BUTTERFIELD CREEK DRAINAGE STUDY



Riverton City

FOR INFORMATION REGARDING THIS PROJECT CONTACT:

Greg Loscher, P.E. 756 East 12200 South Draper, Utah 84020 (801) 495-2224



January 2006

BUTTERFIELD CREEK DRAINAGE STUDY



Prepared by:

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

January 2006

TABLE OF CONTENTS

BACKGROUND AND INTRODUCTION 1	L
STUDY TASKS 2	2
STUDY AREA3	}
EXISTING STORM DRAIN FACILITIES3	}
PREVIOUS STORM DRAINAGE STUDIES 4	ļ
HYDROLOGIC MODELING4	ļ
Design Storm5	5
Modeling Results	}
HYDRAULIC ANALYSIS 8	}
Hydraulic Model Parameters	}
BUTTERFIELD CREEK CHANNEL AND CULVERT DEFICIENCIES9)
IMPROVEMENT ALTERNATIVES AND CONCEPTUAL COST ESTIMATES 9)
CONCLUSIONS AND RECOMMENDATIONS 1	4
REFERENCES 1	6
TECHNICAL APPENDIX	

Table of Contents (continued)

List of Tables

Table No.	Title Page No.
1	Average Impervious Area by Land Use Category5
2	Typical Loss Rate and Overland Flow Parameters for Urban Drainages5
3	Summary of Butterfield Creek Flood Control Improvement Alternatives10
4	Approximate Guidelines for Butterfield Creek Channel Improvements14
5	rioritization of Butterfield Creek Flood Control Improvements15
	List of Figures
Figure No.	e Title
1	Study Area3
2	Drainage Basins and Existing Storm Drain Facilities
3	Design Rainfall Distribution for 10-Year 3-Hour Design Storm7
4	Design Rainfall Distribution for 100-Year 3-Hour Design Storm7
5	Hydraulic Model Results8
6	Hydraulic Model Profile for 100-Year 3-Hour Peak Flow (Existing Conditions).8
7	Butterfield Creek Photos9
8	Butterfield Creek Photos9
9	Butterfield Creek Photos9
10	Recommended Improvements
11	Hydraulic Model Profile for 100-Year 3-Hour Peak Flow with Improvements14

BACKGROUND AND INTRODUCTION

Storm water runoff from the southwest end of the Salt Lake Valley drains to the Jordan River via a number of creeks. Efforts have been made in recent years to reestablish these drainage channels, large portions of which were filled in or diverted as part of the gradual change of natural lands to farm fields and then to urban development. The upstream reach of Butterfield Creek, which has its headwaters in the Oquirrh Mountains, currently terminates at approximately 6000 West. Per Salt Lake County's current regional storm drainage master plan for the area, the Southwest Canal and Creek Study, runoff generated in the Butterfield Creek watershed west of 6000 West will eventually be routed north along 6000 West to join the more well-established Midas Creek channel at approximately 12400 South. The downstream end of the Butterfield Creek channel is also still in existence, beginning at Redwood Road and approximately 13600 South and meandering east to discharge into the Jordan River at approximately 13000 South, near the southeast end of the Riverbend Golf Course in Riverton City.

This lower channel reach, a historic remnant of Butterfield Creek, has two primary purposes:

- Irrigation. Springs and groundwater accretion provide a year-round base flow to the creek which is used for irrigation and livestock watering by property owners along the creek. The creek is also periodically used as an irrigation tailwater conveyance.
- Storm Water. The creek channel serves as a storm water conveyance for runoff discharged to the creek at multiple locations between Redwood Road and Lovers Lane.

New urban development of areas tributary to the creek and encroachment on the creek by adjacent property owners have led to concerns by Riverton City over the capacity of the existing Butterfield Creek channel and culverts to effectively convey storm water runoff. Riverton City has retained Bowen, Collins & Associates (BC&A) to complete a drainage study for areas tributary to Butterfield Creek between the Utah & Salt Lake Canal and Lovers Lane. The objectives of this study are:

- To estimate potential storm water runoff that will discharge into this section of Butterfield Creek from 10-year and 100-year magnitude rainfall events.
- To estimate the hydraulic capacity of the existing channel and culverts.
- To evaluate alternatives for storm drain improvements along Butterfield Creek to resolve any identified deficiencies.

The purpose of this report is to summarize the results of hydrologic and hydraulic analyses completed for the lower section of Butterfield Creek, as well as to recommend storm drain system improvements to alleviate existing and potential future channel and culvert conveyance deficiencies.

STUDY TASKS

The following tasks were completed as part of the Butterfield Creek Drainage Study:

- Collect and Review Existing Information for the Area. Information pertaining to study area storm drainage was collected and reviewed. This included aerial photography, topographic mapping, previous drainage studies, drainage and transportation master plans, land use and zoning maps, detention basin information, and design and as-built drawings for major storm drainage facilities.
- Survey and Field Reconnaissance. A survey of the Butterfield Creek channel was completed between Redwood Road and the Dillman property east of Lovers Lane. The survey included upstream and downstream ends of all accessible channel culverts, and channel cross sections at approximately 500-foot intervals. A field reconnaissance was also completed to photograph and field-verify sizes of all accessible channel culverts.
- Hydrologic Evaluation. Drainage basin maps from previous studies were used and refined as necessary to produce a detailed map of drainage patterns for the study area. A digital hydrologic model was developed to simulate rainfall and runoff processes for the study area under existing development as well as future full build-out development conditions. This model was calibrated as necessary for consistency with local rainfall and runoff historical data and previous study results. Model runs were completed for 10-year and 100-year design rainfall events.
- Hydraulic Evaluation. Information collected during survey and field reconnaissance was used to develop a digital hydraulic model of the existing Butterfield Creek channel and associated culverts. This model was used to estimate the hydraulic capacities of the existing channel and culverts, as well as to estimate the impacts of 10-year and 100-year peak runoff on the Butterfield Creek drainage system.
- Identify Drainage Channel Deficiencies. The results of the hydrologic and hydraulic evaluations were used to identify Butterfield Creek channel deficiencies under existing and full build-out development conditions.
- Evaluate Alternative Channel Improvements. The computer models developed in the previous tasks were used to evaluate improvement alternatives to resolve storm drainage capacity deficiencies along the Butterfield Creek channel. Conceptual cost estimates were also developed to aid in evaluation of channel improvement options.
- Report Preparation. This report was prepared to summarize the results of the drainage study and to recommend storm drain improvements to alleviate existing and potential future storm drainage capacity deficiencies for the Butterfield Creek channel east of Redwood Road.

STUDY AREA

The drainage study area is shown in Figure 1. The western portion of the study area is generally bounded by, Redwood Road, 13400 South, the Utah & Salt Lake Canal, and the Bangerter Highway. The eastern portion of the study area is generally bounded by Lovers Lane, 13200 South, Redwood Road, and Christan Way. Typical slopes in the area range from approximately 0.5 to 1.0 percent sloping downhill south to north, and approximately 0.5 to 2.0 percent sloping downhill west to east. The portion of the study area west of Redwood Road is nearly fully developed and generally consists of residential development with average lot sizes of ¼-acre. The portion of the study area east of Redwood Road generally consists of agricultural areas that are quickly being developed into residential areas with lot sizes ranging from ½-acre to 1 acre.

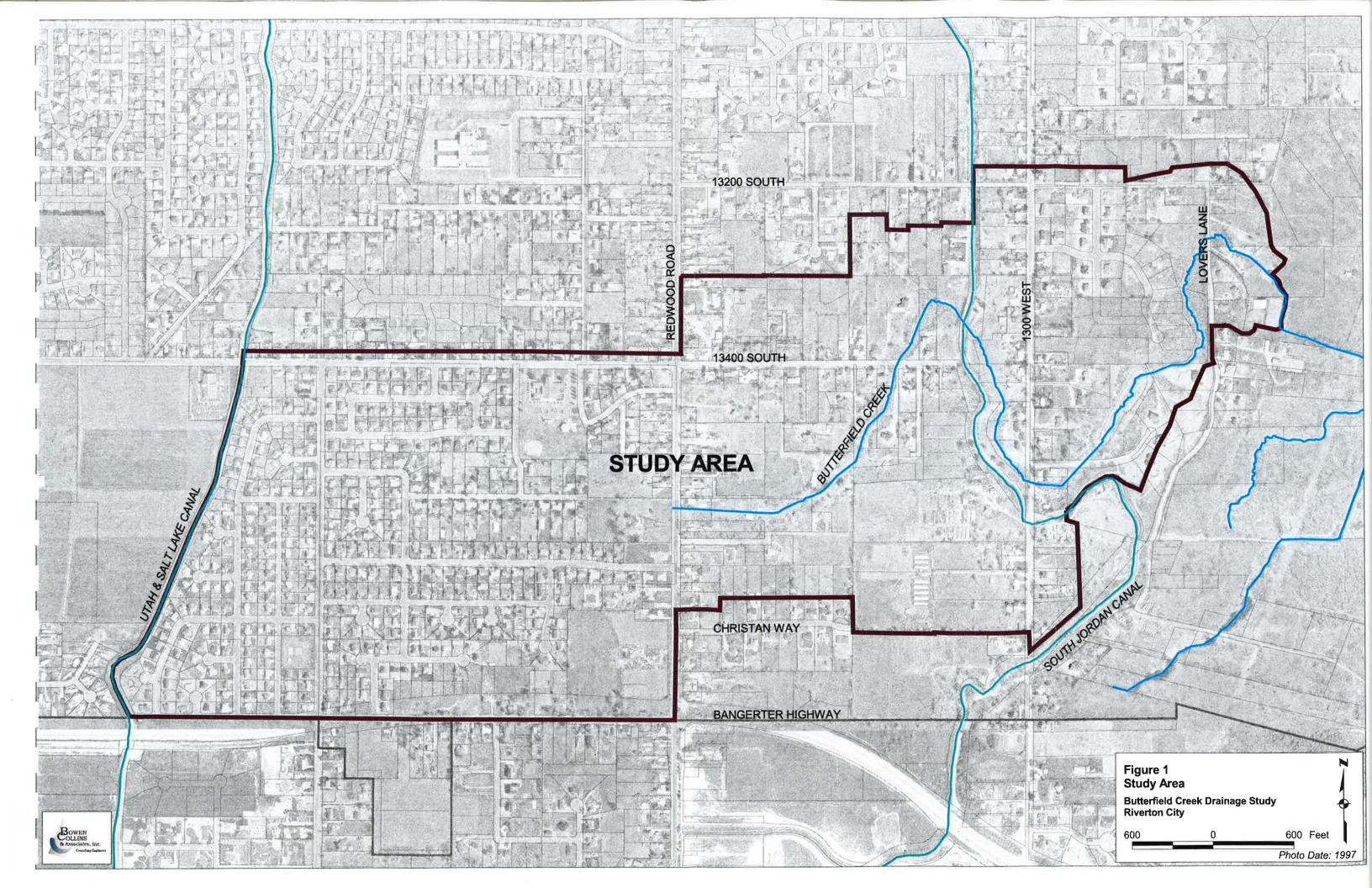
EXISTING STORM DRAIN FACILITIES

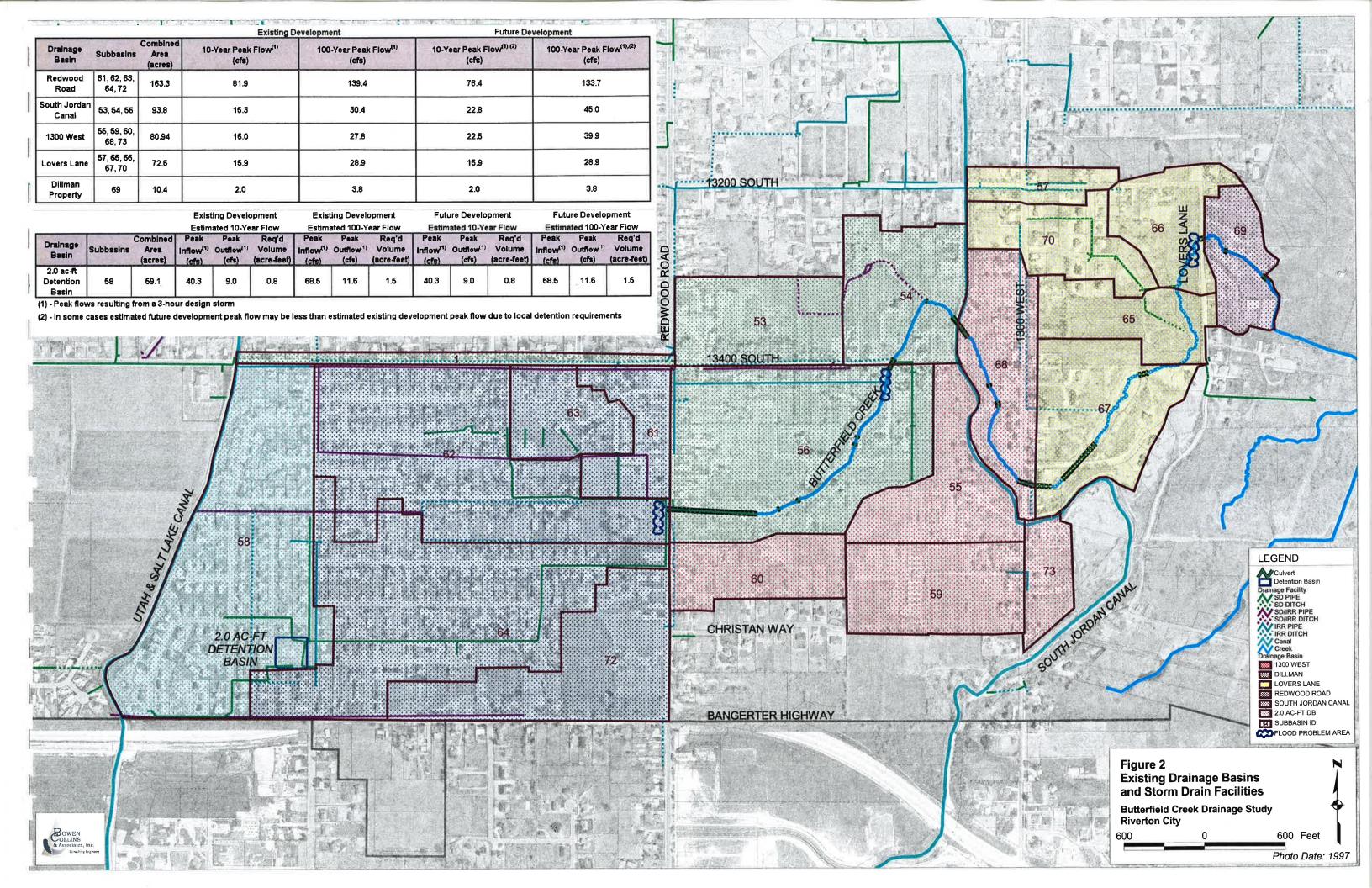
In newly-developed residential portions of the study area, surface runoff is collected and conveyed in curb and gutter facilities, storm drain catch basins, and pipes. Storm drain collection and conveyance facilities in areas of older rural development consist of combination storm drain and irrigation ditches and pipes. A single 2.0 acre-foot storm water detention basin exists in the study area, located at approximately 13730 South and 2200 West (see Figure 2). In general, all storm water runoff and irrigation return flow generated in the study area is conveyed to the Butterfield Creek drainage channel. Water in the Butterfield Creek channel is conveyed eastward, eventually discharging to the Jordan River.

The two primary problems with existing storm drain facilities in the study area are:

- 1. New residential development has increased not only the magnitude and volume of storm water runoff, but also the efficiency with which storm water is conveyed to the Butterfield Creek channel. This situation threatens to overburden the existing channel flood control facilities.
- 2. Although Butterfield Creek is not a dedicated irrigation facility, there are a few property owners along the creek who own water rights to the creek base flow. This groundwater accretion as well as irrigation return flow discharged to the creek make it both an irrigation and a storm water runoff conveyance facility. One of the most significant problems associated with the combination of irrigation and flood control facilities is lack of capacity during summer months when peak irrigation and peak thunderstorm potential coincide.

According to Riverton City personnel, water in Butterfield Creek backs up at nearly all culverts during periods of significant precipitation. Some flooding has occurred in the past at the 13400 South road crossing and west of the Lovers Lane road crossing. Locations in the study area where flooding has occurred in the past as a result of storm water runoff or the combination of storm water runoff and irrigation flow are shown in Figure 2.





PREVIOUS STORM DRAIN STUDIES

A city-wide storm drain master plan was completed by Hansen, Allen & Luce for Riverton City in 2002. The master plan included new hydrologic and hydraulic modeling for areas of the City west of Bangerter Highway. Recommendations for storm drain improvements east of Bangerter Highway were based on the results of a previous study completed by Gilson Engineering in 1995. That master plan included recommendations for a four acre-foot detention basin along Butterfield Creek, just east of the South Jordan Canal, as well as a detention basin of unspecified volume west of Lovers Lane. These proposed facilities were assumed to eliminate any need for culvert replacements along the Butterfield Creek channel between Redwood Road and Lovers Lane.

Various small drainage studies associated with local new residential developments have also been completed for small areas along Butterfield Creek. None of these studies, however, took into account the entire area tributary to Butterfield Creek between Redwood Road and Lovers Lane.

HYDROLOGIC MODELING

A hydrologic computer model was developed for the study area. The model was created using the HEC-HMS computer modeling software developed by the U.S. Army Corps of Engineers. The following assumptions were made in completing the hydrologic analysis for the study area:

- 1. Rainfall return frequency is equal to the associated storm water runoff return frequency.
- 2. Design storm rainfall has a uniform spatial distribution over the study area and a modified Farmer-Fletcher (1972) temporal distribution.
- 3. SCS Type 2 antecedent moisture conditions are applicable at the beginning of the design precipitation event.
- 4. There are no runoff losses in conveyance model elements, i.e. all storm water runoff generated in model basins is routed through downstream model elements.
- 5. The hydrologic computer model is an accurate simulation of watershed response to rainfall events.

Drainage basins and subbasins for the study area are shown in Figure 2. These were delineated using aerial photography, topographic maps, and maps of existing drainage facilities in the study area. Runoff generated in the study area was modeled using the kinematic wave method for urban drainages. This method requires that each subbasin be divided into pervious and impervious areas, with separate loss rates and overland flow routing parameters for each. The percentage of impervious area for existing development conditions for each subbasin was assigned based on recent aerial photographs and ownership parcel maps. The estimated percentage of impervious area for projected full

build-out development conditions was assigned based on zoning and land use projections obtained from Riverton City personnel. Table 1 summarizes the information that was used to assign impervious area to subbasins based on existing and projected land use conditions. It should be noted that the areas listed in Table 1 are effective impervious areas for hydrologic modeling purposes. Actual total lot impervious areas may be somewhat larger than those listed; however, only the portions of impervious area with a means for conveying runoff to the street or a storm drain effectively contribute to storm water accumulation in the creek.

Table 1
Average Percent Impervious Area by Land Use Category

Zoning or Land Use Category	Average Impervious Area (%)
Commercial	95
Apartments/Offices	75
Industrial/Institutional	60
High Density Residential (Trailer Park)	45
Medium Density Residential (1/4-acre lots)	30
Low Density Residential (1/2-acre lots)	15
Irrigated Pasture	2
Open Space	1

Parameters used in developing the hydrologic model of the study area are presented in Table 2. These parameters were estimated using information from previous drainage studies for the Salt Lake Valley (RBG, 1980; USACE, 1984).

Table 2
Typical Loss Rate and Overland Flow Parameters
for Urban Drainages

Area	Percentage of Subbasin Area	Initial Abstraction (in)	Constant Infiltration Loss (in/hr)	Overland Flow Length (ft)	Overland Flow Roughness
Impervious	10 - 95 %	0.063	0.01	100	0.05
Pervious	5 - 90 %	1.0	1.0	200	0.30

Design Storm

Previous studies have demonstrated that peak storm water discharges in the urbanized areas of the Salt Lake Valley are generally associated with short-duration, high-intensity

cloudburst events. Salt Lake County generally uses a 3-hour duration design rainfall event with a modified Farmer-Fletcher distribution as a standard for hydrologic analysis. Design storm depths for the 10-year and 100-year events were estimated based on the report, *Rainfall Intensity Duration Analysis*, prepared for Salt Lake County by TRC North American Weather Consultants in 1999.

The standard Salt Lake County precipitation distribution was applied to these storm depths to create 10-year and 100-year design storms for the study area. These design rainfall distributions are shown in Figures 3 and 4. The total depths of precipitation for the 10-year and 100-year 3-hour design storms (1.25 and 1.82 inches, respectively) can be compared with the more general estimations provided in the NOAA Atlas 14 (2003), of 1.04 and 1.84 inches, respectively.

Generally, it is standard practice in the Salt Lake Valley to design minor storm drain facilities, such as catch basins and storm drain pipes, to collect and convey runoff generated by a precipitation event with 10-year return period. Major storm drainage facilities, specifically creeks with mountain watersheds, are generally designed to convey storm water runoff resulting from a 100-year return period precipitation event. It is also desirable when practical to design streets such that 100-year storm water runoff events are contained in the street right-of-way.

Hydrologic analyses were completed for the study area for a 3-hour storm with 10-year and 100-year return periods. In accordance with standard practice a 100-year design storm was used to evaluate the adequacy of the Butterfield Creek channel and culverts under both existing and projected future development conditions.

Detention basins were incorporated in the hydrologic model using storage routing elements. Basin discharge-storage relationships were estimated based on design or as-built information, where available. Basin modeling parameters for which design or as-built information was not available were assigned based on maps of existing topography and outlet pipe size and material information obtained from Riverton City personnel.

Figure 3
Design Rainfall Distribution for 10-Year 3-Hour Storm

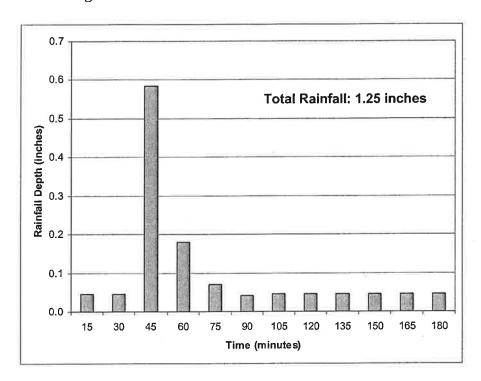
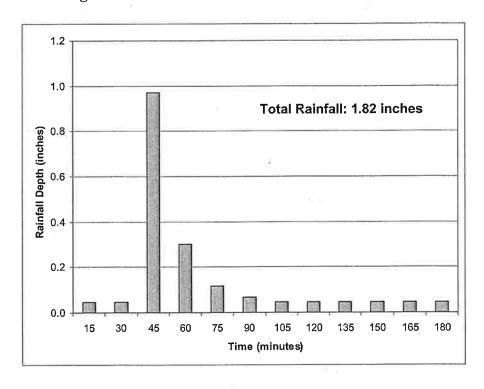


Figure 4
Design Rainfall Distribution for 100-Year 3-Hour Storm



Modeling Results

Rainfall-runoff simulations were completed using the 10-year and 100-year 3-hour design storms for both existing and projected full build-out development conditions. Hydrologic model results for the study area are summarized in Figure 2. Complete model results, as well as HEC-HMS model schematics, are included in the Technical Appendix.

HYDRAULIC ANALYSIS

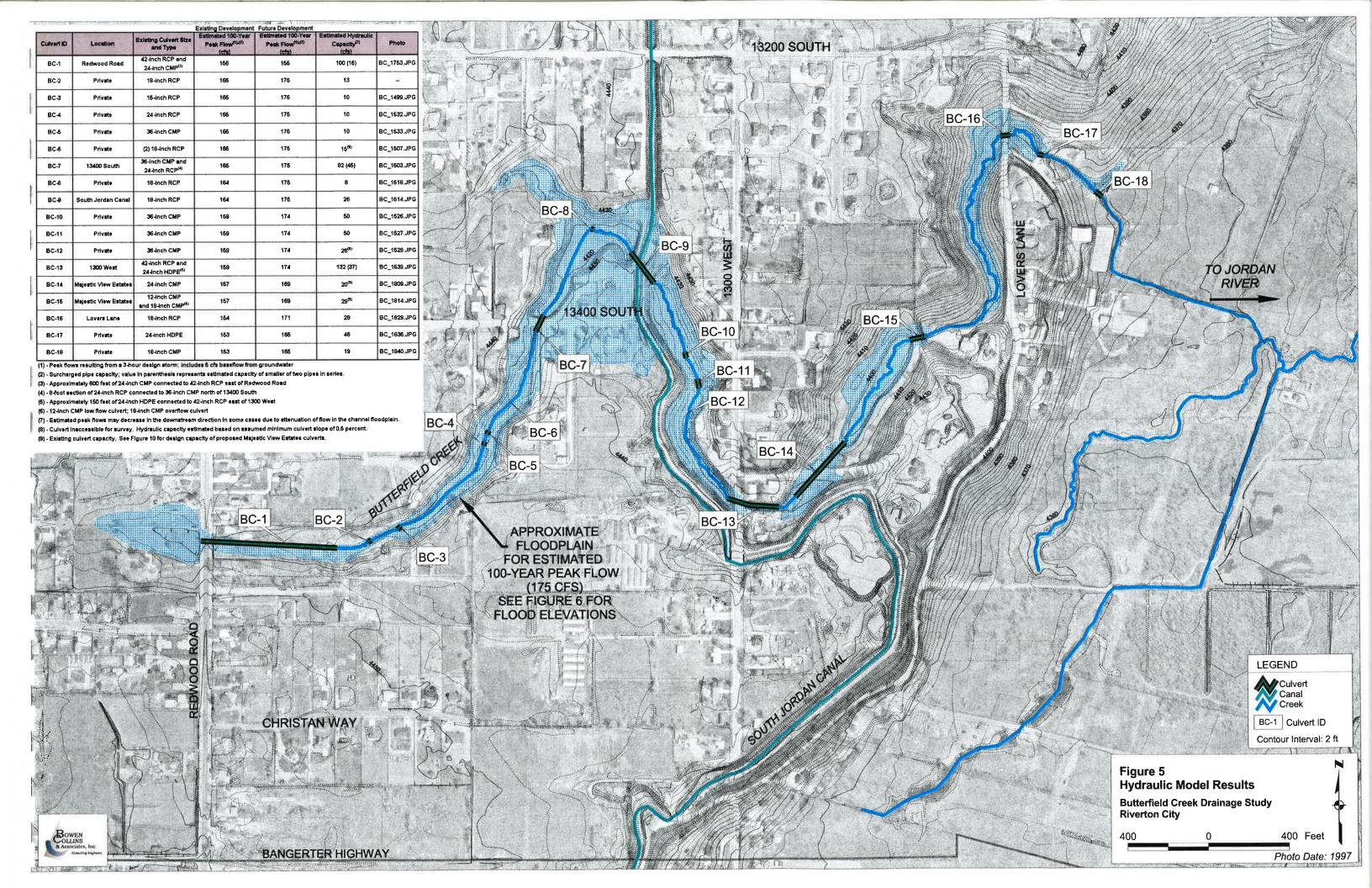
A hydraulic computer model was developed for the Butterfield Creek channel between Redwood Road and the Dillman property (13265 South 1100 West) east of Lovers Lane. The software used was HEC-RAS, a hydraulic computer model developed by the U.S. Army Corps of Engineers.

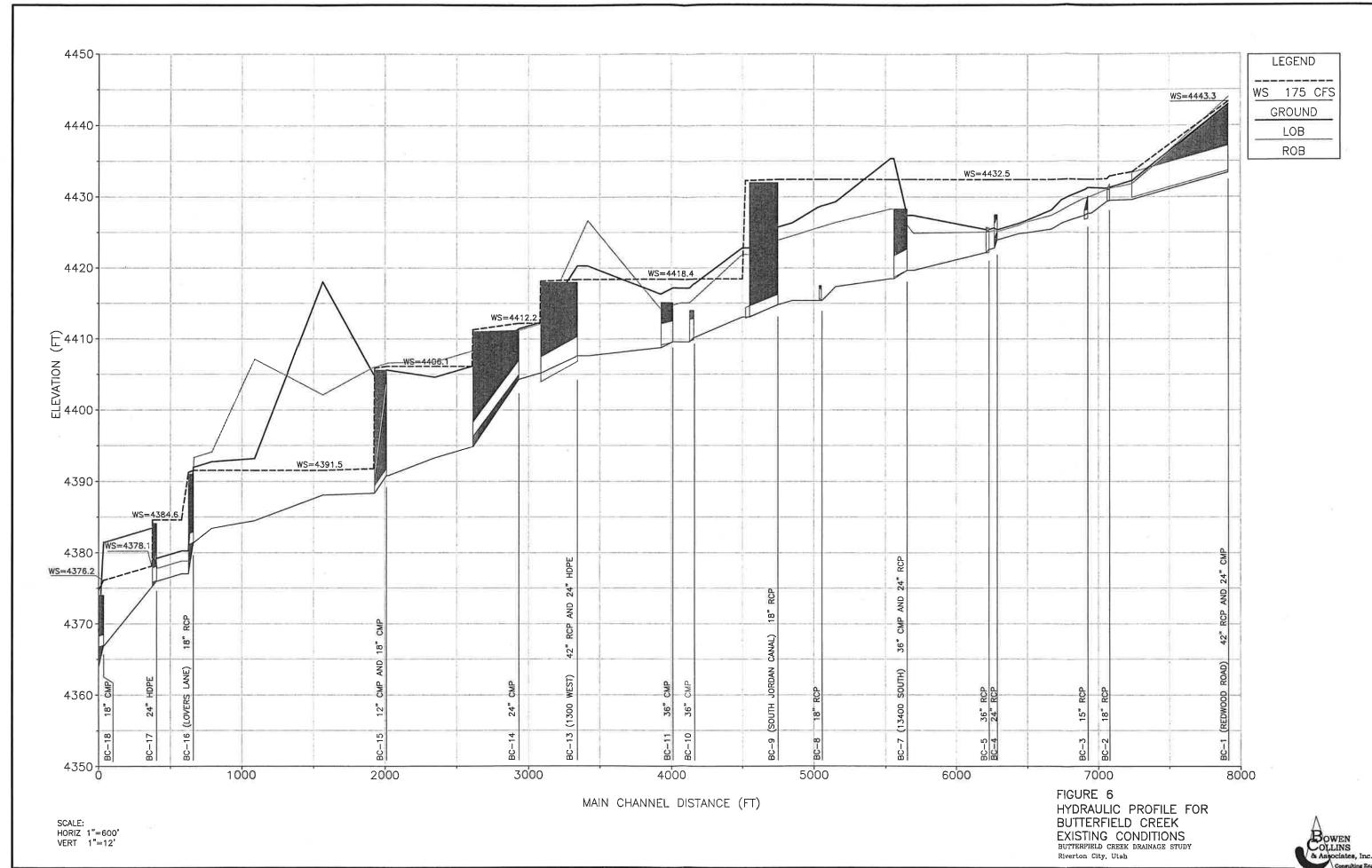
Hydraulic Model Parameters

The HEC-RAS hydraulic computer model consists of two elements. The first of these elements consists of geometric data describing the physical characteristics of the drainage channel and associated culverts. Channel shape, size, and roughness are represented as a series of cross sections. A survey of the Butterfield Creek channel was completed to gather the data needed to define channel cross sections at intervals of approximately 500 feet. Channel roughness was estimated based on field observations. The average assigned to the Butterfield Creek channel was 0.045. roughness value Survey information was also collected for existing bridges and pipe culverts. These data included culvert locations, dimensions, pipe inverts, and top of road elevations. Roughness values for culverts were assigned based on generally accepted values of 0.024 for corrugated metal pipe (CMP), 0.013 for reinforced concrete pipe (RCP), and 0.011 for plastic pipe (PVC or HDPE).

The second element necessary for the development of a HEC-RAS computer model is flow data. These data include total channel flow amounts, end-of-channel boundary conditions, as well as any fixed water surface elevations due to hydraulic controls along the length of the channel. Flow rates for Butterfield Creek were estimated using results from the HEC-HMS hydrologic model for the area tributary to the drainage channel. Boundary conditions at for the downstream end of the channel were estimated based on normal depth calculations.

The primary objective of the hydraulic analysis for the Butterfield Creek channel was to evaluate the capacities of existing pipe culverts associated with road and canal crossings, where storm water overtopping culverts could cause damage to roads or washout of a canal. Many of the culverts along the creek are on private property, and were installed as a means of creating ponds for irrigation and livestock watering. Culvert overtopping at most of these locations would still remain within the overall channel banks, and has relatively small potential for damage to roads or structures. The hydraulic model results for Butterfield Creek are shown in Figure 5. A water surface profile of the channel is included as Figure 6, for estimated peak flows resulting from a 100-year storm under full build-out development conditions. Note that estimated 100-year peak flows for existing development conditions are only slightly (approximately six percent) smaller and would





result in essentially the same flood elevations as those shown in Figure 6. Photographs of existing culverts along the channel, collected as part of field reconnaissance, are included in Figures 7, 8, and 9.

BUTTERFIELD CREEK CHANNEL AND CULVERT DEFICIENCIES

Results of the hydrologic and hydraulic analyses were used to identify deficiencies in the Butterfield Creek channel and associated pipe culverts. As is apparent from the contour information shown in Figure 5, the creek channel between Redwood Road and Lovers Lane is large and well established. Consequently, there do not appear to be any significant deficiencies associated with channel capacity. None of the pipe culverts along the creek, however, has sufficient capacity to convey the estimated 100-year peak flow under existing or future build-out development conditions. Existing capacities of public road crossing and canal crossing culverts range from approximately 10 to 27 percent of the estimated 100-year peak flow, with an average of 18 percent.

It should be noted that a large portion of the estimated 100-year peak flow is generated from the portion of the study area west of Redwood Road. Under existing conditions, a storm drain inlet at the northeast end of the field west of Redwood Road at approximately 13600 South allows any surcharge to the storm drain system at Redwood Road to back up into the field. Under these circumstances, the field topography allows it to act as a de facto detention facility. This is likely the primary reason that significant flooding has not occurred along Butterfield Creek east of Redwood Road in the past. The field is privately owned, however, and it should not be assumed that this natural control will continue to exist and function in the future unless it is developed into a storm water detention basin.

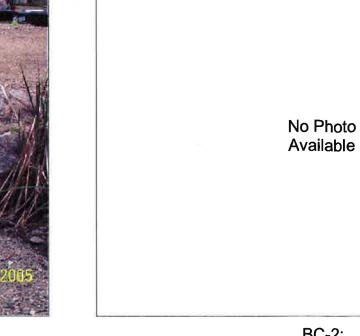
IMPROVEMENT ALTERNATIVES AND CONCEPTUAL COST ESTIMATES

Recommended drainage system improvements for the lower Butterfield Creek drainage were identified to alleviate existing deficiencies and to provide sufficient capacity for the channel to convey storm water runoff resulting from a 3-hour design storm with a 100-year return period under projected full build-out development conditions. In general, the alternatives that were considered consist of detention facilities and culvert improvements. Improvement alternatives were only identified for major public road crossings and canal crossings. Based on the hydraulic model results, it does not appear that overtopping of the majority of the existing private culverts along the channel would cause the creek stage to rise above the overall channel banks. In addition, it was assumed for the purposes of this analysis that storm drain improvements associated with the Majestic View Estates Development will be constructed as planned.

Four improvement alternatives were identified to alleviate existing and estimated future storm water conveyance capacity deficiencies along the Butterfield Creek channel between Redwood Road and Lovers Lane. The first (Alternative A) consists of constructing a new storm water detention basin on the west side of Redwood Road. In addition, the South Jordan Canal and Lovers Lane culverts would be replaced with larger pipes. Finally, proposed creek culvert improvements associated with Majestic View Estates would be constructed per the City-approved plans. Note that some amount of overflow will occur during a 100-year event at the 1300 West crossing; however,



BC-1: BC_1753.JPG REDWOOD ROAD



BC-2: PRIVATE



BC-3: BC_1499.JPG PRIVATE



BC-4: BC_1532.JPG PRIVATE



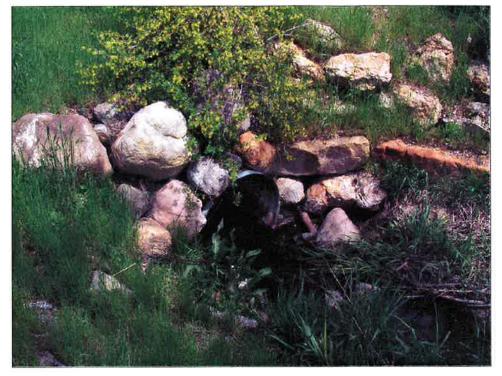
BC-5: BC_1533.JPG PRIVATE



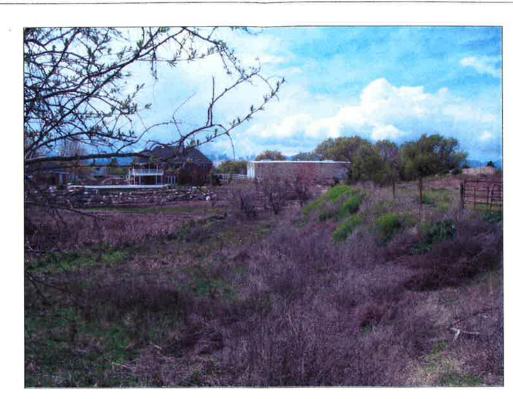
BC-6: BC_1507.JPG PRIVATE







BC-7: BC_1503.JPG 13400 SOUTH



BC-8: BC_1518.JPG PRIVATE



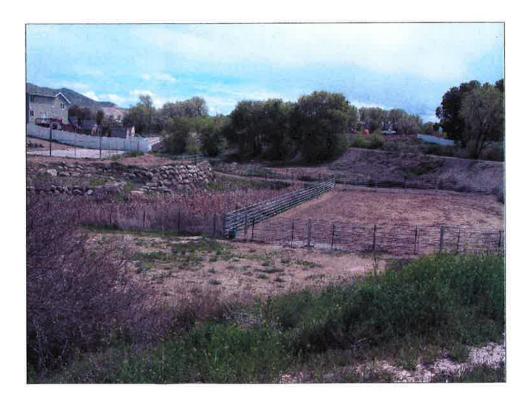
BC-9: BC_1514.JPG SOUTH JORDAN CANAL



BC-10: BC_1526.JPG PRIVATE



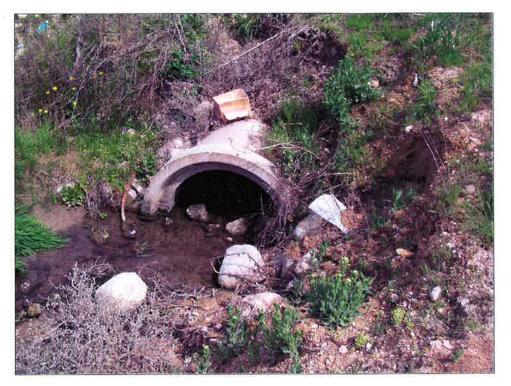
BC-11: BC_1527.JPG PRIVATE



BC-12: BC_1529.JPG PRIVATE







BC-13: BC_1539.JPG 1300 WEST



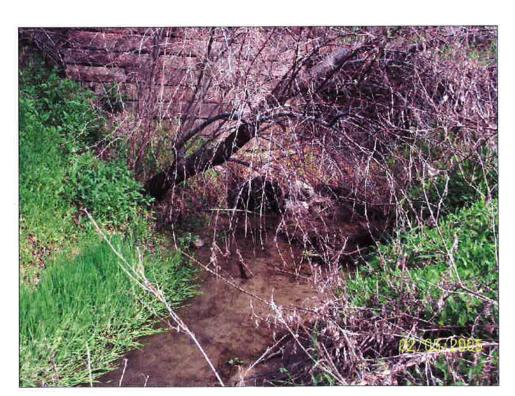
BC-14: BC_1809.JPG MAJESTIC VIEW ESTATES



BC-15: BC_1814.JPG MAJESTIC VIEW ESTATES



BC-16: BC_1829.JPG LOVERS LANE



BC-17: BC_1835.JPG PRIVATE



BC-18: BC_1840.JPG PRIVATE





Riverton City personnel have indicated that the City has a drainage easement at this location to accommodate such an occurrence.

The second improvement alternative (Alternative B) consists of constructing two new storm water detention basins, one on the east side of Redwood Road, and the other just upstream of the South Jordan Canal. Implementing this alternative would eliminate the need to replace the South Jordan Canal crossing culvert, but would still require that the Lovers Lane culvert be replaced, and that the creek culverts associated with Majestic View Estates be constructed as planned. Overflow at 1300 West during a 100-year event is also to be expected, as noted in Alternative A.

The third improvement alternative (Alternative C) also includes construction of two new storm water detention basins, one on the east side of Redwood Road, and the other upstream of a proposed new road crossing at 13400 South and 1350 West. As in Alternative A, the existing South Jordan Canal and Lovers Lane culverts would need to be replaced, and the creek culverts associated with Majestic View Estates would need to be constructed as planned. Overflow at 1300 West during a 100-year event is also to be expected, as noted in Alternative A.

The fourth improvement alternative (Alternative D) consists of replacing six of the seven major pipe culverts along the creek (two of these six culverts will be improved as part of the Majestic View Estates development). Overflow would likely occur at the 1300 West crossing during a 100-year event, as noted in Alternative A. A detailed summary of the improvements associated with each of the four alternatives is presented in Table 3.

Table 3
Summary of Butterfield Creek Flood Control Improvement Alternatives

Alternative	Description	Conceptual Cost Estimate
A	(1) - Construct a detention basin near 13600 South and Redwood Road Approximate Required Parcel Size: 2.5 acres Estimated Volume of Detention: 5.7 acre-feet Estimated Allowable Detention Release Rate: 15 cfs	\$ 987,000
	(2) - Replace existing culvert at South Jordan Canal Pipe Size and Material: 36-inch RCP; Approximate Length: 200 feet	
	(3) - Construct new culvert at upstream end of proposed Majestic View Estates development (parallel to existing 24-inch CMP culvert)Pipe Size and Material: 18-inch RCP; Approximate Length: 350 feet	
	(4) - Replace existing culverts at downstream end of proposed Majestic View Estates developmentPipe Size and Material: 36-inch CMP (2); Approximate Length: 80 feet each	
	(5) - Replace existing culvert at Lovers Lane Pipe Size and Material: 42-inch RCP; Approximate Length: 70 feet	

Table 3 (continued) Summary of Butterfield Creek Flood Control Improvement Alternatives

Alternative	Description	Conceptual Cost Estimate
В	(1) - Construct a detention basin near 13600 South and Redwood Road Approximate Required Parcel Size: 1.0 acre	\$ 1,025,000
	Estimated Volume of Detention: 2.0 acre-feet	
	Estimated Allowable Detention Release Rate: 50 cfs	
	Replace 600 feet of existing 24-inch CMP east of Redwood Road with 42-inch RCP	
	Replace 8-foot section of existing 24-inch RCP north of 13400 South with 36-inch RCP	
	(2) - Construct a detention basin just upstream of South Jordan Canal near 13300 South 1400 West	
	Approximate Required Parcel Size: 2.5 acres	
	Estimated Volume of Detention: 6.3 acre-feet	
	Estimated Allowable Detention Release Rate: 20 cfs	
	(3) - Construct new culvert at upstream end of proposed Majestic View Estates development (parallel to existing 24-inch CMP culvert)	
-	Pipe Size and Material: 18-inch RCP; Approximate Length: 350 feet	
	(4) - Replace existing culverts at downstream end of proposed Majestic View Estates development	
	Pipe Size and Material: 36-inch CMP (2); Approximate Length: 80 feet each	
	(5) - Replace existing culvert at Lovers Lane	
	Pipe Size and Material: 36-inch RCP; Approximate Length: 70 feet	

Table 3 (continued) Summary of Butterfield Creek Flood Control Improvement Alternatives

Alternative	Description	Conceptual Cos Estimate
С	(1) - Construct a detention basin near 13600 South and Redwood Road Approximate Required Parcel Size: 1.0 acre Estimated Volume of Detention: 2.0 acre-feet	\$ 1,187,000
	Estimated Volume of Detention 2.0 tere rect Estimated Allowable Detention Release Rate: 50 cfs	
	Replace 600 feet of existing 24-inch CMP east of Redwood Road with 42-inch RCP	
	Replace 8-foot section of existing 24-inch RCP north of 13400 South with 36-inch RCP	
	(2) - Replace existing culvert at South Jordan Canal	
	Pipe Size and Material: 36-inch RCP; Approximate Length: 200 feet	
	(3) - Construct a detention basin just upstream of proposed 13400 South extension near 13400 South 1350 West	
	Approximate Required Parcel Size: 2.5 acres	
	Estimated Volume of Detention: 6.3 acre-feet Estimated Allowable Detention Release Rate: 20 cfs	
ē	(4) - Construct new culvert at upstream end of proposed Majestic View Estates development (parallel to existing 24-inch CMP culvert)	
	Pipe Size and Material: 18-inch RCP; Approximate Length: 350 feet	
	(5) - Replace existing culverts at downstream end of proposed Majestic View Estates development	
	Pipe Size and Material: 36-inch CMP (2); Approximate Length: 80 feet each	
	(6) - Replace existing culvert at Lovers Lane Pipe Size and Material: 36-inch RCP; Approximate Length: 70 feet	
D	(1) - Replace existing culvert at Redwood Road Pipe Size and Material: 54-inch RCP; Approximate Length: 700 feet	\$ 744,000
	(2) - Replace existing culvert at 13400 South Pipe Size and Material: 54-inch RCP; Approximate Length: 100 feet	
	(3) - Replace existing culvert at South Jordan Canal Pipe Size and Material: 54-inch RCP; Approximate Length: 200 feet	
	(4) - Construct new culvert at upstream end of proposed Majestic View Estates development (parallel to existing 24-inch CMP culvert) Pipe Size and Material: 18-inch RCP; Approximate Length: 350 feet	
	(5) - Replace existing culverts at downstream end of proposed Majestic View Estates development Pipe Size and Material: 36-inch CMP (2); Approximate Length: 80 feet each	
	(6) - Replace existing culvert at Lovers Lane Pipe Size and Material: 54-inch RCP; Approximate Length: 70 feet	

Conceptual cost estimates for storm drain system improvements were developed using a variety of sources, including local contractors, recent bids for similar projects, and estimating guides. These estimates include a construction contingency of 25 percent to allow for project elements not specified in detail at the conceptual level. These estimates also include engineering, legal, and administrative costs associated with each improvement project, estimated as 15 percent of the total construction cost. Detailed versions of these estimates are included in the Technical Appendix of this report.

Regardless of which of these four improvement alternatives is selected, we propose the following general recommendations for storm drain system improvements for the study area:

- 1. Storm water runoff from all new development shall be detained to peak flows less than or equal to 0.2 cfs per acre.
- 2. All storm drain catch basins and pipes tributary to the Butterfield Creek channel and associated with new development shall be designed with capacity to convey estimated peak flows resulting from a 10-year 3-hour design storm under full build-out development conditions. Storm drain pipes shall be designed with slopes that will provide flow velocities greater than or equal to 2.0 feet per second at the design flow rate.
- 3. All new pipe culverts and detention facilities in the Butterfield Creek channel shall be designed to convey estimated peak flows resulting from a 100-year 3-hour design storm under full build-out development conditions. New storm water detention basins should be designed to include a means for emergency overflow.
- 4. All new pipe culverts associated with road and canal crossings shall include headwalls and riprap on the upstream and downstream ends to maintain channel integrity at design flow velocities.
- 5. Any new extensions of existing pipe culverts at road or canal crossings shall have a full-flow capacity greater than or equal to the full-flow capacity of the existing pipe culvert.
- 6. Any channel improvements intended to decrease the estimated extents of flooding impacts should preserve the existing channel slope and existing road crossing culvert invert elevations. Approximate guidelines for channel improvements are presented in Table 4. Rating tables used to develop the guidelines shown in Table 4 are included in the Technical Appendix. Channel bank stabilization should be incorporated in any channel modifications involving restriction of the natural floodplain.

Table 4
Approximate Guidelines for Butterfield Creek
Channel Improvements

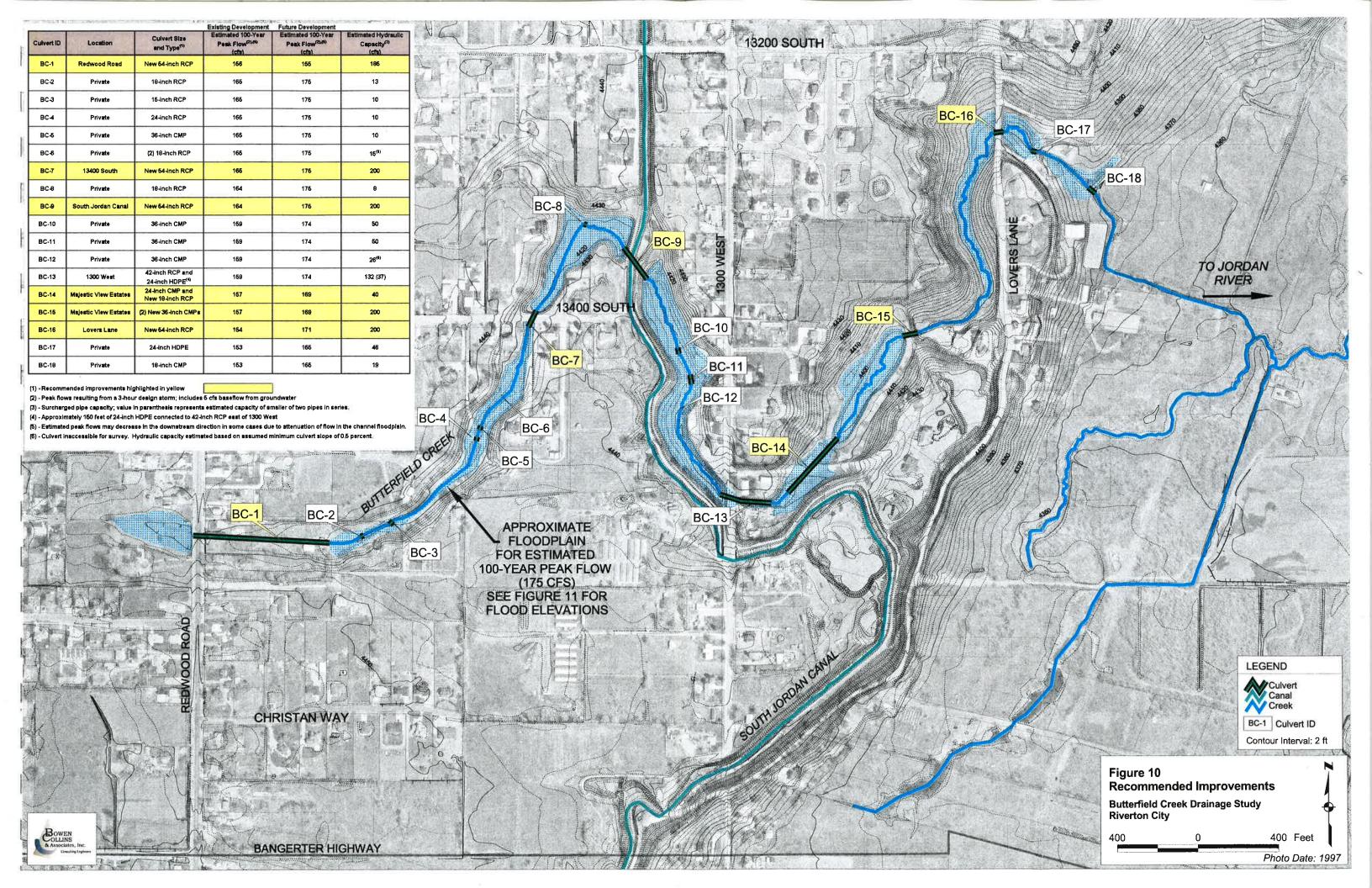
			10-foot Botton	Channel with m Width ⁽¹⁾ and es of 2H:1V
Channel Reach	Upstream Culvert	Downstream Culvert	Slope (ft/ft)	Depth ⁽²⁾ (ft)
Redwood Road to South Jordan Canal	BC-1	BC-9	0.0059	5
South Jordan Canal to 1300 West	BC-9	BC-13	0.0057	5
1300 West to downstream end of proposed Majestic View Estates development	BC-13	BC-15	0.013	4.5
Downstream end of proposed Majestic View Estates development to Lovers Lane	BC-15	BC-16	0.0055	5
Lovers Lane to 18-inch CMP near south end of Dillman Property	BC-16	BC-18	0.023	4

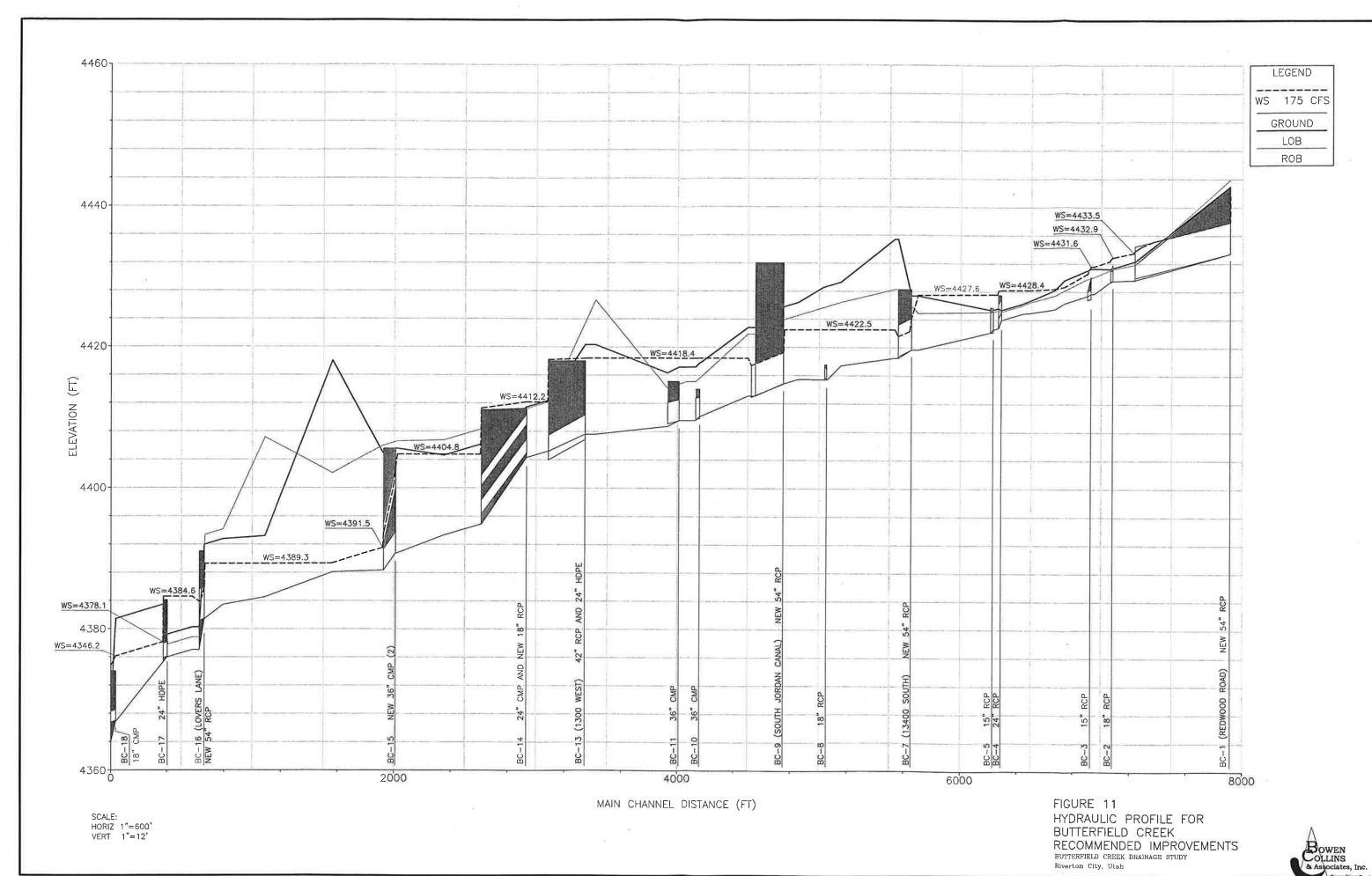
- (1) For other channel bottom widths see rating table included in Technical Appendix
- (2) Includes minimum two feet of freeboard at estimated 100-year peak flow

CONCLUSIONS AND RECOMMENDATIONS

Based on the conceptual cost estimates summarized in Table 3, Alternative D (replacement of six culverts along Butterfield Creek) is the most economical improvement alternative. This is primarily due to the high cost of land acquisition associated with a detention basin west of Redwood Road or upstream of the South Jordan Canal. It should be noted that for the purposes of this report, land costs were assumed to be twice the property tax value. Actual land costs could conceivably be greater than this, especially for the Redwood Road property. BC&A recommends Alternative D, involving replacement of the existing culverts at Redwood Road, 13400 South, the South Jordan Canal, and Lovers Lane with 54-inch reinforced concrete pipe culverts, as well as construction of new culverts associated with the Majestic View Estates development per the approved plans for that development.

Recommended storm drain improvements for the study area are presented in Figure 10. An estimated hydraulic profile of the channel and associated culverts incorporating the recommended improvements is included as Figure 11. A recommended prioritization of storm drain improvements for Butterfield Creek is provided in Table 5. Recommended





improvements were prioritized based on the degree of existing deficiency (culverts with the smallest capacities were given higher priority) combined with perceived potential for damage associated with flooding (culverts with the potential for flood damage to nearby property and infrastructure were given higher priority).

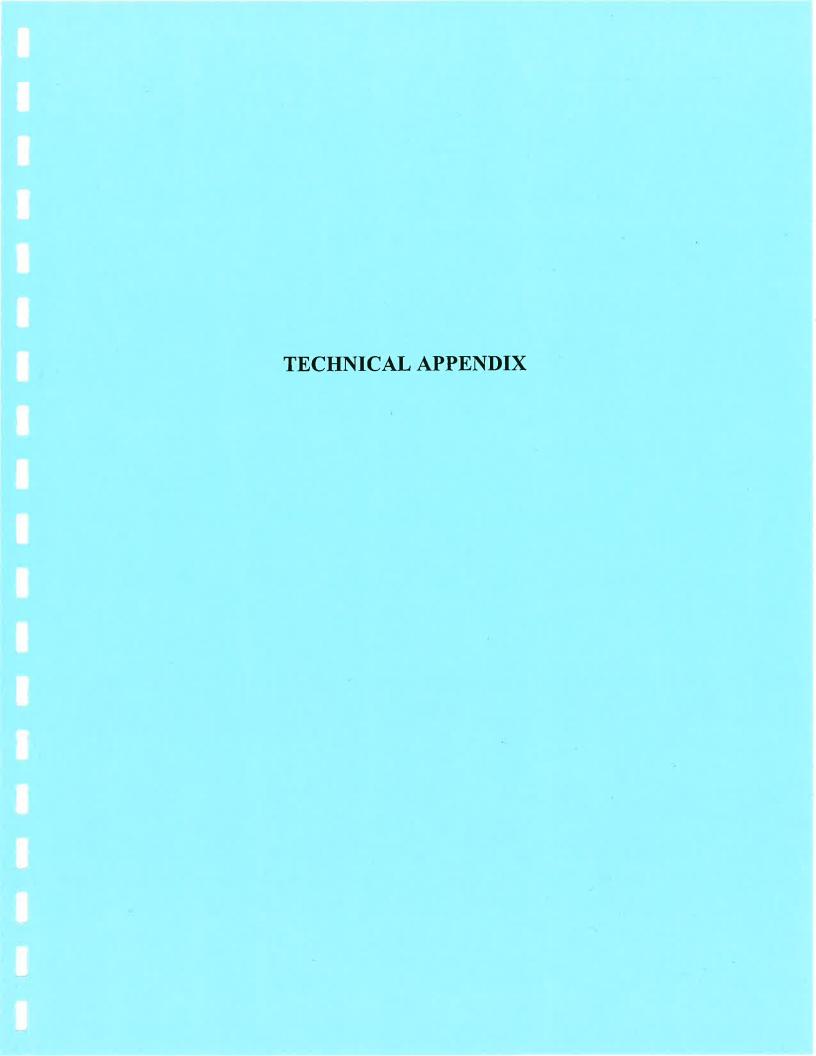
Table 5
Prioritization of Butterfield Creek Flood Control Improvements

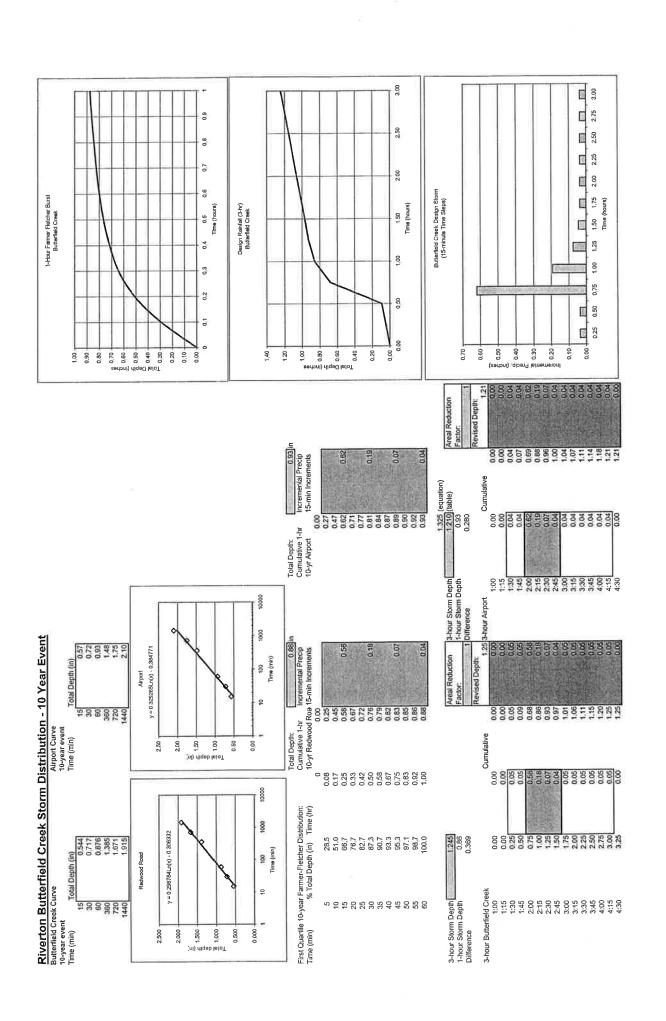
Improvement Description	Priority
Replace existing 18-inch RCP culvert at South Jordan Canal with new 54-inch RCP culvert	1
Replace existing 12-inch CMP and 18-inch CMP culverts at downstream end of proposed Majestic View Estates development with two new 36-inch CMP culverts	2
Construct new 18-inch RCP culvert at upstream end of proposed Majestic View Estates development (parallel to existing 24-inch CMP culvert)	3
Replace existing 36-inch CMP and 24-inch RCP culverts (in series) at 13400 South with new 54-inch RCP culvert	4
Replace existing 18-inch RCP culvert at Lovers Lane with new 54-inch RCP culvert	5
Replace existing 42-inch RCP and 24-inch CMP culverts (in series) at Redwood Road with new 54-inch RCP culvert	6

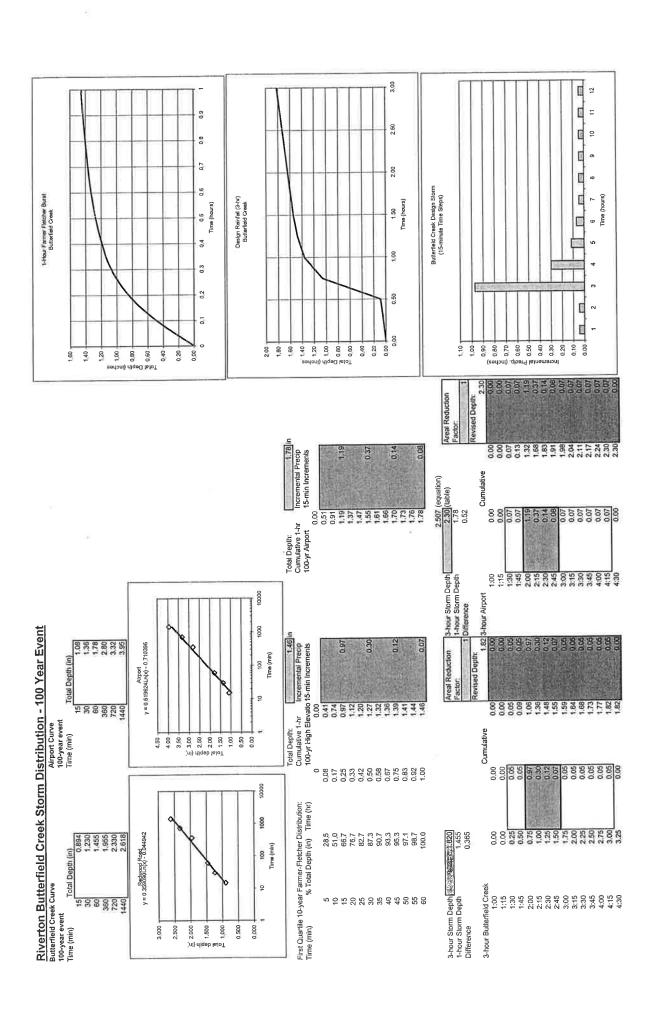
REFERENCES

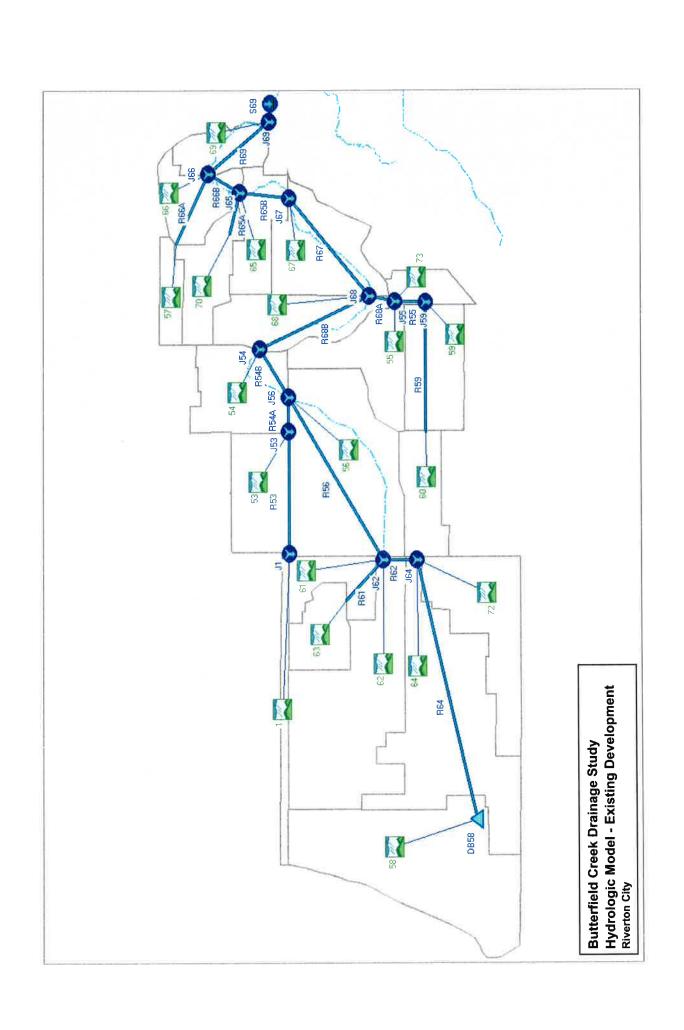
- Farmer, E.E., and J.E. Fletcher, February 1972, <u>Rainfall Intensity-Duration-Frequency</u> <u>Relations for the Wasatch Mountains of Northern Utah</u>, Water Resources Research, Vol.8, No. 1.
- National Oceanic and Atmospheric Administration, 2003, NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 1, Version 3.
- Rollins, Brown and Gunnell, Inc., August 1980, <u>Hydrology Report of Flood Insurance Studies for Selected Communities in the Unincorporated Areas of Salt Lake County</u>, <u>Utah</u>, FEMA Contract Number H-4593.
- TRC North American Weather Consultants, September 1999, <u>Rainfall Intensity Duration</u>
 <u>Analysis</u>, <u>Salt Lake County</u>, <u>Utah</u>, prepared for Salt Lake County.
- U.S. Army Corps of Engineers, May 1984, <u>Jordan River Investigation</u>, <u>Upper Jordan River Interim</u>, <u>Utah</u>, <u>Hydrology</u> (<u>Revised</u>), Office Report.

16







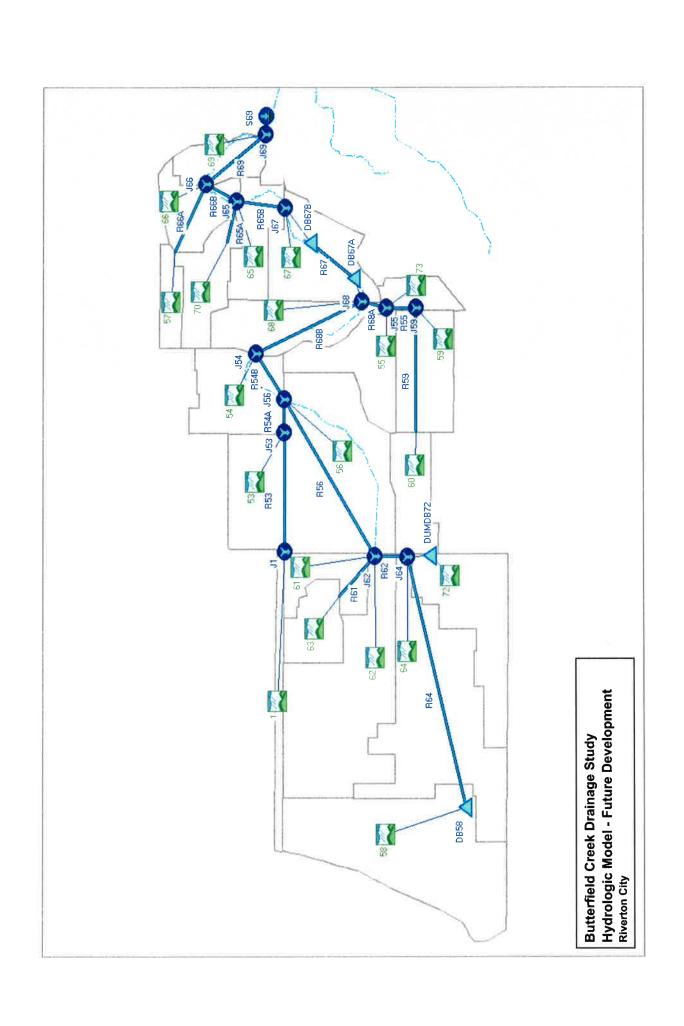


iverton Bu	utterfield Cree	Riverton Butterfield Creek Drainage Study: HEC-HMS Model Results	: HEC-HMS Mode	I Results			
7-Year 3-H	lour Design S	10-Year 3-Hour Design Storm: Existing Development	velopment				
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow_per_Unit_Area	Flow_per_Unit_Area
н	(cfs)		(ac-ft)	(sq mi)	16		(cfs/sq mi)
-	3.9504	01 Aug 05 0200	0.18047	0.011	7.04	0.56	359.13
53	4.3277	01 Aug 05 0200	0.16966	0.03	19.20	0.23	144.26
54	4.8878	01 Aug 05 0200	0.19242	0.034	21.76	0.22	143.76
55	4.0269	01 Aug 05 0200	0.1657	0.029	18.56	0.22	138.86
56	5.5645	01 Aug 05 0220	0.4666	0.083	53.12	0.10	67.04
57	2.1477	01 Aug 05 0200	0.084436	0.01	6.40	0.34	214.77
28	40.282	01 Aug 05 0200	1.5758	0.092	58.88	0.68	437.85
29	4.6878	01 Aug 05 0200	0.18381	0.032	20.48	0.23	146.49
09	4.7856	01 Aug 05 0200	0.18738	0.022	14.08	0.34	217.53
61	5.1251	01 Aug 05 0200	0.20082	0.018	11.52	0.44	284.73
62	30.24	01 Aug 05 0200	1.1831	0.083	53.12	0.57	364.34
63	8.0203	01 Aug 05 0200	0.31447	0.019	12.16	99.0	422.12
64	39.376	01 Aug 05 0200	1.5339	60.0	57.60	0.68	437.51
65	4.2618	01 Aug 05 0200	0.18473	0.022	14.08	0:30	193.72
99	3.0308	01 Aug 05 0200	0.11878	0.021	13.44	0.23	144.32
29	3.2167	01 Aug 05 0210	0.21716	0.038	24.32	0.13	84.65
68	4.4155	01 Aug 05 0200	0.18186	0.032	20.48	0.22	137.98
69	2.0052	01 Aug 05 0200	0.09178	0.016	10.24	0.20	125.33
70	3.2594	01 Aug 05 0200	0.12758	0.022	14.08	0.23	148.15
72	6.5482	01 Aug 05 0200	0.25427	0.045	28.80	0.23	145.52
73	1.5675	01 Aug 05 0200	0.061332	0.011	7.04	0.22	142.50
DB58	9.0164	01 Aug 05 0220	1.5758	0.092	58.88	0.15	98.00
ال	3.9504	01 Aug 05 0200	0.18047	0.011	7.04	0.56	359.13
J53	7.1209	01 Aug 05 0205	0.3503	0.04	25.60	0.28	178.02
J54	999.06	01 Aug 05 0215	6.0788	0.505	323.20	0.28	179.54
J55	11.752	01 Aug 05 0205	0.59884	0.094	60.16	0.20	125.02
156	95.103	01 Aug 05 0210	5.9109	0.471	301.44	0.32	201.92
J59	8.2519	01 Aug 05 0205	0.37131	0.054	34.56	0.24	152.81
J62	90.946	01 Aug 05 0200	5.065	0.347	222.08	0.41	262.09
J64	47.913	01 Aug 05 0200	3.3649	0.227	145.28	0.33	211.07
165	85.991	01 Aug 05 0230	7.401	0.714	456.96	0.19	120.44
996	83.708	01 Aug 05 0235	7.6031	0.744	476.16	0.18	112.51

ton Bu	utterfield Cree	Riverton Butterfield Creek Drainage Study: HEC-HMS Model Results	TUDOM SMULTING	CHINCAL			
ar 3-h	four Design S	10-Year 3-Hour Design Storm: Existing Development	velopment				=
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
	(cfs)		(ac-ft)	(sq mi)			(cfs/sq mi)
790	86.119	01 Aug 05 0230	7.0774	0.669	428.16	0.20	128.73
996	90.227	01 Aug 05 0220	6.858	0.631	403.84	0.22	142.99
996	79.788	01 Aug 05 0240	7.6924	0.761	487.04	0.16	104.85
R53	3.8843	01 Aug 05 0205	0.18063	0.011	7.04	0.55	353.12
R54A	7.0864	01 Aug 05 0205	0.35095	0.04	25.60	0.28	177.16
R54B	89.112	01 Aug 05 0215	5.8864	0.471	301.44	0:30	189.20
R55	7.5397	01 Aug 05 0205	0.37181	0.054	34.56	0.22	139.62
R56	84.675	01 Aug 05 0210	5.0933	0.347	222.08	0.38	244.02
R59	4.6559	01 Aug 05 0205	0.18749	0.022	14.08	0.33	211.63
R61	8.0136	01 Aug 05 0200	0.31492	0.019	12.16	99:0	421.77
R62	47.567	01 Aug 05 0200	3.3662	0.227	145.28	0.33	209.55
R64	8.9888	01 Aug 05 0225	1.5767	0.092	58.88	0.15	97.70
R65A	3.258	01 Aug 05 0200	0.12795	0.022	14.08	0.23	148.09
R65B	84.845	01 Aug 05 0230	7.0883	0.669	428.16	0.20	126.82
R66A	2.0729	01 Aug 05 0200	0.084445	0.01	6.40	0.32	207.29
R66B	83.201	01 Aug 05 0235	7.3999	0.714	456.96	0.18	116.53
R67	84.537	01 Aug 05 0230	6.8603	0.631	403.84	0.21	133.97
R68A	11.645	01 Aug 05 0205	0.59968	0.094	60.16	0.19	123.88
R68B	83.511	01 Aug 05 0220	6.0764	0.505	323.20	0.26	165.37
R69	79.545	01 Aug 05 0240	7.6007	0.744	476.16	0.17	106.92
898	79.788	01 Aug 05 0240	7.6924	0.761	487.04	0.16	104.85
				BASIN	MIN:	0.10	67.04
				BASIN	MAX:	0.68	437.85
				BASIN	AV:	0.33	214.31

Riverton Bu	utterfield Cree	Riverton Butterfield Creek Drainage Study: HEC-HMS Model Results	:: HEC-HMS Mode	I Results			
100-Year 3-	Hour Design	100-Year 3-Hour Design Storm: Existing Development	evelopment				
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
	(cfs)			(sq mi)	(ac)	(cfs/ac)	(cfs/sq mi)
_	7.5145	01 Aug 05 0200	0.32009	0.011	7.04	1.07	683.14
53	7.4273	01 Aug 05 0200	0.40629	0.03	19.20	0.39	247.58
54	8.3936	01 Aug 05 0200	0.46434	0.034	21.76	0.39	246.87
55	7.126	01 Aug 05 0200	0.39941	0.029	18.56	0.38	245.72
56	12.252	01 Aug 05 0215	1.1287	0.083	53.12	0.23	147.61
57	3.6884	01 Aug 05 0200	0.17609	0.01	6.40	0.58	368.84
58	68.511	01 Aug 05 0200	2.823	0.092	58.88	1.16	744.68
59	8:038	01 Aug 05 0200	0.44156	0.032	20.48	0.39	251.19
09	8.164	01 Aug 05 0200	0.39116	0.022	14.08	0.58	371.09
61	8.7766	01 Aug 05 0200	0.38831	0.018	11.52	0.76	487.59
62	51.404	01 Aug 05 0200	2.1583	0.083	53.12	0.97	619.33
63	13.587	01 Aug 05 0200	0.56648	0.019	12.16	1.12	715.11
64	66.801	01 Aug 05 0200	2.7071	0.09	92.29	1.16	742.23
65	7.8663	01 Aug 05 0200	0.38613	0.022	14.08	0.56	357.56
99	5.2187	01 Aug 05 0200	0.28664	0.021	13.44	0.39	248.51
29	6.5755	01 Aug 05 0210	0.52356	0.038	24.32	0.27	173.04
89	7.8317	01 Aug 05 0200	0.43849	0.032	20.48	0.38	244.74
69	3.8165	01 Aug 05 0200	0.22107	0.016	10.24	0.37	238.53
70	5.6308	01 Aug 05 0200	0.3082	0.022	14.08	0.40	255.95
72	6.5482	01 Aug 05 0200	0.25427	0.045	28.80	0.23	145.52
73	1.5675	01 Aug 05 0200	0.061332	0.011	7.04	0.22	142.50
DB58	11.6	01 Aug 05 0200	2.823	0.092	58.88	0.20	126.09
JI	7.5145	01 Aug 05 0200	0.32009	0.011	7.04	1.07	683.14
153	13.01	01 Aug 05 0200	0.72556	0.04	25.60	0.51	325.25
J54	159.35	01 Aug 05 0210	11.189	0.505	323.20	0.49	315.54
155	20.379	01 Aug 05 0200	1.2939	0.094	60.16	0.34	216.80
156	159.99	01 Aug 05 0205	10.736	0.471	301.44	0.53	339.68
159	13.871	01 Aug 05 0205	0.83229	0.054	34.56	0.40	256.87
J62	150.96	01 Aug 05 0200	8.9036	0.347	222.08	0.68	435.04
J64	77.657	01 Aug 05 0200	5.7858	0.227	145.28	0.53	342.10
165	154.42	01 Aug 05 0225	14.155	0.714	456.96	0.34	216.27
996	148.8	01 Aug 05 0230	14.611	0.744	476.16	0.31	200.00

Model ID Peak Flow Time of Peak Total (cfs) (act 152.01 01 Aug 05 0225 13.	lonmont				
++++	- Company				
225	Total Volume	Drainage_Area	Drainage Area	Flow_per_Unit_Area	Flow_per_Unit_Area
25	(ac-ft)	(sq mi)	(ac)	(cfs/ac)	(cfs/sq mi)
	13.461	0.669	428.16	0.36	227.22
0	12.932	0.631	403.84	0.38	243.99
01 Aug 05 0230	14.833	0.761	487.04	0:30	193.93
	0.31927	0.011	7.04	1.00	636.85
	0.7268	0.04	25.60	0.49	311.18
	10.725	0.471	301.44	0.52	330.64
	0.83313	0.054	34.56	0.39	251.81
	8.8801	0.347	222.08	0.62	397.84
	0.39072	0.022	14.08	0.58	368.70
	0.56796	0.019	12.16	1.12	714.58
	5.7891	0.227	145.28	0.53	340.08
	2.8245	0.092	58.88	0.20	126.09
	0.30883	0.022	14.08	0.40	255.23
	13.46	0.669	428.16	0.35	225.43
	0.1757	0.01	6.40	0.57	363.85
	14.148	0.714	456.96	0.32	205.57
	12.937	0.631	403.84	0.37	234.94
	1.2953	0.094	60.16	0.33	212.29
	11.198	0.505	323.20	0.44	279.66
	14.611	0.744	476.16	0.31	196.92
	14.833	0.761	487.04	0:30	193.93
		BASIN	MIN:	0.22	142.50
		BASIN	MAX:	1.16	744.68
		BASIN	AV:	0.57	365.59



Riverton Bu	utterfield Cre	Riverton Butterfield Creek Drainage Study: HEC-HMS Model Results	:: HEC-HINS Mode	Results			
0-Year 3-h	lour Design S	10-Year 3-Hour Design Storm: Future Developme	elopment				
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage_Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
	(cfs)		(ac-ft)	(sq mi)	(ac)	(cfs/ac)	cfs/sq mi)
~	3.9504	01 Aug 05 0200	0.18047	0.011	7.04	0.56	359.13
53	6.4976	01 Aug 05 0200	0.25421	0.03	19.20	0.34	216.59
54	7.3449	01 Aug 05 0200	0.28855	0.034	21.76	0.34	216.03
55	6.1916	01 Aug 05 0200	0.24799	0.029	18.56	0.33	213.50
56	9.4946	01 Aug 05 0215	0.7009	0.083	53.12	0.18	114.39
57	2.1477	01 Aug 05 0200	0.084436	0.01	6.40	0.34	214.77
28	40.282	01 Aug 05 0200	1.5758	0.092	58.88	0.68	437.85
59	7.0461	01 Aug 05 0200	0.27578	0.032	20.48	0.34	220.19
09	4.7856	01 Aug 05 0200	0.18738	0.022	14.08	0.34	217.53
61	5.1251	01 Aug 05 0200	0.20082	0.018	11.52	0.44	284.73
62	30.24	01 Aug 05 0200	1.1831	0.083	53.12	0.57	364.34
63	8.0203	01 Aug 05 0200	0.31447	0.019	12.16	99.0	422.12
64	39.376	01 Aug 05 0200	1.5339	60.0	57.60	0.68	437.51
65	4.2618	01 Aug 05 0200	0.18473	0.022	14.08	0.30	193.72
99	3.0308	01 Aug 05 0200	0.11878	0.021	13.44	0.23	144.32
29	3.2167	01 Aug 05 0210	0.21716	0.038	24.32	0.13	84.65
89	6.7842	01 Aug 05 0200	0.27307	0.032	20.48	0.33	212.01
69	2.0052	01 Aug 05 0200	0.09178	0.016	10.24	0.20	125.33
70	3.2594	01 Aug 05 0200	0.12758	0.022	14.08	0.23	148.15
72	62.199	01 Aug 05 0200	2.4295	0.045	28.80	2.16	1382.20
73	2.3459	01 Aug 05 0200	0.091869	0.011	7.04	0.33	213.26
DB58	9.0164	01 Aug 05 0220	1.5758	0.092	58.88	0.15	98.00
DB67A	98.033	01 Aug 05 0225	9.7067	0.631	403.84	0.24	155.36
DB67B	83.449	01 Aug 05 0230	9.7124	0.631	403.84	0.21	132.25
DUMDB72	2.2878	01 Aug 05 0425	2.4015	0.045	28.80	0.08	50.84
L L	3.9504	01 Aug 05 0200	0.18047	0.011	7.04	0.56	359.13
J53	9.0914	01 Aug 05 0200	0.43484	0.04	25.60	0.36	227.29
J54	92.207	01 Aug 05 0215	8.6349	0.505	323.20	0.29	182.59
J22	16.23	01 Aug 05 0200	0.80415	0.094	60.16	0.27	172.66
J56	95.542	01 Aug 05 0210	8.3654	0.471	301.44	0.32	202.85
159	9.8261	01 Aug 05 0205	0.46328	0.054	34.56	0.28	181.96
J62	85.442	01 Aug 05 0200	7.2134	0.347	222.08	0.38	246.23

rerton B	utterfield Cree	Riverton Butterfield Creek Drainage Study: HEC-I	: HEC-HMS Model Results	el Results			
-Year 3-F	Hour Design S	10-Year 3-Hour Design Storm: Future Development	lopment				
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
1	(cfs)	I.	(ac-ft)	(sq mi)	(ac)	(cfs/ac)	(cfs/sq mi)
J64	42.453	01 Aug 05 0200	5.5121	0.227	145.28	0.29	187.02
J65	84.439	01 Aug 05 0230	10.24	0.714	456.96	0.18	118.26
996	82.641	01 Aug 05 0235	10.441	0.744	476.16	0.17	111.08
J67	85.031	01 Aug 05 0230	9.9296	0.669	428.16	0.20	127.10
996	91.801	01 Aug 05 0220	9.7076	0.631	403.84	0.23	145.48
996	79.009	01 Aug 05 0240	10.531	0.761	487.04	0.16	103.82
R53	3.8843	01 Aug 05 0205	0.18063	0.011	7.04	0.55	353.12
R54A	8.7299	01 Aug 05 0200	0.43568	0.04	25.60	0.34	218.25
R54B	89.932	01 Aug 05 0215	8.3463	0.471	301.44	0.30	190.94
R55	9.3686	01 Aug 05 0205	0.46429	0.054	34.56	0.27	173.49
R56	80.034	01 Aug 05 0210	7.2288	0.347	222.08	0.36	230.65
R59	4.6559	01 Aug 05 0205	0.18749	0.022	14.08	0.33	211.63
R61	8.0136	01 Aug 05 0200	0.31492	0.019	12.16	0.66	421.77
R62	42.063	01 Aug 05 0200	5.5146	0.227	145.28	0.29	185.30
R64	8.9888	01 Aug 05 0225	1.5767	0.092	58.88	0.15	97.70
R65A	3.258	01 Aug 05 0200	0.12795	0.022	14.08	0.23	148.09
R65B	83.294	01 Aug 05 0230	9.9272	0.669	428.16	0.19	124.51
R66A	2.0729	01 Aug 05 0200	0.084445	0.01	6.40	0.32	207.29
R66B	82.134	01 Aug 05 0235	10.238	0.714	456.96	0.18	115.03
R67	92.112	01 Aug 05 0225	9.7131	0.631	403.84	0.23	145.98
R68A	15.736	01 Aug 05 0200	0.80531	0.094	60.16	0.26	167.40
R68B	83.197	01 Aug 05 0220	8.6292	0.505	323.20	0.26	164.75
R69	78.766	01 Aug 05 0240	10.439	0.744	476.16	0.17	105.87
698	79.009	01 Aug 05 0240	10.531	0.761	487.04	0.16	103.82
				BASIN	MIN:	0.13	84.65
				BASIN	MAX:	2.16	1382.20
				BASIN	AV:	0.46	296.30

. 10		All Datter Date of the Character of the Control of	. HECTIMO MODELINGSHIES	Negation 1			
יייייי	infilsa.	100-Tear 3-nour Design Storm: Future Development	Leiopinent				
Peak	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
၁	(cfs)		(ac-ft)	(sq mi)	(ac)	(cfs/ac)	(cfs/sq mi)
7.5	7.5145	01 Aug 05 0200	0.32009	0.011	7.04	1.07	683.14
11.	11.103	01 Aug 05 0200	0.52792	0.03	19.20	0.58	370.10
12.	12.593	01 Aug 05 0200	0.60219	0.034	21.76	0.58	370.38
10.	10.725	01 Aug 05 0200	0.52036	0.029	18.56	0.58	369.83
19.	19.819	01 Aug 05 0210	1.4697	0.083	53.12	0.37	238.78
3.6	3.6884	01 Aug 05 0200	0.17609	0.01	6.40	0.58	368.84
68.	68.511	01 Aug 05 0200	2.823	0.092	58.88	1.16	744.68
12	12.02	01 Aug 05 0200	0.57374	0.032	20.48	0.59	375.63
œ	8.164	01 Aug 05 0200	0.39116	0.022	14.08	0.58	371.09
8.7	8.7766	01 Aug 05 0200	0.38831	0.018	11.52	0.76	487.59
51.	51.404	01 Aug 05 0200	2.1583	0.083	53.12	0.97	619.33
13.	13.587	01 Aug 05 0200	0.56648	0.019	12.16	1.12	715.11
.99	66.801	01 Aug 05 0200	2.7071	0.09	27.60	1.16	742.23
7.8	7.8663	01 Aug 05 0200	0.38613	0.022	14.08	0.56	357.56
5.2	5.2187	01 Aug 05 0200	0.28664	0.021	13.44	0.39	248.51
6.5	6.5755	01 Aug 05 0210	0.52356	0.038	24.32	0.27	173.04
17.	11.796	01 Aug 05 0200	0.57197	0.032	20.48	0.58	368.63
3.8	3165	01 Aug 05 0200	0.22107	0.016	10.24	0.37	238.53
5.6	5.6308	01 Aug 05 0200	0.3082	0.022	14.08	0.40	255.95
62.	62.199	01 Aug 05 0200	2.4295	0.045	28.80	2.16	1382.20
2.3	2.3459	01 Aug 05 0200	0.091869	0.011	7.04	0.33	213.26
_	11.6	01 Aug 05 0200	2.823	0.092	58.88	0.20	126.09
17	171.63	01 Aug 05 0220	16.059	0.631	403.84	0.42	272.00
16	168.32	01 Aug 05 0220	16.069	0.631	403.84	0.42	266.75
DUMDB72 2.2	2.2878	01 Aug 05 0425	2.4015	0.045	28.80	0.08	50.84
7.5	7.5145	01 Aug 05 0200	0.32009	0.011	7.04	1.07	683.14
16.	16.686	01 Aug 05 0200	0.84719	0.04	25.60	0.65	417.15
16.	165.26	01 Aug 05 0210	13.912	0.505	323.20	0.51	327.25
28	28.872	01 Aug 05 0200	1.5782	0.094	60.16	0.48	307.15
16.	163.05	01 Aug 05 0205	13.315	0.471	301.44	0.54	346.18
16	16.95	01 Aug 05 0200	0.96446	0.054	34.56	0.49	313.89
14	145.28	01 Aug 05 0200	11.049	0.347	222.08	0.65	418.67

Riverton Bu	tterfield Cree	Riverton Butterfield Creek Drainage Study: HEC-HMS Model Results	: HEC-HMS Mode	A Results			
100-Year 3-	Hour Design	100-Year 3-Hour Design Storm: Future Developm	velopment				
Model ID	Peak Flow	Time of Peak	Total Volume	Drainage Area	Drainage Area	Flow per Unit Area	Flow per Unit Area
•	(cfs)	l	II (76)	(sq mi)		(cfs/ac)	(cfs/sq mi)
J64	72.197	01 Aug 05 0200	7.9331	0.227	145.28	0.50	318.05
J65	163.32	01 Aug 05 0220	17.288	0.714	456.96	0.36	228.74
996	162.19	01 Aug 05 0225	17.761	0.744	476.16	0.34	218.00
J67	172.84	01 Aug 05 0220	16.592	699.0	428.16	0.40	258.36
996	162.68	01 Aug 05 0220	16.06	0.631	403.84	0.40	257.81
169	154.47	01 Aug 05 0225	17.983	0.761	487.04	0.32	202.98
R53	7.0053	01 Aug 05 0205	0.31927	0.011	7.04	1.00	636.85
R54A	16.164	01 Aug 05 0200	0.84861	0.04	25.60	0.63	404.10
R54B	160.35	01 Aug 05 0210	13.31	0.471	301.44	0.53	340.45
R55	16.377	01 Aug 05 0205	0.96592	0.054	34.56	0.47	303.28
R56	130.66	01 Aug 05 0205	10.997	0.347	222.08	0.59	376.54
R59	8.1114	01 Aug 05 0205	0.39072	0.022	14.08	0.58	368.70
R61	13.577	01 Aug 05 0200	0.56796	0.019	12.16	1.12	714.58
R62	71.524	01 Aug 05 0200	7.9344	0.227	145.28	0.49	315.08
R64	11.6	01 Aug 05 0215	2.8245	0.092	58.88	0.20	126.09
R65A	5.6151	01 Aug 05 0200	0.30883	0.022	14.08	0.40	255.23
R65B	158.75	01 Aug 05 0220	16.593	0.669	428.16	0.37	237.29
R66A	3.6385	01 Aug 05 0200	0.1757	0.01	6.40	0.57	363.85
R66B	159.87	01 Aug 05 0225	17.299	0.714	456.96	0.35	223.91
R67	165.74	01 Aug 05 0220	16.069	0.631	403.84	0.41	262.66
R68A	28.128	01 Aug 05 0200	1.58	0.094	60.16	0.47	299.23
R68B	147.07	01 Aug 05 0220	13.908	0.505	323.20	0.46	291.23
R69	153.22	01 Aug 05 0225	17.762	0.744	476.16	0.32	205.94
698	154.47	01 Aug 05 0225	17.983	0.761	487.04	0.32	202.98
				BASIN	IMIN:	0.27	173.04
				BASIN	MAX:	2.16	1382.20
				BASIN	AV:	0.72	461.64

Point ID	Northing	Easting	Elevation	Note
1000	7353992.756	1518431.478	4452.111	FND MON 13400 S 1700 W
1001	7353992.758	1518431.454	4452.093	FND MON 13400 S 1700 W
1002	7353994.988	1521067.807	4436.422	FND MON 13400 S 1300 W
1003	7353994.977	1521067.827	4436.417	FND MON 13400 S 1300 W
1004	7353991.341	1529044.047	4414.252	FND MON 13400 S 400 W
1005	7353991.387	1529043.953	4413.834	FND MON 13400 S 400 W
1006	7353991.39	1529043.988	4413.879	FND MON 13400 S 400 W
2000	7354121.044	1522113.722	4419.907	GPS H&T 5-19-05
3000	7353005.781	1517760.504	4444.297	CB TOG SD PIPE
3001	7352991.504	1518166.507	4440.672	NG APPROX UG SD PIPE LOC
3002	7352993.332	1518398.709	4442.919	NG APPROX UG SD COB LOC
3003	7352998.652	1517937.277	4442.024	NG APPROX UG SD PIPE LOC
3004	7352927.061	1518398.06	4442.399	CB TOG SD PIPE N S E
3005	7353003.829	1518408.063	4442.767	EOA W SIDE REDWOOD
3006	7352843.237	1518407.348	4443.929	EOA W SIDE REDWOOD
3007	7352844.253	1518436.835	4444.102	SSMH
3008	7352844.832	1518446.559	4444.24	TBC E SIDE REDWOD
3009	7353002.692	1518447.715	4443.185	TBC E SIDE REDWOD
3010	7353002.891	1518446.703	4442.606	CB TOG
3011	7352989.429	1518438.191	4443.061	SSMH
3012	7352919.063	1518441.105	4443.222	WV
3013	7352918.354	1518452.016	4443.72	SD COB
3014	7352946.804	1518455.581	4443.897	TOP RET WALL
3015	7352840.348	1518454.664	4444.774	TOP RET WALL
3016	7352843.763	1518454.806	4439.909	NG BTTM RET WALL
3017	7352843.173	1518459.185	4440.941	END FL 12" PVC PIPE S
3018	7352944.49	1518455.893	4440.825	NG BTTM RET WALL
3019	7353001.306	1519026.016	4442.074	NG TOP
3020	7352985.522	1519027.03	4434.517	NG TOE
3021	7352896.13	1519074.747	4432.268	NG TOP1
3022	7352898.041	1519182.913	4431.366	NG TOP1 POND
3023	7352926.292	1519206.184	4431.685	NG TOP1 POND
3024	7352925.614	1519227.662	4431.516	NG TOP1 POND
3025	7352898.493	1519234.503	4431.945	NG TOP1 POND
3026	7352876.019	1519217.269	4432.034	NG TOP1 POND
3027	7352878.561	1519181.566	4431.793	NG TOP1 POND
3028	7352887.605	1519154.483	4431.378	NG TOP1 POND
3029	7352886.042	1519073.816	4431.826	NG TOP1
3030	7352890.234	1519073.194	4429.93	END FL PIPE W
3031	7352887.564	1519080.308	4429.631	TOE 1
3032	7352897.958	1519083.556	4430.106	TOE 1
3033	7352895.203	1519179.38	4429.77	TOE 1 POND
3034	7352922.493	1519203.364	4429.654	TOE 1 POND
3035	7352924.308	1519224.651	4429.771	TOE 1 POND
3036	7352900.512	1519230.484	4429.48	TOE 1 POND
3037	7352880.976	1519214.557	4429.595	TOE 1 POND
3038	7352890.256	1519171.334	4429.757	TOE 1 POND
3039	7352921.711	1519227.996	4429.512	BEG FL 18" RCP
3040	7352928.201	1519243.403	4429.498	END FL 18" RCP
3041	7352960.959	1519237.635	4432.146	TOE
0011	7352934.655	1519246.617	4431.239	TOP 2

Point ID	Northing	Easting	Elevation	Note
3043	7352931.34	1519248.604	4429.721	TOE 2
3044	7352929.343	1519249.624	4429.372	TOE 2
3045	7352928.043	1519250.852	4431.068	TOP 2
3046	7352918.078	1519272.738	4432.072	NG
3047	7352944.075	1519361.815	4431.351	NG
3048	7352969.808	1519352.12	4430.114	TOP 2
3049	7352973.818	1519351.186	4427.859	TOE 2
3050	7352975.467	1519348.729	4427.696	TOE 2
3051	7352982.291	1519345.708	4431.31	TOP 2
3052	7352994.128	1519340.219	4431.79	NG
3053	7352981.182	1519372.93	4426.992	FL PI
3054	7352998.797	1519389.366	4426.851	FL PI
3055	7353057.141	1519542.355	4428.506	NG
3056	7353060.759	1519540.971	4428.115	TOP 2
3057	7353064.675	1519538.851	4426.49	TOE 2
3058	7353072.816	1519533.745	4426.275	TOE 2
3059	7353081.233	1519530.487	4429.575	TOP 2
3060	7353092.458	1519522.727	4430.043	NG
3061	7353133.75	1519569.282	4428.556	NG
3062	7353130.543	1519574.544	4428.201	TOP 2
3063	7353128.091	1519578.723	4425.743	TOE 2
3064	7353117.015	1519586.933	4425.49	TOE 2
3065	7353113.815	1519589.001	4427.434	TOP 2
3066	7353100.741	1519601.619	4428.16	NG
3067	7353214.234	1519729.012	4426.808	NG
3068	7353224.261	1519716.741	4426.489	TOP 2
3069	7353226.195	1519715.772	4424.966	TOE 2
3070	7353251.238	1519716.044	4425.729	TOE 2
3071	7353253.852	1519713.557	4426.704	TOP 2
3072	7353266.702	1519708.252	4427.321	NG
3072	7353295.318	1519737.558	4426.439	NG
3074	7353290.954	1519741.557	4426.289	TOP 2 POND
3075	7353288.917	1519741.537	4424.86	TOE 2 POND
3076	7353233.822	1519782.616	4427.917	NG
3077	7353233.822	1519772.263	4426.039	TOP 2 POND
		1519772.203	4425.335	TOE 2 POND
3078	7353243.192 7353382.393	1519771.016	4424.637	TOE 2 POND
3079		1519826.291	4426.357	TOP 2 POND
3080	7353381.529		4426.943	NG
3081	7353378.385	1519836.727	4427.117	TOP RCP POND
3082	7353395.352	1519803.325	4427.117	FL RCP POND
3083	7353395.299	1519803.201		TOP RCP POND 2
3084	7353415.175	1519807.887	4426.262	FL RCP POND 2
3085	7353415.541	1519808.077	4424.216	
3086	7353416.401	1519802.69	4426.536	TOP POND 2
3087	7353418.987	1519808	4423.185	TOE POND 2
3088	7353417.928	1519826.4	4425.311	TOP POND 2
3089	7353422.315	1519822.014	4422.882	TOE POND 2
3090	7353446.794	1519831.078	4425.342	TOP POND 2
3091	7353445.425	1519824.513	4422.253	TOE POND 2
3092	7353451.337	1519819.336	4424.6	TOP RCP POND 2
3093	7353455.176	1519810.574	4425.845	TOP POND 2

Point ID	Northing	Easting	Elevation	Note
3094	7353478.014	1519809.884	4425.741	NG
3095	7353472.218	1519821.873	4425.409	TOP 2
3096	7353472.159	1519825.74	4422.499	TOE 2
3097	7353469.444	1519827.333	4422.121	END FL PIPE
3098	7353469.214	1519831.206	4422.173	TOE 2
3099	7353462.019	1519837.185	4425.064	TOP 2
3100	7353455.114	1519844.879	4425.26	NG
3101	7353593.697	1519893.914	4424.309	NG
3102	7353588.464	1519899.738	4423.714	TOP 2
3103	7353586.724	1519901.146	4420.565	TOE 2 & 15 FT E TO TOE 2
3104	7353909.321	1520082.095	4425.927	NG
3105	7353909.923	1520070.997	4424.88	TOP 2
3106	7353908.845	1520059.253	4420.445	TOE 2
3107	7353909.284	1520051.563	4420.24	TOE 2
3108	7353913.168	1520038.741	4427.379	TOP 2
3109	7353916.435	1520023.836	4427.978	NG
3110	7353961.026	1520062.067	4422.675	TOP PIPE
3111	7353992.376	1520069.935	4427.653	EOA
3112	7354012.222	1520087.332	4427.705	EOA
3113	7354023.487	1520091.181	4427.406	SDMH
3114	7354066.324	1519988.24	4435.402	TOP 2
3115	7354062.423	1520059.352	4421.607	TOE 2
3116	7354044.073	1520103.678	4418.72	FL RCP
3117	7354066.318	1520155.023	4419.529	TOE 2
3118	7354066.579	1520183.193	4428.265	TOP 2
3119	7354060.949	1520211.484	4429.67	NG
3120	7354283.018	1520355.337	4428.502	NG
3121	7354297.087	1520337.99	4426.398	TOP 2
3122	7354311.061	1520322.873	4418.075	TOE 2
3123	7354402.514	1520275.611	4417.585	TOP BANK
3124	7354405.41	1520272.73	4415.546	FL CREEK
3125	7354405.429	1520266.804	4417.376	TOP BANK
3126	7354434.615	1520243.909	4418.714	TOE 2
3127	7354441.405	1520230.882	4429.289	TOP 2
3128	7354474.174	1520338.698	4415.41	FL FCP
3129	7354469.027	1520358.098	4415.781	FL FCP
	7354263.859	1520532.402	4427.306	TOP
3130		1520638.556	4427.555	TOE
3131	7354259.518	1520658.03	4422.667	TOP
3132	7354253.013		4413.766	TOE
3133	7354229.715	1520677.568		TOE
3134	7354217.07	1520716.025	4413.462	
3135	7354207.533	1520780.875	4423.46	TOP FL RCP
3136	7354199.194	1520652.885	4412.892	
3137	7353771.548	1520904.635	4418.54	NG
3138	7353770.203	1520887.006	4417.174	TOP
3139	7353764.84	1520877.196	4409.576	TOE
3140	7353779.57	1520829.766	4409.747	TOE
3141	7353778.204	1520823.277	4415.098	TOP
3142	7353775.934	1520798.639	4417.549	TOE
3143	7353760.842	1520766.589	4427.465	ТОР
3144	7353856.451	1520804.485	4409.865	FL PIPE

Point ID	Northing	Easting	Elevation	Note
3145	7353827.977	1520811.724	4409.744	FL PIPE
3146	7353723.653	1520867.429	4409.517	FL PIPE
3147	7353150.841	1520919.509	4426.707	TOP
3148	7353166.719	1520943.641	4412.473	TOE
3149	7353181.961	1520964.135	4410.213	TOP
3150	7353189.801	1520969.758	4407.609	TOE
3151	7353199.218	1520981.327	4408.132	TOE
3152	7353221.833	1521006.414	4420.321	TOP
3153	7353128.861	1521014.815	4406.863	FL RCP
3154	7353120.066	1521043.929	4417.94	SDMH
3155	7353120.459	1521055.15	4417.704	EOA
3156	7353078.681	1521267.05	4411.382	TOP
3157	7353085.747	1521268.807	4403.959	FL PIPE
3158	7353101.841	1521258.427	4414.604	TOP
3159	7353174.393	1521395.906	4411.223	TOP
3160	7353176.045	1521377.104	4404.3	TOE
3161	7353183.974	1521370.501	4405.596	TOE
3162	7353196.661	1521355.278	4411.442	TOP
3163	7353381.478	1521548.91	4411.908	SSMH
3164	7353406.322	1521598.52	4396.281	FL PIPE
3165	7353376.561	1521646.02	4411.437	SSMH
3166	7353598.464	1521804.877	4410.23	NG
3167	7353616.071	1521775.954	4406.741	TOP
3168	7353623.123	1521768.648	4401.429	TOE
3169	7353632.585	1521756.047	4400.02	TOP
3170	7353637.835	1521746.108	4393.296	TOE
3171	7353649.032	1521707.914	4395.103	TOE
3172	7353657.654	1521680.76	4404.605	TOP
3173	7353665.087	1521669.123	4405.048	NG
3174	7353970.799	1521909.113	4406.387	NG
3175	7353952.293	1521914.254	4405.575	TOP
3176	7353917.68	1521918.343	4391.982	TOE @ HEADWALL
3177	7353914.642	1521924.408	4390.786	FL PIPE @ HEADWALL
3178	7353907.429	1521920.168	4391.281	TOE @ HEADWALL
3179	7353842.204	1521918.805	4398.878	TOP
3180	7353833.79	1521924.693	4401.552	TOE
3181	7353829.125	1521941.032	4406.597	TOP
3182	7353824.739	1521962.641	4408.951	NG
3183	7354061.93	1522413.916	4403.044	EOA
3184	7354063.909	1522397.009	4402.112	TOP
3185	7354067.397	1522382.846	4394.548	TOE
3186	7354081.808	1522329.459	4388.482	TOE
3187	7354088.605	1522304.038	4388.069	TOP BANK
3188	7354090.016	1522299.282	4386.97	FL CRK
3189	7354089.712	1522293.362	4391.834	TOP
3190	7354092.924	1522249.806	4396.65	TOE
3191	7354117.222	1522162.748	4418.027	TOP
3192	7354173.504	1522178.085	4419.284	CL 4X4 SD BX TOP GRT
3193	7354528.113	1522170.003	4388.014	TOE
3194	7354530.053	1522204.791	4384.791	TOE CRK
3195	7354535.994	1522217.276	4384.498	TOE CRK

Point ID Northing Easting Elevation Note 3196 7354545.076 1522249.738 4386.646 TOE 3197 7354541.726 1522375.389 4407.163 TOP 3198 7354784.283 1522377.92 4394.118 TOP 3199 7354801.855 1522355.009 4387.219 TOP 3200 7354803.155 1522351.508 4383.661 TOE CRK 3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3208 7354967.13 1522449.222 4380.244 TOP 3208 7354953.232 1522452.879 4377.017 TOE CRK </th <th>WALL</th>	WALL
3198 7354784.283 1522377.92 4394.118 TOP 3199 7354801.855 1522355.009 4387.219 TOP 3200 7354803.155 1522351.508 4383.661 TOE CRK 3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3199 7354801.855 1522355.009 4387.219 TOP 3200 7354803.155 1522351.508 4383.661 TOE CRK 3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354953.232 1522452.879 4377.017 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3199 7354801.855 1522355.009 4387.219 TOP 3200 7354803.155 1522351.508 4383.661 TOE CRK 3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3201 7354798.13 1522286.418 4383.424 TOE CRK 3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3202 7354827.294 1522234.339 4392.753 TOP 3203 7354921.62 1522380.152 4381.448 FL PIPE @ HEAD 3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	WALL
3204 7354924.71 1522390.164 4389.238 EOA 3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3205 7354928.691 1522414.81 4388.767 EOA 3206 7355066.015 1522436.8 4391.676 TOP 3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3207 7354967.13 1522449.222 4380.244 TOP 3208 7354964.111 1522444.908 4377.67 TOE CRK 3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3209 7354953.232 1522452.879 4377.017 TOE CRK 3210 7354930.948 1522466.498 4378.818 TOE	
3210 7354930.948 1522466.498 4378.818 TOE	
1 0211 1007000,220 1022,700,110 7002,010	
3212 7354854.478 1522600.265 4384.093 NG	
3213 7354840.164 1522598.044 4383.463 TOP	
3214 7354829.257 1522594.738 4375.858 TOE CRK	
3215 7354826.456 1522591.391 4375.85 FL PIPE	
3216 7354824.414 1522594.818 4375.302 TOE CRK	
3217 7354811.515 1522591.154 4383.509 TOP	
3218 7354802.204 1522586.387 4384.09 NG	
3219 7354799.394 1522897.874 4380.498 TOP	=
3220 7354767.374 1522963.156 4374.44 TOP POND	
3221 7354765.139 1522966.492 4372.224 TOE POND	
3222 7354762.815 1522969.916 4369.577 FL CRK PIPE B	BX
3223 7354758.992 1522974.824 4372.477 TOE POND	
3224 7354756.561 1522977.118 4374.124 TOP POND	
3225 7354752.367 1522982.709 4373.874 TOP	
3226 7354785.459 1523029.774 4369.579 12" OPEN GRND WAT	TER PIPE?
3227 7354608.029 1522867.78 4370.837 TOP	
3228 7354609.789 1522874.54 4367.826 TOE	
3229 7354614.359 1522882.384 4364.023 TOE CRK	
3230 7354619.909 1522885.146 4366.748 FL PIPE	
3231 7354620.904 1522886.272 4364.22 TOE CRK	
3232 7354630.956 1522897.636 4368.976 TOP	
3233 7354640.824 1522860.035 4373.973 TOP POND 8FT EAS	ST GATE
3234 7354639.409 1522852.711 4373.949 TOP POND	
3235 7354714.567 1522870.145 4376.363 NG	
3236 7354696.511 1522862.737 4375.326 TOP POND	
3237 7354691.472 1522861.414 4372.381 TOE POND @ WAT	ER LINE
3238 7354529.729 1522171.371 4389.704 TOE	
3239 7354526.689 1522168.658 4393.186 TOP	
3240 7354522.809 1522104.101 4405.692 TOE	
3241 7354562.428 1522101.044 4405.561 CL 4X4 SD BX TO	P GRT
52994 7355555.044 1532109.066 0 WIT COR	
53598 7353995.01 1521067.814 4436.321 SEC COR	
53599 7353992.739 1518431.473 4452.111 SEC COR	
53606 7355558.549 1526677.293 4364.841 SEC COR	
53607 7354008.161 1523713.692 4356.361 SEC COR	

Point ID	Northing	Easting	Elevation	Note
53640	7353991.335	1529044.045	4413.961	SEC COR
54037	7355554.854	1532136.086	4432.531	WIT COR
54460	7351401.902	1526315.815	4426.631	SEC COR

Conceptual Cost Estimate Summary



, ,	ect: Butterfield Creek Flood Control Improv	ements	Date:		
	er: Riverton City	-1	Prepar		GL
No.	Item	Quantity	Units	Unit Cost	Cost
	native A				
1	Butterfield Creek Improvements	1	LS	\$987,000	\$987,000
	Total Alternative A Conceptual Cost				\$987,000
Alteri	native B				
1	Butterfield Creek Improvements	1	LS	\$1,025,000	\$1,025,000
	Total Alternative B Conceptual Cost				\$1,025,000
Alteri	native C				
1	Butterfield Creek Improvements	1	LS	\$1,187,000	\$1,187,000
	Total Alternative C Conceptual Cost				\$1,187,000
Alteri	native D	J			
1	Butterfield Creek Improvements	1	LS	\$744,000	\$744,000
	Total Alternative D Conceptual Cost				\$744,000

	L				



Proje	ct: Butterfield Creek Flood Control - Alterna	ative A	Date:	1/23/2006	
	er: Riverton City		Prepare	ed by:	GL
No.	Item	Quantity		Unit Cost	Cost
Redw	ood Road Detention Basin				
1	Property Acquisition	2.5	AC	\$120,000	\$300,000
2	Excavation and Hauling (5.7 acre-feet)	9200	CY	\$12	\$110,400
3	Landscaping	108900	SF	\$0.50	\$54,450
4	Inlet Structure	11	LS	\$4,500	\$4,500
5	Outlet Structure	1	LS	\$9,500	\$9,500
	Subtotal				\$478,850
	Contingency	25%			\$119,713
	Engineering, Legal & Administration	15%			\$89,784
	Detention Basin Total Cost				\$689,000
South	Jordan Canal Crossing				U
6	36-inch RCP @ 0.6% Slope	200	LF	\$500	\$100,000
7	Headwall	2	EA	\$4,500	\$9,000
8	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$112,300
	Contingency	25%			\$28,075
	Engineering, Legal & Administration	15%			\$21,056
	Culvert Total Cost				\$162,000
Maies	tic View Estates (Upstream Culvert)		<u> </u>		
9	18-inch RCP @ 2.7% Slope	350	LF	\$68	\$23,800
10	Headwall	2	EA	\$4,500	\$9,000
11	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$36,100
	Contingency	25%			\$9,025



	ect: Butterfield Creek Flood Control - Alter	native A	Date:	1/23/2006	
_	er: Riverton City		Prepare		GL
No.		Quantity	Units	Unit Cost	
	Engineering, Legal & Administration	15%			\$6,769
	Culvert Total Cost				\$52,00
Maje:	□ stic View Estates (Downstream Culvert	s)			
12	36-inch CMP @ 0.6% Slope	80	LF	\$136	\$10,880
13	36-inch CMP @ 11.9% Slope	80	LF	\$136	\$10,880
14	Headwall	2	EA	\$4,500	\$9,000
15	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$34,060
	Contingency	25%			\$8,51
	Engineering, Legal & Administration	15%			\$6,386
	Culvert Total Cost				\$49,000
Love	rs Lane Crossing				
16	42-inch RCP @ 1.0% Slope	70	LF	\$168	\$11,760
17	Headwall	2	EA	\$4,500	\$9,000
18	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$24,060
	Contingency	25%			\$6,01
	Engineering, Legal & Administration	15%			\$4,51°
	Culvert Total Cost				\$35,000
	Detention and Culvert Total Cost				\$987,000
	*Note: Total costs rounded up to neares	st \$1000.			
	Property acquisition costs assur	ned to be twice	ce tax va	lue	



	ct: Butterfield Creek Flood Control - Alterna	ntive B	Date:	1/23/2006	
	er: Riverton City		Prepared		GL
No.	Item	Quantity	Units	Unit Cost	Cost
	ood Road Detention Basin	,		,	
1	Property Acquisition	1.0	AC	\$120,000	\$120,000
2	Excavation and Hauling (2.0 acre-feet)	3300	CY	\$12	\$39,600
3	Landscaping	43560	SF	\$0.50	\$21,780
4	Inlet Structure	11	LS	\$4,500	\$4,500
5	Outlet Structure	11	LS	\$9,500	\$9,500
6	Replace 24-inch CMP with 42-inch RCP	600	LF	\$168	\$100,800
7	Replace 24-inch RCP @ 13400 South	8	LF	\$136	\$1,088
	with 36-inch RCP				
	Subtotal	-			\$297,268
	Contingency	25%			\$74,317
	Engineering, Legal & Administration	15%			\$55,738
	Detention Basin Total Cost				\$428,000
South	Jordan Canal Detention Basin	4			
8	Property Acquisition	2.5	AC	\$92,000	\$230,000
9	Excavation and Hauling (1.2 acre-feet)	2000	CY	\$12	\$24,000
10	Landscaping	108900	SF	\$0.50	\$54,450
11	Inlet Structure	1	LS	\$4,500	\$4,500
12	Outlet Structure	1	LS	\$9,500	\$9,500
	Subtotal				\$322,450
	Contingency	25%			\$80,613
	Engineering, Legal & Administration	15%			\$60,459
	Detention Basin Total Cost				\$464,000
Maioo	tic View Estates (Upstream Culvert)				
<i>majes</i> 13	18-inch RCP @ 2.7% Slope	350	LF	\$68	\$23,800
14	Headwall	2	EA	\$4,500	\$9,000
15	Riprap	60	CY	\$55	\$3,300
	diameter de la constantina della constantina del				T - , 5 0



	ct: Butterfield Creek Flood Control - Alterna	tive C	Date:	1/23/2006	
Owne	er: Riverton City		Prepared		GL
No.	Item	Quantity	Units	Unit Cost	Cost
	ood Road Detention Basin				
1	Property Acquisition	1.0	AC	\$120,000	\$120,000
2	Excavation and Hauling (2.0 acre-feet)	3300	CY	\$12	\$39,600
3	Landscaping	43560	SF	\$0.50	\$21,780
4	Inlet Structure	11	LS	\$4,500	\$4,500
5	Outlet Structure	1	LS	\$9,500	\$9,500
6	Replace 24-inch CMP with 42-inch RCP	600	LF	\$168	\$100,800
7	Replace 24-inch RCP @ 13400 South	8	LF	\$136	\$1,088
	with 36-inch RCP				
	Subtotal				\$297,268
	Contingency	25%			\$74,317
	Engineering, Legal & Administration	15%			\$55,738
	Detention Basin Total Cost				\$428,000
					7.20,000
South	Jordan Canal Crossing	*			
8	36-inch RCP @ 0.6% Slope	200	LF	\$500	\$100,000
9	Headwall	2	EA	\$4,500	\$9,000
10	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$112,300
	Contingency	25%			\$28,075
	Engineering, Legal & Administration	15%			\$21,056
	Culvert Total Cost				\$162,000
South	Jordan Canal Detention Basin				
11	Property Acquisition	2.5	AC	\$92,000	\$230,000
12	Excavation and Hauling (1.2 acre-feet)	2000	CY	\$12	\$24,000
13	Landscaping	108900	SF	\$0.50	\$54,450
	1=aacoaping	100000			
14	Inlet Structure	1	LS	\$4,500	\$4,500



-	ect: Butterfield Creek Flood Control - Alter	native C	Date:	1/23/2006	0.1
	er: Riverton City	T a	Prepare		GL
No.	Item	Quantity	Units	Unit Cost	Cost
	Subtotal	_			\$322,45
	Cubicial				Ψ022, T0
	Contingency	25%			\$80,61
	Engineering, Legal & Administration	15%			\$60,45
	Detention Basin Total Cost				\$464,00
Majes	stic View Estates (Upstream Culvert)			L	
16	18-inch RCP @ 2.7% Slope	350	LF	\$68	\$23,80
17	Headwall	2	EA	\$4,500	\$9,00
18	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$36,10
	Contingency	25%	-		\$9,02
-	Engineering, Legal & Administration	15%			\$6,76
	Culvert Total Cost				\$52,00
Majes	 stic View Estates (Downstream Culvert	s)		L	
19	36-inch CMP @ 0.6% Slope	80	LF	\$136	\$10,88
20	36-inch CMP @ 11.9% Slope	80	LF	\$136	\$10,88
21	Headwall	2	EA	\$4,500	\$9,00
22	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$34,06
	Contingency	25%			\$8,51
	Engineering, Legal & Administration	15%			\$6,38
	Culvert Total Cost				\$49,00
Lovei	rs Lane Crossing			L	
23	36-inch RCP @ 1.0% Slope	70	LF	\$136	\$9,52
24	Headwall	2	EA	\$4,500	\$9,00



Proje	ct: Butterfield Creek Flood Control - Alterna	ative C	Date:	1/23/2006	
Owne	er: Riverton City		Prepared	d by:	GL
No.	Item	Quantity	Units	Unit Cost	Cost
25	Riprap	60	CY	\$55	\$3,300
	Subtotal				\$21,820
	Contingency	25%			\$5,4 55
	Engineering, Legal & Administration	15%			\$4,091
	Culvert Total Cost				\$32,000
	Detention and Culvert Total Cost				\$1,187,000
	*Note: Total costs rounded up to nearest	\$1000.			
	Property acquisition costs assume	ed to be twice	ce tax val	lue	



•	ct: Butterfield Creek Flood Control - Alter	native D	Date:	1/23/2006	
	er: Riverton City		Prepared		GL
No.	ltem	Quantity	Units	Unit Cost	Cost
	ood Road Crossing				
1	54-inch RCP @ 0.6% Slope	700	LF	\$254	\$177,80
2	Headwall	2	EA	\$4,500	\$9,00
3	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$190,10
	Contingency	25%			\$47,52
	Engineering, Legal & Administration	15%			\$35,64
	Culvert Total Cost				\$274,00
13400	South Crossing			<u> </u>	
4	54-inch RCP @ 1.0% Slope	100	LF	\$231	\$23,10
5	Headwall	2	EA	\$4,500	\$9,00
6	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$35,40
	Contingency	25%			\$8,85
	Engineering, Legal & Administration	15%			\$6,63
	Culvert Total Cost				\$51,00
South	Jordan Canal Crossing				
7	54-inch RCP @ 0.6% Slope	200	LF	\$900	\$180,00
	Headwall	2	EA	\$4,500	\$9,00
9	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$192,30
	Contingency	25%			\$48,07
	Engineering, Legal & Administration	15%			\$36,05
	Culvert Total Cost				\$277,00



	ect: Butterfield Creek Flood Control - Alter er: Riverton City		Date: Prepared	1/23/2006	GL
No.	Item	Quantity	Units	Unit Cost	Cost
140.	Tom service and the service an	Quartity	Office	OTHE GOSE	0001
Maios	stic View Estates (Upstream Culvert)				
10	18-inch RCP @ 2.7% Slope	350	LF	\$68	\$23,80
11	Headwall	2	EA	\$4,500	\$9,00
12	Riprap	60	CY	\$55	\$3,30
12	Τιριαρ	+ 55	<u> </u>	ΨΟΟ	ΨΟ,Ο
	Subtotal				\$36,10
	Cabicia	-			φου, το
	Contingency	25%			\$9,02
	Engineering, Legal & Administration	15%			\$6,76
	3, 2-3				+-,,,
	Culvert Total Cost				\$52,00
Maies	stic View Estates (Downstream Culvert	s)			
13	36-inch CMP @ 0.6% Slope	80	LF	\$136	\$10,88
14	36-inch CMP @ 11.9% Slope	80	LF	\$136	\$10,88
15	Headwall	2	EA	\$4,500	\$9,00
16	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$34,06
	Contingency	25%			\$8,5
	Engineering, Legal & Administration	15%			\$6,38
	Culvert Total Cost				\$49,00
_over	s Lane Crossing				
17	54-inch RCP @ 1.0% Slope	70	LF	\$231	\$16,17
18	Headwall	2	EA	\$4,500	\$9,00
19	Riprap	60	CY	\$55	\$3,30
	Subtotal				\$28,47
	Contingency	25%			\$7,11
	Engineering, Legal & Administration	15%			\$5,33



Proje	ct: Butterfield Creek Flood Control - Alterna	tive D	Date:	1/23/2006	
Owne	r: Riverton City		Prepared	d by:	GL
No.	Item	Quantity	Units	Unit Cost	Cost
	Culvert Total Cost				\$41,000
	Culvert Total Cost				\$744,000
	*Note: Total costs rounded up to nearest	\$1000.			

Table Rating Table for Trapezoidal Channel

Project Description	on
Project File	p:\riverton\butterfield creek drainage study\calculations\conceptu.fm2
Worksheet	Reach 1 Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.045
Left Side Slope	2.000000 H:V
Right Side Slope	2.000000 H:V
Discharge	175.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	0.005000	0.025000	0.001000 ft/ft
Bottom Width	6.00	20.00	2.00 ft

Rating Ta	able				
Bott	om (Channel			
Wic	ith	Slope	Depth	Velocity	
(ft	:)	(ft/ft)	(ft)	(ft/s)	
0		005000	0.54	0.00	
6.0		005000	3.51	3.83	
6.0		006000	3.36	4.10	
6.0		007000	3.23	4.34	
6.0		008000	3.13	4.56	
6.0	00 0.	009000	3.04	4.76	
6.0	00 0.	010000	2.96	4.95	
6.0	00 0.	011000	2.89	5.13	
6.0	00 0.	012000	2.83	5.29	
6.0	00 0.	013000	2.78	5.45	
6.0	00 0.	014000	2.73	5.60	
6.0	00 0.	015000	2.68	5.75	
6.0	00 0.	016000	2.64	5.88	
6.0	00 0.	017000	2.60	6.01	
6.0	00 0.	018000	2.56	6.14	
6.0	00 0.	019000	2.53	6.26	
6.0	00 0.	020000	2.49	6.38	
6.0	00 0.	021000	2.46	6.50	
6.0	00 0.	022000	2.44	6.61	
6.0	00 0.	023000	2.41	6.72	
6.0	00 0.	024000	2.38	6.82	
6.0	00 0.	025000	2.36	6.92	
8.0	00 0.	005000	3.20	3.79	

Table
Rating Table for Trapezoidal Channel

Rat	ting Table			
	Bottom	Channel		
	Width	Slope	Depth	Velocity
	(ft)	(ft/ft)	(ft)	(ft/s)
	8.00	0.006000	3.06	4.05
	8.00	0.007000	2.94	4.28
	8.00	0.008000	2.84	4.50
	8.00	0.009000	2.76	4.69
	8.00	0.010000	2.68	4.88
	8.00	0.011000	2.62	5.05
	8.00	0.012000	2.56	5.21
	8.00	0.013000	2.51	5.36
	8.00	0.014000	2.46	5.51
	8.00	0.015000	2.42	5.64
	8.00	0.016000	2.38	5.78
	8.00	0.017000	2.34	5.90
	8.00	0.018000	2.30	6.03
	8.00	0.019000	2.27	6.14
	8.00	0.020000	2.24	6.26
	8.00	0.021000	2.21	6.37
	8.00	0.022000	2.18	6.48
	8.00	0.023000	2.16	6.58
	8.00	0.024000	2.13	6.68
	8.00	0.025000	2.11	6.78
	10.00	0.005000	2.95	3.73
	10.00	0.006000	2.81	3.99
	10.00	0.007000	2.70	4.21
	10.00	0.008000	2.60	4.42
	10.00	0.009000	2.52	4.61
	10.00	0.010000	2.45	4.78
	10.00	0.011000	2.39	4.95
	10.00	0.012000	2.34	5.10
	10.00	0.013000	2.29	5.25
	10.00	0.014000	2.24	5.39
	10.00	0.015000	2.20	5.52
	10.00	0.016000	2.16	5.65
	10.00	0.017000	2.13	5.77
	10.00	0.018000	2.09	5.89
	10.00	0.019000	2.06	6.01
	10.00	0.020000	2.03	6.12
	10.00	0.021000	2.01	6.22
	10.00	0.021000	1.98	6.32
	10.00	0.022000	1.96	6.42
	10.00	0.023000	1.94	6.52
	10.00	0.024000	1.94	6.61
	12.00	0.025000	2.73	3.67
	12.00	0.006000	2.60	3.91
	12.00	0.007000	2.49	4.13
	12.00	0.008000	2.40	4.33

Table
Rating Table for Trapezoidal Channel

Rating Table			
Bottom	Channel		
Width	Slope	Depth	Velocity
(ft)	(ft/ft)	(ft)	(ft/s)
12.00	0.009000	2.33	4.51
12.00	0.010000	2.26	4.68
12.00	0.011000	2.20	4.84
12.00	0.012000	2.15	4.99
12.00	0.013000	2.10	5.13
12.00	0.014000	2.06	5.27
12.00	0.015000	2.02	5.40
12.00	0.016000	1.99	5.52
12.00	0.017000	1.95	5.64
12.00	0.018000	1.92	5.75
12.00	0.019000	1.89	5.86
12.00	0.020000	1.87	5.96
12.00	0.021000	1.84	6.06
12.00	0.022000	1.82	6.16
12.00	0.023000	1.79	6.26
12.00	0.024000	1.77	6.35
12.00	0.025000	1.75	6.44
14.00	0.005000	2.55	3.60
14.00	0.006000	2.42	3.84
14.00	0.007000	2.32	4.05
14.00	0.008000	2.23	4.24
14.00	0.009000	2.16	4.42
14.00	0.010000	2.10	4.58
14.00	0.011000	2.04	4.73
14.00	0.012000	1.99	4.88
14.00	0.013000	1.95	5.01
14.00	0.014000	1.91	5.14
14.00	0.015000	1.87	5.26
14.00	0.016000	1.84	5.38
14.00	0.017000	1.81	5.50
14.00	0.018000	1.78	5.60
14.00	0.019000	1.75	5.71
14.00	0.020000	1.73	5.81
14.00	0.021000	1.70	5.91
14.00	0.022000	1.68	6.00
14.00	0.023000	1.66	6.09
14.00	0.024000	1.64	6.18
14.00	0.025000	1.62	6.27
16.00	0.005000	2.39	3.53
16.00	0.006000	2.27	3.76
16.00	0.007000	2.17	3.96
16.00	0.008000	2.09	4.15
16.00	0.000000	2.02	4.32
16.00	0.009000	1.96	4.48
16.00	0.010000	1.91	4.62
10.00	0.011000	1.01	7.02

Table
Rating Table for Trapezoidal Channel

ing Table				
Bottom	Channel			
Width	Slope	Depth	Velocity	
(ft)	(ft/ft)	(ft)	(ft/s)	
16.00	0.012000	1.86	4.76	
16.00	0.013000	1.82	4.89	
16.00	0.014000	1.78	5.02	
16.00	0.015000	1.75	5.14	
16.00	0.016000	1.72	5.25	
16.00	0.017000	1.69	5.36	
16.00	0.018000	1.66	5.46	
16.00	0.019000	1.63	5.56	
16.00	0.020000	1.61	5.66	
16.00	0.021000	1.59	5.75	
16.00	0.022000	1.57	5.84	
16.00	0.023000	1.55	5.93	
16.00	0.024000	1.53	6.01	
16.00	0.025000	1.51	6.10	
18.00	0.005000	2.25	3.46	
18.00	0.006000	2.14	3.68	
18.00	0.007000	2.04	3.88	
18.00	0.008000	1.97	4.06	
18.00	0.009000	1.90	4.22	
18.00	0.010000	1.84	4.37	
18.00	0.011000	1.79	4.52	
18.00	0.012000	1.75	4.65	
18.00	0.013000	1.71	4.78	
18.00	0.014000	1.67	4.90	
18.00	0.015000	1.64	5.01	
18.00	0.016000	1.61	5.12	
18.00	0.017000	1.58	5.22	
18.00	0.018000	1.56	5.32	
18.00	0.019000	1.53	5.42	
18.00	0.020000	1.51	5.51	
18.00	0.021000	1.49	5.60	
18.00	0.022000	1.47	5.69	
18.00	0.023000	1.45	5.77	
18.00	0.024000	1.43	5.86	
18.00	0.025000	1.42	5.93	
20.00	0.005000	2.13	3.39	
20.00	0.006000	2.02	3.60	
20.00	0.007000	1.93	3.80	
20.00	0.008000	1.86	3.97	
20.00	0.009000	1.80	4.13	
20.00	0.010000	1.74	4.27	
20.00	0.011000	1.70	4.41	
20.00	0.012000	1.65	4.54	
		1.62	4.66	
20.00	0.013000	1.07	4.00	

Table
Rating Table for Trapezoidal Channel

Rating Table			
Bottom	Channel		
Width	Slope	Depth	Velocity
(ft)	(ft/ft)	(ft)	(ft/s)
22.22	0.045000	4 ==	4.00
20.00	0.015000	1.55	4.89
20.00	0.016000	1.52	4.99
20.00	0.017000	1.49	5.09
20.00	0.018000	1.47	5.19
20.00	0.019000	1.45	5.28
20.00	0.020000	1.43	5.37
20.00	0.021000	1.40	5.46
20.00	0.022000	1.39	5.55
20.00	0.023000	1.37	5.63
20.00	0.024000	1.35	5.71
20.00	0.025000	1.34	5.78