and creeks to examine capacity. Boundary conditions at the downstream ends of the creeks were set based on the water surface elevation of the Jordan River during a 100-year flood event. Boundary conditions at the ends of the canals were based on normal depth in the canal. No fixed water surface elevations were used along the length of the drainage channels.

Model Calibration

Calibration of a hydraulic computer model generally consists of measuring actual flow conditions in the field and comparing these measurements with those predicted by the model. Because of the ephemeral nature of the creeks in this study, no data could be collected on the creeks for calibration. Without this data, the validity of the model results will be directly tied to the accuracy of the initial, visual assessment of the creeks. Since this is the case, detailed photographic logs of the creeks have been included in the Technical Appendix of this report. There should not be great concern over the lack of calibration data on the creeks. As will be demonstrated later in this report, all of the creeks generally have more than adequate capacity to convey peak flows during major storm events. Any capacity problems that do exist on the creeks are generally confined to undersized culverts and bridges. Hence, minor changes in roughness coefficients would have little or no effect on the conclusions of this report.

Conversely, the capacities of the canals are generally very dependent on roughness coefficient. This means that calibration is an important component of building accurate models of the canals. Fortunately, the canals are nearly full during the summer months, allowing a significant amount of flow data to be collected for calibration. Salt Lake County personnel collected flow data for calibration of the canals in September of 2001. The roughness coefficients in the model were adjusted so the calculated water surface elevation would match the associated field measurements.

Coordination With Canal Companies

A number of meetings were held with representatives of the four joint-use canal companies to review the results of the hydraulic models. In general, the canal company representatives verified the accuracy of the hydraulic models. Where problems were noted, additional information was collected and changes were made as necessary.

Estimated Peak Irrigation Canal Flows

One major reason for meeting with representatives from the canal companies was to determine the maximum irrigation flows in the canals during growing season. This is important because only canal capacity in excess of 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 maximum irrigations flows reported by each canal company are summarized with the hydraulic modeling results later in this section.

HYDRAULIC MODELING RESULTS AND DEFICIENCIES

The major storm water conveyance facilities in Salt Lake County's southwest quadrant were evaluated using the calibrated hydraulic models discussed above. The major findings of this evaluation are presented in the following sections.

Canals

Table 7-1 presents the pertinent hydraulic parameters of each joint-use canal by reach. Additional commentary follows. Included in the table are canal capacity estimates for a bank-full canal condition (no freeboard) and canal capacity estimates for six inches of freeboard. Canal capacities with six inches of freeboard were used to identify deficiencies.

Table 7-1
Existing Hydraulic Capacity of Canals by Reach

Reach	Maximum Irrigation Flow (cfs)	No Freeboard		Six Inches of Freeboard	
		Total Canal Capacity (cfs)	Capacity Available for Storm Water (cfs)	Total Canal Capacity (cfs)	Capacity Available for Storm Water (cfs)
Utah Lake Distributing Canal					
Point of Diversion to Rose Creek	73	100	27	80	7
Rose Creek to Midas Creek	55	75	20	55	0
Midas Creek to Bingham Creek	30	50	20	35	5
Utah & Salt Lake Canal					
Point of Diversion to Rose Creek	170	400	230	350	180
Rose Creek to Midas Creek	140	300	160	250	110
Midas Creek to Bingham Creek	130	275	145	240	110

Table 7-1
Existing Hydraulic Capacity of Canals by Reach
(continued)

Reach	Maximum Irrigation Flow (cfs)	No Freeboard		Six Inches of Freeboard	
		Total Canal Capacity (cfs)	Capacity Available for Storm Water (cfs)	Total Canal Capacity (cfs)	Capacity Available for Storm Water (cfs)
Utah & Salt Lake Canal (continued)					
Bingham Creek to 7800 South	120	250	130	210	90
7800 South to 5400 South	100	220	120	180	80
5400 South to 4700 South	70	280	210	240	170
4700 South to 7800 West	60	210	150	175	115
7800 West to 8000 West	30	210	180	175	145
South Jordan Canal					
Point of Diversion to Rose Creek	80	100	20	80	0
Rose Creek to 12600 South	45(1)	55	10	35(4)	0
12600 South to Midas Creek	45	125	80	105	60
Midas Creek to 10400 South	35	95	60	75	40
10400 South to Bingham Creek	35(2)	45	10	30(4)	0
Bingham Creek to 7800 South	35	70	35	45	10
7800 South to 5400 South	30(3)	75	45	50	20
5400 South to 4700 South	30	50	20	40	10
4700 South to 4000 West	30	40	10	30	0
North Jordan Canal					
Point of Diversion to Bingham Creek	80	175	95	135	55
Bingham Creek to 7800 South	65	135	70	105	40
7800 South to 7200 South	65	135	70	105	40
7200 South to 6400 South	65	135	70	105	40
6400 South to 5600 South	60	125	65	95	35
5600 South to 5400 South	60	180	120	175	115
5400 South to 4700 South	60	150	90	125	65
4700 South to I-215	55	120	65	90	35
I-215 to 2700 West	40	100	60	75	35
2700 West to 3400 West	40	40	0	30(4)	0
3400 West to Bangerter Highway	25	25	0	17(4)	0

(1) Irrigation flow in the canal measured at 38 cfs on 6/14/02 at 12800 South.
(2) Irrigation flow in the canal measured at 24 cfs on 6/14/02 at 9000 South.
(3) Irrigation flow in the canal measured at 20 cfs on 6/14/02 at 7000 South.
(4) Canal does not have sufficient capacity for maximum irrigation flow.

Utah Lake Distributing Canal

Of the canals examined in this study, the Utah Lake Distributing Canal is the furthest to the west. This makes it the first canal that can capture runoff from the large drainage areas on west side of the valley. As such, it would be desirable if this canal could intercept and convey a large amount of storm water. Unfortunately, this is not the case. The canal has capacity to convey only about 20 cfs of storm water. This is fairly consistent along the entire length of the canal. There are no major low spots along the canal limiting capacity nor are there any culverts that are significantly undersized. Hence, the capacity of the canal cannot be increased without significant and costly improvements along its entire length.

The one possible exception to this is a minor low spot approximately 1,200 feet long, starting 1,000 feet south of Bangerter Highway. By increasing the height of the east bank at this location by approximately one foot, the total capacity of the reach between the canal's point of diversion and Rose Creek could be increased to approximately 120 cfs. This would result in a modest increase in the capacity available for storm water to 47 cfs (an increase of 20 cfs).

Utah and Salt Lake Canal

The Utah and Salt Lake Canal is the largest canal examined as part of this study. It is also the canal with the greatest capacity to convey storm water. Capacity of the canal is fairly consistent throughout its length. This means there are only a few improvements in capacity that can be obtained outside of a complete renovation of the canal.

The two improvements that can be made to increase capacity are both located at the upper end of the canal. First, there is a low spot on the west bank of the canal that was captured in the survey approximately 9,000 feet south of where the canal crosses Camp Williams Road. Elimination of this low spot would increase the capacity of the reach from the point of diversion to Rose Creek to 450 cfs (an increase of 50 cfs).

The second possible improvement to the Utah and Salt Lake Canal is located south of 11800 South. There are low spots on both the east and west banks extending from the bridge located at 11800 South for approximately 2,500 feet to the south. Increasing the height of these banks would increase the capacity of the canal reach from Rose Creek to Midas Creek to 400 cfs (an increase of 100 cfs). All of this new capacity would be available to convey storm water.

South Jordan Canal

Capacity in the South Jordan Canal is severely restricted in two reaches because of low spots along the channel banks. The capacity between Rose Creek and 12600 South is limited to 55 cfs by a 1,000-foot low spot on the east bank just south of 12800 South. If the height of the west bank at this location were increased approximately two feet, the capacity of this reach would be increased to 100 cfs.

Flow is limited at a second location in the reach between Midas Creek and Bingham Creek. This is the result of 1,500-foot low spot just south of the Bingham Creek overflow. Increasing the height of both the east and west banks at this location by approximately two feet would result in a total capacity for the reach of 70 cfs.

North Jordan Canal

To facilitate discussion of the North Jordan Canal capacity, the canal was broken into three sections. The first section is between the canal's point of diversion at 9400 South and 5400 South. Through this section the canal is fairly large. Except for a few low spots that limit capacity, the canal through this section has an estimated capacity of 175 cfs. The second section is between 5400 South and 2700 West. In this section the North Jordan Canal transitions from a large canal to a large ditch. The capacity of the canal in this section gradually diminishes from 175 cfs to 40 cfs as it flows to the north. The final section is between 2700 West and the end of the canal. In this section, the North Jordan Canal is only a small irrigation ditch without any significant capacity to accept storm water.

In the lower sections of the North Jordan Canal, little can be done to increase capacity outside of complete canal renovation. Conversely, capacity in the upper section of the canal can be significantly increased by increasing the height of the east bank at three low spots.

Two of the low spots are no more than a few hundred feet long. One is located immediately north of the 7000 South crossing. The other is located at a small private crossing approximately 2,000 feet south of the 7000 South crossing. By increasing the bank height at these two locations, the capacity of the reach between Bingham Creek and 6400 South would be increased to 175 cfs. The third low spot is significantly larger. Eliminating this low spot would involve increasing the height of the east bank between 5600 South (Bullion Street) and I-215, a distance of approximately 1,500 feet. If this low spot were eliminated, the capacity of the reach between 6400 South and 5600 South would be increased to 175 cfs.

Major Drainage Systems (Creeks)

Hydraulic evaluation of the creeks in the study area produced results very different from those of the canals. Whereas none of culverts on the canals restricted capacity and capacity problems were only observed on the canals themselves, exactly the opposite is true for the creeks. The conveyance capacity of each creek is more than ample to convey projected 100-year storm flows, while many of the existing culverts are undersized. All of the recommended culvert improvements for the creeks are identified in Section 8 (Recommended Storm Drainage System Improvements) of this report. The following paragraphs summarize the major findings for the individual creeks.

Beef Hollow

A hydraulic model was not developed for the Beef Hollow drainage area. However, based on the results of the other creeks and the general dimensions of the drainage channel, the channel apparently has capacity to convey the 100-year peak discharge. A brief hydraulic analysis was performed on the existing culverts on Beef Hollow and these also appear to have sufficient capacity.

The only significant problem with the Beef Hollow drainage area appears to be that it currently ends at the Utah Lake Distributing Canal. As discussed above, the Utah Lake Distributing Canal does not have capacity to accept the full 100-year discharge from Beef Hollow. To minimize the risk of flooding at this location and along the Utah Lake Distributing Canal it is recommended that a new channel be constructed to convey the drainage from Beef Hollow to the Jordan River. This is only a distance of about 700 feet, but will involve crossing three canals.

Wood Hollow

No hydraulic model of Wood Hollow was developed, but, like Beef Hollow, it appears to have adequate capacity to convey the 100-year peak discharge. Also like Beef Hollow, the major problem appears to be that the existing stream channel ends at a canal instead of continuing to the Jordan River. In this case, a new channel is recommended for construction from the terminus of the Wood Hollow drainage channel at the Welby Jacobs Canal to the Jordan River. This will require over a mile of new channel, the crossing of four existing canals, and the crossing of one major road.

Butterfield Creek

A detailed hydraulic analysis of Butterfield Creek was not performed as part of this study. All proposed developments in the vicinity of Butterfield Creek would need to be examined on a case-by-case basis. This study does assume that drainage from Butterfield Creek will ultimately be conveyed to Midas Creek.

The lower portion of Butterfield Creek was abandoned a number of years ago. Flow in the creek is slowly diverted for irrigation purposes until the creek completely disappears somewhere near 6000 West. In the past, these agricultural diversions have been sufficient to minimize flooding along Butterfield Creek. As development occurs, however, many of the existing diversions will be abandoned and a new destination for Butterfield Creek drainage will be required. It is recommended that a new conduit be constructed on 6000 West to convey drainage from the end of Butterfield Creek to Midas Creek. The recommended capacity for this conduit is 200 cfs.

Rose, Midas and Bingham Creeks

Hydraulic models of Rose, Midas, and Bingham Creeks indicate that the drainage channels themselves have adequate capacity to convey peak 100-year discharges, but several culverts on those creeks are currently undersized. The culvert capacity problems and recommended improvements are detailed in Section 8 of this report.

HYDRAULIC ANALYSIS OF CANAL STORM WATER OVERFLOW STRUCTURES

The five irrigation canals within the study area were originally designed for the sole purpose of conveying irrigation flows. Due to the limited capacity of the canals to convey storm water, Salt Lake County has adopted a strategy of removing storm water from the canals at overflow structures. These overflow structures are located at points where the canals cross the creeks or other major storm drain facilities. Ideally, storm water discharged into a canal in a given reach will be discharged to a creek or storm drain at the next downstream overflow point.

In general, the storm water overflow structures installed along the canals consist of a weir and gate. The weir is intended to allow a release of water from the canal when storm water discharges to the canal cause the water level to rise above the weir crest. Stop logs are present on most of the weir structures to allow for adjustments in the level the canal must reach for overflow to occur. Overflow structures also include one or more gates which allow a canal operator to manually release a large amount of flow from the canal in an emergency situation.

As part of this study, the canal overflow structures within the study area were inventoried. Weir length, crest elevation, stop log elevation, water surface elevation, and gate width were measured for each structure. Section 8 of this report includes a summary of inventory information as well as photographs of the majority of these structures.

The overflow capacity of each of the automatic weirs inventoried was estimated based on weir length and available spill height. A summary of these results is presented in Table 7-2. The estimated canal storm water capacity is also included in the table for reference. It should be noted that the capacities of some of the overflow weirs may be restricted by the downstream storm drain systems to which they discharge. The estimates summarized in Table 7-2 do not reflect this.

Table 7-2
Estimated Capacity of Weir Overflow Structures

Overflow Location	Estimated Canal Storm Water Capacity Six Inches Freeboard (cfs)	Stop Logs Present		Stop Logs Removed	
		Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)	Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)
Utah Lake Distributing Canal					
Rose Creek	7	2	17	95	134
Bingham Creek	5	44	89	277	353
Utah & Salt Lake Canal					
Rose Creek	180	80	130	288	360
Midas Creek	110	46	88	330	405
Bingham Creek(1)	110	NA	NA	317	395
5400 South	80	123	172	226	285
4700 South	170	123	172	337	404
7800 West	115	1	12	38	73
8000 West	145	289	366	464	554

Table 7-2 (continued)
Estimated Capacity of Weir Overflow Structures

Overflow Location	Estimated Canal Storm Water Capacity Six Inches Freeboard (cfs)	Stop Logs Present		Stop Logs Removed	
		Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)	Overflow Capacity Six Inches Freeboard (cfs)	Overflow Capacity No Freeboard (cfs)
South Jordan Canal					
Rose Creek	0	12	37	221	275
Midas Creek(2)	60	NA	NA	111	135
10400 South	40	187	228	396	449
Bingham Creek	0	83	125	129	178
5400 South	20	163	204	190	232
4700 South(1)	10	NA	NA	270	323
North Jordan Canal					
7800 South(3)	40	NA	NA	NA	NA
7200 South(1)	40	NA	NA	161	223
6400 South	40	33	67	44	80
5600 South 1300 West(1)	35	NA	NA	85	131
5400 South(3)	115	NA	NA	NA	NA
4700 South	65	156	235	279	373
I-215	35	6	24	24	26
2700 West	35	32	52	45	67
Bangerter Highway	0	37	60	72	99

(1) No stop logs presently in place at these locations.

(2) Gate serves as weir. No existing provision for stop logs.

(3) Gate only. No overflow weir present.

The results of the hydraulic analysis of the canal overflow structures indicate that most of the overflows have capacity sufficient to divert the maximum potential storm water inflow from the upstream canal reach into a major storm water facility. The exceptions to this are the weir at 7800 West on the Utah & Salt Lake Canal, and the weir at I-215 on the North Jordan Canal. In both cases, however, redundancy provided by nearby overflow structures makes improvements to these structures a low priority. It should be noted that stop log modifications might be necessary on several weirs to lower the weir crest and increase overflow capacity. All recommended improvements to canal overflow structures are included in Section 8 of this report.

In addition to the locations listed above, it is expected that storm water overflow structures will be installed at locations identified in Table 7-3. These locations are based on information obtained from agencies currently working on storm drain projects within the study area as well as anticipated project information from Salt Lake County.

Table 7-3
Expected Future Overflow Locations

Canal	Future Overflow Locations
Utah Lake Distributing Canal	Midas Creek
Utah Lake Distributing Canal	7800 South
Utah & Salt Lake Canal	7800 South
South Jordan Canal	12600 South
South Jordan Canal	7800 South

SECTION 8
RECOMMENDED STORM DRAINAGE SYSTEM IMPROVEMENTS

GENERAL APPROACH

The following major tasks were completed in accomplishing the objectives of this study:

- Peak discharge rates and runoff volumes produced by design storms were estimated for the drainage basins and subbasins within the study area.
- Existing hydraulic capacities of canal and creek facilities in the study area were estimated.
- The results of the hydrologic and hydraulic analyses were utilized to identify storm drainage facility deficiencies within the integrated canal and creek storm drainage system.
- Improvements were recommended for the integrated canal and creek storm drainage system to resolve identified deficiencies.

The following items outline the general criteria used in identifying deficiencies and recommending improvements within the canal and creek storm drainage system:

- In terms of storm water, the canals are considered tributary to the major drainage facilities (creeks). All storm water collected in the canals should ultimately discharge to a creek or major storm drain.
- All creeks and major storm drains should ultimately discharge to the Jordan River.
- All recommended improvements should accommodate design storm peak discharges generated from projected full build-out development conditions.
- Creek facilities should have the capacity to convey peak discharges from a 100-year design storm.
- Canal facilities should have the capacity to convey storm water produced by a 10-year design storm in addition to the maximum irrigation flow with a minimum of six inches of freeboard.

STORM DRAINAGE DEFICIENCIES AND RECOMMENDED IMPROVEMENTS

The results of the hydrologic and hydraulic analyses were used to identify storm drainage facilities that have the potential for flooding during high intensity cloudburst events. The figures included in this section summarize the results of these analyses as well as the improvements recommended to alleviate system deficiencies.

Creek Deficiencies and Improvements

As a general rule, the natural creek drainage corridors have developed a channel and floodplain sufficient to convey the estimated 100-year discharges associated with ultimate development conditions with non-destructive channel velocities. In areas where development had previously altered or blocked the natural drainage corridor, the channels have been rerouted and restored with sufficient conveyance capacity. Exceptions to this include the Beef Hollow, Wood Hollow, and Butterfield Creek drainages. Drainage from these channels to the Jordan River has been obstructed by roads, canals, or other development. For the Beef and Wood Hollow drainages, improvements are recommended to restore drainage to the Jordan River. For the Butterfield Creek drainage, improvements are recommended to route channel flow to Midas Creek. A few minor channel improvements are also recommended in conjunction with road and canal crossing improvements for Rose, Midas, and Bingham Creeks, as detailed in the summary tables in this section.

In addition, several reaches of the Rose Creek and Midas Creek drainages on the undeveloped western side of the study area are estimated to be at or near bank-full under design flow conditions. Lack of development in these areas means that the risk of damage associated with the identified flood potential is presently low. Salt Lake County has indicated that channel improvements in these reaches shall be implemented by the developer as development occurs. Consequently, these reaches (identified in the figures summarized in Table 8-1 as "Development Driven") are not included in the list of recommended improvements or the associated conceptual cost estimate.

Figures 8-1 through 8-11 are plan and profile sheets showing an inventory of the storm drainage facilities associated with each of the natural drainage channels. The plan figures include summaries of hydrologic and hydraulic model results for these facilities, as well as recommended improvements. A photographic inventory of existing creek storm drainage facilities is also included. Table 8-1 is an index summarizing the figures associated with each major drainage.

Table 8-1
Recommended Improvement Summary Figures for Creeks

Drainage	Plan Sheet(s)	Profile Sheet(s)	Photo Sheet(s)
Beef and Wood Hollows	Figure 8-1	NA	Figure 8-2
Rose Creek	Figure 8-3	Figure 8-4	Figure 8-5
Midas Creek	Figure 8-6	Figure 8-7	Figure 8-8
Bingham Creek	Figure 8-9	Figure 8-10	Figure 8-11

Levels of deficiency were assigned to the problems or deficiencies identified in the figures. These deficiency levels were combined with other considerations to prioritize the recommended improvements in Section 9. The deficiency levels are defined as follows:

I. Estimated capacity of existing facility less than or equal to 50 percent of estimated 100-year peak discharge for existing development conditions.

II. Estimated capacity of existing facility greater than 50 percent of 100-year peak discharge for existing development conditions but less than estimated full 100-year peak discharge for existing development conditions.

III. Estimated capacity greater than estimated 100-year peak discharge for existing development conditions but less than 85 percent of 100-year peak discharge for ultimate development conditions.

IV. Minor potential flooding associated with estimated 100-year peak discharge for ultimate development conditions. No improvement recommended.

The identified deficiencies and recommended improvements for each of the creeks in the study area are summarized in the following paragraphs. It should be noted that the recommended improvements were based on maintaining existing culvert slopes and existing roadway elevations.

Beef Hollow

The Beef Hollow drainage channel currently ends at the Utah Lake Distributing Canal. Recommended improvements to this creek are intended to restore drainage to the Jordan River. These improvements are summarized in Table 8-2 and shown in Figure 8-1.

Table 8-2
Recommended Improvements for Beef Hollow

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
BH-3	Utah Lake Distributing Canal to Jordan River	No existing facility	48-inch RCP under two canals. Restoration of approximately 700 feet of channel.	I

Wood Hollow

A portion of runoff from Wood Hollow crosses the Welby Jacobs Canal via an inefficient drainage facility (see Figure 8-2 photograph from Wood Hollow) and dissipates in the fields north of the power substation. Runoff that is not conveyed through the crossing discharges directly into the Welby Jacobs Canal. The improvements recommended for the Wood Hollow drainage are intended to restore a drainage corridor to the Jordan River, and are summarized in Table 8-3 and shown in Figure 8-1.

Table 8-3
Recommended Improvements for Wood Hollow

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
WH-1	Welby Jacobs Canal to Jordan River	No existing facilities or identifiable channel	48-inch RCP under Welby Jacobs Canal, Redwood Road, and 3 additional canals. Approximately 5500 feet of channel restoration and improvements from Welby Jacobs Canal to the Jordan River.	I

Rose Creek

With one exception, all identified potential problem areas for the Rose Creek drainage are between the Welby Jacobs Canal crossing and the box culvert at 3160 West. The exception is an undersized corrugated metal pipe culvert at the mouth of Rose Canyon, near 8000 West. The recommended improvements for Rose Creek are outlined in Table 8-4 and shown in Figures 8-3 and 8-4.

Table 8-4
Recommended Improvements for Rose Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
RC-1	Rose Canyon near 8000 West	36-inch CMP	Replace with 60-inch RCP	I
RC-7	Welby Jacobs Canal Crossing	6' x 1.45' box culvert	Replace with 14' x 4' box culvert	I
RC-8	4000 West	6' x 5' box culvert	Add 6' x 5' box culvert; improve approximately 1,600 feet of channel from Welby Jacobs Canal to 4000 West	II
RC-9	Field east of 4000 West	Approximately 150' of 48-inch CMP in poor condition	Remove pipe and restore channel	I
RC-11	3600 West	8' x 5' box culvert. Currently silted to 8' x 3'[(1)].	Replace with 10' x 5' box culvert	III
RC-13	3160 West	10' x 3.7' box culvert	Replace with 14' x 5' box culvert	II

(1) Clean existing box.

Butterfield Creek

There is currently no visible drainage channel for Butterfield Creek east of 6400 West. It is recommended that the channel be restored from 6400 West to 6000 West. It is further recommended that a storm drain conveyance system be installed along 6000 West to convey runoff from the Butterfield Creek drainage to the Copper Creek drainage. It is also recommended that the Copper Creek channel be improved from this point on 6000 West to convey the combined Butterfield Creek and Copper Creek storm flows northeast to Midas Creek. Recommended improvements for Butterfield Creek are summarized in Table 8-5 and shown in Figure 8-6A.

Table 8-5
Recommended Improvements for Butterfield Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
MC-1	Butterfield Creek – 6400 to Copper Creek, and northeast along the Copper Creek channel to Midas Creek	No existing facilities	Restore approximately 3,500 feet of channel from 6400 West to 6000 West. Install approximately 2,800 feet of 60-inch RCP along 6000 West north to Copper Creek. Improve approximately 5,700 feet of Copper Creek channel from 6000 West northeast to Midas Creek.	I

Midas Creek

Of the six major drainages considered in this study, the Midas Creek drainage has the greatest number of deficient drainage facilities. The potential problem areas and recommended improvements for Midas Creek are shown in Table 8-6 and shown in Figures 8-6 and 8-7.

Table 8-6
Recommended Improvements for Midas Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
MC-5	Welby Jacobs Canal Crossing	3.5' x 2.5' arch	Replace with 14' x 4' box culvert	I
MC-6	4000 West	48-inch RCP	Replace with 14' x 6' box culvert	I
MC-11	2700 West	42-inch CMP	Replace with 12' x 6' box culvert	I
MC-17	Redwood Road	7' x 2.4' box culvert	Replace with 10' x 5' box culvert (2)	I
MC-18	South Jordan Canal Crossing	6' x 1.5' box culvert	Replace with 12' x 4' box culvert	I
MC-19	11500 South	13.5' x 2.5' bridge	Replace with 14' x 6' bridge	I
MC-20	1300 West	60-inch RCP	Replace with 14' x 5' box culvert	I

Bingham Creek

In contrast with Midas Creek, the majority of the facilities along the Bingham Creek drainage channel are sufficient to accommodate the runoff resulting from the 100-year design storm for ultimate build-out conditions. The exceptions are a few road crossings, and the existing drainage culverts in all of these cases except one are 48-inch corrugated metal pipe culverts. Two of the problem areas are located west of 4000 West, and two additional problem areas are located in a trailer park just east of Redwood Road, near 8200 South. The latter has been the location of historic flooding problems. The final potential problem area is relatively minor, and is located at 1300 West. Recommended improvements for Bingham Creek are summarized in Table 8-7 and shown in Figures 8-9 and 8-10.

Table 8-7
Recommended Improvements for Bingham Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
BC-1	Skye Drive	48-inch CMP	Replace with 66-inch RCP	I
BC-3	4000 West	48-inch CMP	Replace with 72-inch RCP	I
BC-16	1650 West	48-inch CMP	Replace with 16' x 5' box culvert	I
BC-17	1500 West	48-inch CMP	Replace with 12' x 5' box culvert; improve approximately 1,000 feet of channel between 1650 West and 1500 West	I
BC-18	1300 West	8' x 5.5' box culvert	Replace with 10' x 6' box culvert; improve approximately 1,300 feet of channel between 1500 West and 1300 West	II

General Recommendations for Creeks

In addition to the recommendations summarized above, the following general recommendations are given for the natural drainages:

1. The size, invert elevation, and low chord elevation for new creek crossings should be determined using the hydraulic models developed as part of this study. These models should be updated periodically to reflect improvements. Locations and elevations for new creek crossings should be established using the survey benchmarks given in the Technical Appendix.

2. New creek crossings should be designed to convey a flow greater than or equal to the 100-year peak flow based on ultimate development conditions.

3. All new creek crossings and improvements to existing conveyance facilities should be riprapped upstream and downstream to maintain channel integrity at velocities associated with the design flow.

4. All improvements or other channel modifications involving restriction of the natural channel should incorporate riprap upstream and downstream as well as along the length of the restriction.

Canal Deficiencies and Improvements

The gradual transition of the study area from agricultural land to urban development has resulted in numerous canal bridges and other crossings, primarily for roadways. The canal companies have been careful not to allow these crossings to form restrictions in the overall conveyance capacity of the canals. As a result, canal deficiencies and recommended improvements identified as part of this study fall into three categories:

- Installation of new canal overflow structures
- Modifications to existing canal overflow structures
- Capacity enhancement of canal reaches (increases in canal bank height).

It should be noted that canal capacities could also be increased by channel dredging; however, the general experience in the past has been that extensive dredging leads to problems with irrigation turnouts. In particular, the Utah & Salt Lake Canal has been dredged historically to add capacity. Consequently, it was also necessary to install check structures along the canal to maintain water levels sufficient to supply irrigation facilities. Operation of these check structures renders the extra dredged capacity ineffective.

Figures 8-12 through 8-21 are plan and profile sheets for each of the four canals considered in this study. Included in the plan figures are summaries of hydrologic and hydraulic model results for existing storm drainage facilities along the canals with recommended improvements for these facilities. Also included in these figures are recommendations for the installation of new storm drainage facilities along the canals. Table 8-8 is an index of the figures associated with each canal.

Table 8-8
Recommended Improvement Summary Figures for Canals

Canal	Plan Sheet(s)	Profile Sheet(s)	Photo Sheet(s)
Utah Lake Distributing Canal	Figure 8-12	Figure 8-13	Figure 8-14
Utah & Salt Lake Canal	Figure 8-15	Figure 8-16	Figure 8-14
South Jordan Canal	Figure 8-17	Figure 8-18	Figure 8-19
North Jordan Canal	Figure 8-20	Figure 8-21	Figure 8-19

The problem areas identified in these figures were assigned a deficiency level based on the scale outlined below. These deficiency levels were combined with other considerations to prioritize recommended improvements in Section 9.

I. Major canal capacity enhancements and installation of new storm water overflow structures.

II. Replacement or major modifications to existing storm water overflow structures

III. Minor modifications to existing storm water overflow structures, especially stop log adjustments.

IV. Minor canal capacity enhancements.

These deficiency levels are combined with other factors, such as ease of implementation, in Section 9 to assign a priority to the recommended canal improvements.

The recommended improvements for each of the canals are summarized in the following paragraphs.

Utah Lake Distributing Canal

The Welby Jacobs Canal has historically been a location of high flood potential. This is due to the fact that a large amount of storm water runoff from the mountains and undeveloped areas west of the Welby Jacobs discharges directly into the canal. The fact that the canal operates near bank-full during peak irrigation flows compounds the problem. Due to this minimal storm water capacity, the Welby Jacobs Canal was not considered as a storm water conveyance facility as part of this study. For modeling purposes, all upstream drainage was routed over the top of this canal to the next downstream storm water conveyance.

In many areas, this assumption resulted in large amounts of runoff being routed to the Utah Lake Distributing Canal. This canal also has very little capacity for storm water when it is conveying irrigation water in the summer months. Improvements to this canal which would accommodate the 10-year storm water design flow in addition to the peak irrigation flow are not feasible in most reaches. The recommended improvements for the Utah Lake Distributing Canal, summarized in Table 8-9 and shown in Figures 8-12 and 8-13, are intended to maximize capacity in reaches where this can be reasonably accomplished, and to minimize the distance along the canal over which storm water runoff can accumulate before being discharged to a creek or other major storm drainage facility.

Table 8-9
Recommended Improvements for the Utah Lake Distributing Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
ULDC-1 (A and B)	South of Bangerter Highway	No existing facility	(A) Raise approximately 1,200 feet of east bank by 1' (B) Revise approximately 300 feet of northeast bank by 2'.	I
ULDC-3	Midas Creek	No existing facility	Add storm water overflow structure	I
ULDC-5	7800 South	No existing facility	Add storm water overflow structure	I

(1) Currently under construction.

As discussed previously, these improvements will increase the storm water capacity of the canal significantly; however, they are not sufficient to allow the canal to convey the 10-year design storm runoff added to the peak irrigation flow. Consequently, the following recommendations are also made for the Utah Lake Distributing Canal:

- Additional storm water discharge to the canal should not be permitted under present canal operation and canal capacity conditions.

- Runoff from all mountain and undeveloped drainage basins not flowing to the Jordan River shall be detained. This should particularly be the case for the mountain drainages near Beef and Wood Hollows, west of the Welby Jacobs Canal. Detained flows from these areas shall be routed to the nearest major creek ultimately draining to the Jordan River.

- Any new storm drain trunklines which cross this canal and drain to the Jordan River should include canal storm water overflow facilities.

Utah & Salt Lake Canal

Of the four canals considered as part of this study, the Utah & Salt Lake Canal has the most capacity to accommodate storm water runoff. All canal reaches have capacity sufficient to convey the 10-year design flow in addition to the peak irrigation flow. Storm water overflow weirs along this canal are generally adequate to release the design storm water flows. One additional storm water overflow structure is recommended for this canal at 7800 South. All other recommendations involve minor stop log adjustments at overflow weirs. Recommended improvements for the Utah & Salt Lake Canal are listed in Table 8-10 and shown in Figures 8-15 and 8-16.

Table 8-10
Recommended Improvements for the Utah & Salt Lake Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
USLC-2	Rose Creek	18' weir with stop logs, 48-inch gate (2)	Remove 12 to 18 inches of stop logs	III
USLC-4	Midas Creek	18' weir with stop logs, 48-inch gate (2)	Remove 10 to 14 inches of stop logs	III
USLC-6	7800 South	No existing facility	Add storm water overflow structure	I
USLC-7	5400 South	15' weir with stop logs, 50-inch gate	Remove 3 to 6 inches of stop logs	III
USLC-9	7800 West	12' weir with stop logs	Remove all stop logs	III

In addition to these recommendations, it is also recommended that any future additional permitted storm water discharges to the Utah & Salt Lake Canal be limited so as not to exceed the total storm water capacity of the canal. Any new storm drain trunklines which cross this canal and drain to the Jordan River should include canal storm water overflow facilities.

South Jordan Canal

Like the Utah Lake Distributing Canal, the South Jordan Canal also has little or no capacity for storm water. With the exception of one reach from 12600 South to Midas Creek, the combination of the 10-year design storm water discharge to the canal and the peak irrigation flow exceeds the total canal capacity with six inches of freeboard (a few canal reaches could potentially convey this flow at or near bank-full). The recommended improvements for the South Jordan canal subsequently focus on maximizing capacity in reaches where this can be reasonably accomplished, and minimizing the distance along the canal over which storm water runoff can accumulate before being discharged to a creek or other major storm drainage facility. Recommended improvements for the South Jordan Canal are summarized in Table 8-11 and shown in Figures 8-17 and 8-18.

Table 8-11
Recommended Improvements for the South Jordan Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
SJC-2	South of 12800 South	No existing facility	Raise approximately 1,000 feet of east bank by 2'	I
SJC-3	12600 South	No existing facility	Add storm water overflow structure	I
SJC-6	South of Bingham Creek	No existing facility	Raise approximately 1,500 feet of both banks by 2'	I
SJC-7	Bingham Creek	15' weir with stop logs, 50-inch gate	Remove all stop logs	III
SJC-8	7800 South	No existing facility	Add storm water overflow structure	I
SJC-9	5400 South	10' weir with stop logs	Remove all stop logs	III

These improvements are not sufficient to allow the canal to convey the 10-year design storm runoff added to the peak irrigation flow, although they will significantly increase the storm water capacity of the canal. The following recommendations are also made for the South Jordan Canal:

- Additional storm water discharge to the canal should not be permitted under present canal operations and canal capacity conditions.
- Any new storm drain trunklines which cross this canal and drain to the Jordan River should include canal storm water overflow facilities.

North Jordan Canal

The majority of the reaches of the North Jordan Canal have capacity sufficient to accommodate the design 10-year storm water flow in addition to the peak irrigation flow. The major exception is the reach from Bingham Creek to I-215. There are three apparent feasible improvements to this section of canal which would significantly increase capacity. These improvements would add 40 to 50 cfs of storm water capacity to this reach of the canal. There are multiple storm water overflow structures along the North Jordan Canal, which minimize the potential for storm water accumulation. The remainder of the recommended improvements for this canal, summarized in Table 8-12 and shown in Figures 8-20 and 8-21, involve adjustments or modifications to existing storm water overflow facilities.

Table 8-12
Recommended Improvements for the North Jordan Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Deficiency Level
NJC-2	South of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	I
NJC-4	North of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	I
NJC-6	South of 5600 South	No existing facility	Raise approximately 1,500 feet of east bank by 1'	I
NJC-8	5400 South	60-inch gate, no weir	Install weir structure	II

The following recommendations are also made for the North Jordan Canal:

- Additional storm water discharge to the canal should not be permitted under present canal operations and canal capacity conditions.
- Any new storm drain trunklines which cross this canal and drain to the Jordan River should include canal storm water overflow facilities.

General Recommendations for Canals

In addition to the recommendations presented above, the following general recommendations are made for canal conveyances and canal storm drainage facilities:

1. The size, invert elevation, and low chord elevation for new canal crossings should be determined using the canal hydraulic models developed as part of this project. These models should be periodically updated. Locations and elevations for new canal crossings should be established using the survey benchmarks given in the Technical Appendix.

2. New canal crossings should be designed to convey a minimum of the peak irrigation flow in addition to the 10-year peak flow (future development conditions). Sizing of a canal crossing should be coordinated with the corresponding canal company.

3. New canal storm water overflow structures should include both an automatic weir and a manually operated gate. The weir should be designed with a stage-discharge relationship consistent with the canal, and should

have a capacity greater than or equal to the 10-year peak flow (future development conditions).

4. Concrete weir crest elevations should be set at or slightly below maximum irrigation flow elevations. Stop logs should be used to allow adjustments based on field observations of canal response to storm water events.

5. Installation of new overflow structures and modifications to existing facilities should be closely coordinated with and must be and must be approved by the canal companies.

6. Canal storm water overflow structures should be inspected and associated gates exercised yearly. Maintenance should be performed as determined by these inspections.

Other General Recommendations

The results of the ultimate development scenario hydrologic analysis completed as part of this study are based on several general assumptions regarding new development. In accordance with these assumptions and in order to preserve the relevance of model results the following recommendations are made:

1. All new development in areas where development was anticipated as part of this study shall detain storm water discharge such that the outflow to a county storm drainage facility is less than or equal to 0.2 cfs per acre.

2. All new development in areas where development was not anticipated as part of this study shall detain storm water discharge such that the outflow to a county storm drainage facility is less than or equal to the undeveloped natural condition discharge.

MODEL ACCURACY

The hydrologic and hydraulic models developed as part of the SWCC Study were developed based on data obtained during field surveys and investigations, current available information obtained from the cities within the study area, information obtained from Salt Lake County, and information from other drainage studies completed for the area. Bowen, Collins & Associates and Salt Lake County cannot be responsible for the accuracy of these models when used by others, especially if the computer models are modified.

SECTION 9
PRIORITIZATION AND COSTS OF RECOMMENDED IMPROVEMENTS

Conceptual cost estimates for the recommended storm drain facility improvements identified in Section 8 were developed. These cost estimates were based on information from a variety of sources, including local contractors, recent bids for similar projects, and estimating guides. A construction contingency of 20 percent was included in these estimates, since all project elements were not specified in detail at the conceptual plan level. The contingency is intended to allow for:

- Variation in quantities
- Unknown economic conditions and bidding climate
- Special requirements of affected agencies.

The conceptual cost estimates presented in this section are presented in 2003 dollars and also include engineering, legal, and administrative costs, estimated as 15 percent of the total construction cost for each improvement. Detailed calculations for the cost estimates summarized in this section are included in the Technical Appendix.

Recommended improvements were assigned a priority of 1, 2, or 3 based on a variety of factors for a given facility, including level of deficiency, potential for flood damage, and relative ease of implementation. Improvements assigned a priority of 1 require the most immediate attention, while improvements assigned priorities of 2 or 3 should be implemented subsequently.

CONCEPTUAL COST ESTIMATES FOR RECOMMENDED IMPROVEMENTS

Priorities and Costs of Recommended Creek Improvements

The recommended improvements to storm drainage facilities along the creeks considered as part of this study were assigned priorities based on two factors. The first of these was the level of deficiency assigned in Section 8, which is an indicator of the capacity of a given facility to convey a flood resulting from a 100-year rainfall event. This factor was combined with an assigned potential for flood damage to establish a priority (ranging from 1 to 3) for each recommended improvement. Facilities with major deficiencies in capacity (deficiency level 1) and significant potential for damage due to flooding were given a priority of 1. Facilities with minor deficiencies and little or no potential for flood damage were assigned a priority of 3.

Beef Hollow

Recommended improvements to the Beef Hollow drainage involve creating a continuous channel for storm water discharge to the Jordan River. The conceptual costs for these improvements are summarized in Table 9-1. These improvements were assigned a low priority since there is minimal potential for costly flood damage at the current channel terminus (the Utah Lake Distributing Canal).

Table 9-1
Priorities and Costs of
Recommended Improvements for Beef Hollow

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
BH-3	Utah Lake Distributing Canal to Jordan River	No existing facility	48-inch RCP under 2 canals. Restoration of approximately 700 feet of channel.	$250,000	3

Wood Hollow

The improvements recommended for the Wood Hollow drainage are intended to restore a drainage corridor to the Jordan River. Cost estimates for these improvements are summarized in Table 9-2. These improvements were given a high priority due to the high potential for flood damage along the Welby Jacobs Canal.

Table 9-2
Priorities and Costs of
Recommended Improvements for Wood Hollow

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
WH-1	Welby Jacobs Canal to Jordan River	No existing facilities or identifiable channel	48-inch RCP under Welby Jacobs Canal, Redwood Road, and 3 additional canals. Approximately 5500 feet of channel restoration and improvements from Welby Jacobs Canal to the Jordan River.	$645,000	1

Rose Creek

The recommended improvements for Rose Creek are shown in Table 9-3, along with cost estimates and priorities for these improvements.

Table 9-3
Priorities and Costs of
Recommended Improvements for Rose Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
RC-1	Rose Canyon near 8000 West	36-inch CMP	Replace with 60-inch RCP	$90,000	3
RC-7	Welby Jacobs Canal Crossing	6' x 1.45' box culvert	Replace with 14' x 4' box culvert	$144,000	3
RC-8	4000 West	6' x 5' box culvert	Add 6' x 5' box culvert; improve approximately 1,600 feet of channel from Welby Jacobs Canal to 4000 West	$312,000	2
RC-9	Field east of 4000 West	Approximately 150' of 48-inch CMP in poor condition	Remove pipe and restore channel	$80,000	1
RC-11	3600 West	8' x 5' box culvert. Currently silted to 8' x 3'(1).	Replace with 10' x 5' box culvert	$114,000	3
RC-13	3160 West	10' x 3.7' box culvert	Replace with 14' x 5' box culvert	$136,000	2

(1) Clean existing box.

Butterfield Creek

Cost estimates for recommended improvements to the Butterfield Creek drainage are summarized in Table 9-4. Estimates for the purchase of right-of-way and construction easements, provided by Salt Lake County, were included in the total estimated cost of these improvements.

Table 9-4
Priorities and Costs of
Recommended Improvements for Butterfield Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
MC-1	Butterfield Creek – 6400 to Copper Creek, and northeast along the Copper Creek channel to Midas Creek	No existing facilities	Restore approximately 3500 feet of channel from 6400 West to 6000 West. Install approximately 2800 feet of 60-inch RCP along 6000 West north to Copper Creek. Improve approximately 5700 feet of Copper Creek channel from 6000 West northeast to Midas Creek.	$1,970,000	2

Midas Creek

As mentioned in the previous chapter, the Midas Creek drainage has the greatest number of drainage facilities with significant capacity deficiencies of the six major drainages considered in this study. The recommended improvements for Midas Creek are shown in Table 9-5, along with the corresponding cost estimates and priorities. Note that the cost of MC-18 includes replacement of the canal storm water overflow structure, even though this structure was not identified as a potential problem. The reason for this is economic: it would be more costly to work around the existing overflow structure than to replace it.

Table 9-5
Priorities and Costs of Recommended Improvements for Midas Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
MC-5	Welby Jacobs Canal Crossing	3.5' x 2.5' arch	Replace with 14' x 4' box culvert	$153,000	3
MC-6	4000 West	48-inch RCP	Replace with 14' x 6' box culvert	$142,000	2
MC-11	2700 West	42-inch CMP	Replace with 12' x 6' box culvert	$149,000	1
MC-17	Redwood Road	7' x 2.4' box culvert	Replace with 10' x 5' box culvert (2)	$151,000	1
MC-18	South Jordan Canal Crossing	6' x 1.5' box culvert	Replace with 12' x 4' box culvert	$359,000(1)	2
MC-19	11500 South	13.5' x 2.5' bridge	Replace with 14' x 6' bridge	$134,000	1
MC-20	1300 West	60-inch RCP	Replace with 14' x 5' box culvert	$157,000	1

(1) Cost includes replacement of canal overflow structure.

Bingham Creek

Cost estimates for recommended improvements to Bingham Creek are summarized in Table 9-6. The improvements with the highest priority for this drainage channel involve replacement of the two culverts in the trailer park east of Redwood Road.

Table 9-6
Priorities and Costs of
Recommended Improvements for Bingham Creek

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
BC-1	Skye Drive	48-inch CMP	Replace with 66-inch RCP	$194,000	3
BC-3	4000 West	48-inch CMP	Replace with 72-inch RCP	$161,000	3
BC-16	1650 West	48-inch CMP	Replace with 16' x 5' box culvert	$246,000	1
BC-17	1500 West	48-inch CMP	Replace with 12' x 5' box culvert; improve approximately 1,000 feet of channel between 1650 West and 1500 West	$459,000	1
BC-18	1300 West	8' x 5.5' box culvert	Replace with 10' x 6' box culvert; improve approximately 1,300 feet of channel between 1500 West and 1300 West	$403,000	3

Priorities and Costs of Recommended Canal Improvements

Priorities were assigned to the canal improvements recommended in Section 8 based on two factors. As with the creeks, as level of deficiency was assigned to each canal improvement, based on the capacity of the facility to convey flow from the design storm (the 10-year event for the canals). The second factor used in assigning priorities to canal improvements was ease of implementation. Improvements with relatively small costs, and which could be quickly and easily implemented (such as overflow weir stop log adjustments and minor fill and grading to increase canal capacity) were assigned a high priority.

Utah Lake Distributing Canal

Cost estimates for the recommended improvements to the Utah Lake Distributing Canal are summarized in Table 9-7. These improvements are intended to maximize capacity in reaches where this can be reasonably accomplished, and to minimize the distance along the canal over which storm water runoff can accumulate before being discharged to a creek or other major storm drainage facility.

Table 9-7
Priorities and Costs of
Recommended Improvements for the Utah Lake Distributing Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
ULDC-1 (A and B)	South of Bangerter Highway	No existing facility	(A) Raise approximately 1,200 feet of east bank by 1' (B) Raise approximately 300 feet of northeast bank by 2'	$30,000	2
ULDC-3	Midas Creek	No existing facility	Add storm water overflow structure	$132,000	3
ULDC-5	7800 South	No existing facility	Add storm water overflow structure	$132,000	1

Utah & Salt Lake Canal

With the exception of the planned storm water overflow structure at 7800 South, recommended improvements to the Utah & Salt Lake Canal are limited to minor adjustments in the stop logs at multiple weir overflow locations. These recommended improvements are listed along with estimated costs and assigned priorities in Table 9-8.

Table 9-8
Priorities and Costs of
Recommended Improvements for the Utah & Salt Lake Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
USLC-2	Rose Creek	18' weir with stop logs, 48-inch gate (2)	Remove 12 to 18 inches of stop logs	$1,000	1
USLC-4	Midas Creek	18' weir with stop logs, 48-inch gate (2)	Remove 10 to 14 inches of stop logs	$1,000	1
USLC-6	7800 South	No existing facility	Add storm water overflow structure	$132,000	1
USLC-7	5400 South	15' weir with stop logs, 50-inch gate	Remove 3 to 6 inches of stop logs	$1,000	1
USLC-9	7800 West	12' weir with stop logs	Remove all stop logs	$1,000	1

South Jordan Canal

The South Jordan Canal also has little or no capacity for storm water. The recommended improvements for the South Jordan canal are intended to maximize capacity in reaches where this can be reasonably accomplished, and to minimize the distance along the canal over which storm water runoff can accumulate before being discharged to a creek or other major storm drainage facility. Cost estimates and priorities for recommended improvements to the South Jordan Canal are summarized in Table 9-9.

Table 9-9
Priorities and Costs of
Recommended Improvements for the South Jordan Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
SJC-2	South of 12800 South	No existing facility	Raise approximately 1,000 feet of east bank by 2'	$40,000	2
SJC-3	12600 South	No existing facility	Add storm water overflow structure	$132,000	3
SJC-6	South of Bingham Creek	No existing facility	Raise approximately 1,500 feet of both banks by 2'	$118,000	2
SJC-7	Bingham Creek	15' weir with stop logs, 50-inch gate	Remove all stop logs	$1,000	1
SJC-8	7800 South	No existing facility	Add storm water overflow structure	$132,000	1
SJC-9	5400 South	10' weir with stop logs	Remove all stop logs	$1,000	1

North Jordan Canal

The recommended improvements for the North Jordan Canal, along with cost estimates and priorities, are summarized in Table 9-10.

Table 9-10
Priorities and Costs of
Recommended Improvements for the North Jordan Canal

Facility ID	Location	Existing Facility	Recommended Improvement	Estimated Cost	Priority
NJC-2	South of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	$20,000	2
NJC-4	North of 7000 South	No existing facility	Raise approximately 500 feet of east bank by 2'	$20,000	2
NJC-6	South of 5600 South	No existing facility	Raise approximately 1,500 feet of east bank by 1'	$30,000	1
NJC-8	5400 South	60-inch gate, no weir	Install weir structure	$132,000	3

SUMMARY OF CONCEPTUAL COST ESTIMATES

Total estimated costs for recommended improvements to each of the creeks and canals are summarized in Table 9-11. The total estimated costs summarized by priority are shown in Table 9-12.

Table 9-11
Summary of Estimated Costs of
Recommended Improvements by Channel

Natural Drainage or Canal	Total Estimated Cost of Recommended Improvements
Creeks	
Beef Hollow	$250,000
Wood Hollow	$645,000
Rose Creek	$876,000
Butterfield Creek	$1,970,000
Midas Creek	$1,245,000
Bingham Creek	$1,463,000
Creek Total:	**$6,449,000**
Canals	
Utah Lake Distributing Canal	$294,000
Utah & Salt Lake Canal	$136,000
South Jordan Canal	$424,000
North Jordan Canal	$202,000
Canal Total:	**$1,056,000**

Table 9-12
Summary of Estimated Costs of
Recommended Improvements by Priority

Priority	Total Estimated Cost of Recommended Improvements
1	$2,453,000
2	$3,147,000
3	$1,905,000
Estimated Total Cost of Improvements:	**$7,505,000**