Copper Creek Project

Final Report

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Executive summary

The area around Copper Creek is currently covered in farmland and smalls hills and gullies. The creek itself does not have any water to hold for the majority of the year, and when there is water, it is so small that it does not affect any of the surrounding area. In the future however, this same surrounding area will no longer be farm land. The town of Herriman is growing quickly and the Copper Creek will no longer be able to flow unchecked. With the developmental master plan of the area, a master plan of Copper Creek must also be developed.

There are three options to manage the flow of Copper Creek. First is to do nothing at all and leave it as is, which ultimately will result in flooding. Second is to pipe the water, which is expensive and may not be cost efficient for a creek that does not flow for most of the year. The third and final option is to design an open channel. This is much more cost efficient than piping, and can account for flooding when a detention basin is added to the open channel.

The basic process of designing an open channel consisted of five basic steps that are summarized in a bulleted list below.

- Hydrological Analysis
- Cross-Section and Detention Basin Design
- Channel and Detention Basin Placement
- Hydraulic Analysis
- Cost Analysis

The designs and analyses that were developed use various computer software. The programs used most in the design and analysis process were WMS, HEC-RAS and Microsoft Excel. The cross section of the channel is trapezoidal in shape, but has a small inner channel to hold a 2-yr storm flow and a larger outer channel to hold a 100-yr storm flow. The inner channel will be lined in cobbles to help prevent high velocity flows. The outer channel will be lined with grass to make it friendly to society when creek flow does not exceed the capabilities of the inner channel. The channel was placed on property boundaries as much as was possible to avoid running a channel through the middle of a land owner's property. The detention basin was placed on property that is owned by a school so that it could double as a soccer field when a detention basin is not needed.

Ultimately, the best option for containing the flow in Copper Creek is to use an open channel. Based on the cost analysis, it is least expensive of the action oriented alternatives because the main cost is excavation and equipment costs. No action is not acceptable because of the flooding damages that would be the result in leaving the creek to run naturally. Piping would be extremely expensive due to the price of excavation with the added cost of pipe and grates to allow rainfall to enter the pipe. When places on the boundary lines, the open channel is not extremely invasive to the future community. The detention basin can be used for recreation which also minimizes the negative effects it might have on the community. The design of the channel allows the channel to be aesthetically pleasing as well as operational when needed. The recommendation of BAJRS Engineering is an open channel with a trapezoidal channel containing an inner, and outer portion of the channel and a detention basin to prevent flooding.

Introduction

Project Overview

Copper Creek is a small creek near 600 West in Salt Lake that is the single creek used for runoff from the canyon. It is braided, not visible in some places during the dry months of the year. Flooding has not been a concern to Salk Lake County because the creek runs through fields and non-residential areas before it reaches Salt Lake. However, much of this area will be turned into residential areas. A flood analysis needs to be performed before the projects can begin.

In order to complete the project we will split it up into four different phases. Each phase will need to be completed in order and will help in the overall organization and completion of the project.

- **Phase 1** - Adequately define creek.
- **Phase 2** - Define the watershed that empties to the creek using HEC-HMS. This is essential in order to calculate an accurate 100 year return period.
- **Phase 3** - Design a typical cross-section that will be adequate for the 100-yr flood calculated in phase 2. A pipeline should also be designed with adequate capacity. Detention basins must also be considered as well as environmental impacts, economics and the future impact and flood potential of the future residential areas. Making no changes and leaving the creek as is should also be a considered alternative. Compare all alternatives.
- **Phase 4** - Submit a final report to Salt Lake County that will include both models, well indexed so they can be used if needed. A recommendation based on the criteria in phase 3 also needs to be included in the report.

Purpose of the Study

The purpose of this study is to develop a master plan for Copper Creek that will include a hydrologic analysis to calculate 100-year flows, alternatives to convey the design flows to 6000 West taking right-of-way requirements into account, and a cost analysis and recommendation for alternatives.

Summary of Recommended Alternative

The recommended alternative is an open channel. This allows for a design base on the idea of having a small inner channel to hold the extremely small flows that are normal for Copper Creek, and a much larger outer channel for the event of a 100-yr storm. To account for flood risks a detention basin will be included in the design to prevent those risks. The placement of the channel will be based upon property boundary lines to reduce the social affects it could have on the community. The detention basin will be designed and placed in such a way as to support recreational activities to the surrounding community.

Project constraints

Design Standards

The following design parameters were given as requirements for the development of a master plan.

- The outflow from a detention basin is restricted 0.2 cfsper acre of development
- 100 year SCS Type II design storm
- Material constraints HDP pipe/RCP based on size /no CMP
- Slope of channel
- Side slope
- Smaller, 2-year flow channel

Physical Constraints

At the top of the channel, the natural channel can hold the 100-yr flow with extra room. However, further down the channel, this is not the case. The channel becomes too spread out to adequately hold the 100-yr flow if the area is developed. When designing the channel finding where the channel no longer holds the flow is where the designed channel will be put into place.

Private Stakeholders' Interests

Jordan School District owns a large amount of property where the Copper Creek channel will have its outlet. The amount of property that the channel will use from the Jordan School District is quite small, however, a detention basin will need to be placed on Jordan School District property if the land in the area is developed. In the interest of Jordan School District a detention basin has been designed that can also be used as a soccer field. The detention basin will be large enough for two soccer fields to fit comfortably in the detention basin, and since that detention basin will likely fill with the 100 year storm, the soccer fields will be free for use the majority of the time.

While determining where the Copper Creek Channel should be placed the land owners interest in the area had to be considered. Land owners that will be affected by the Copper Creek Channel Design are OM Enterprises Co, The Last Holdout LLC, and Jordan School District. The channel was designed to follow the existing property lines in order to minimize the land used for the channel and bisecting large plots of land. The proposed channel alignment can be seen below in Figure 1.

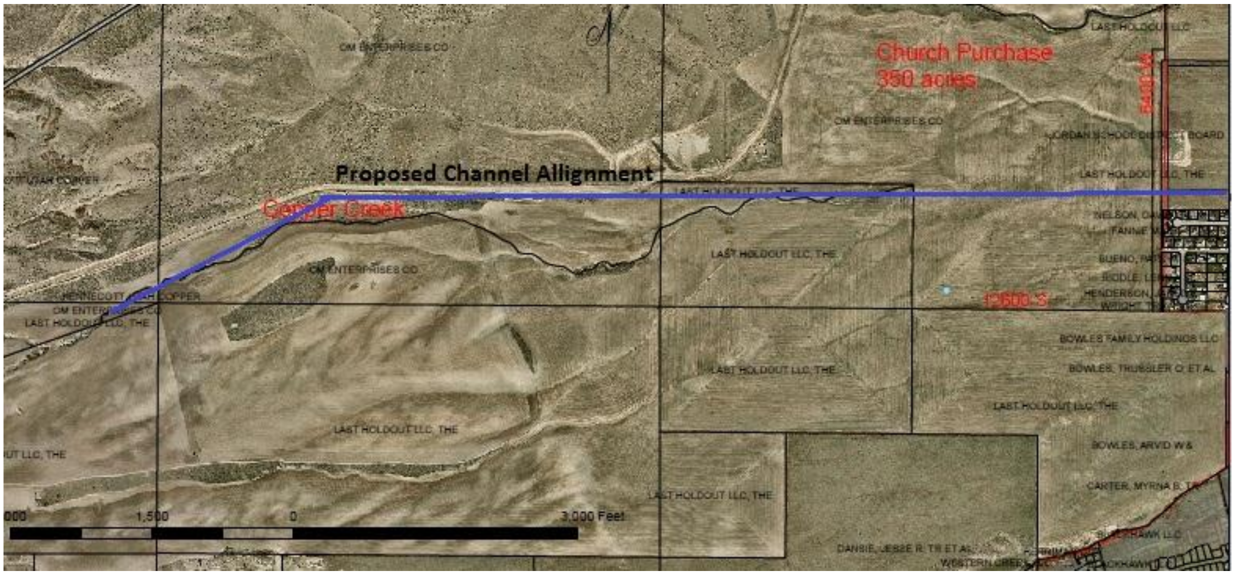

Figure 1. Proposed channel alignment

Development of Hydrologic Model

It was important to create a model to simulate the runoff from the basin in its present condition to compare the results of changing land use.The watershed modeling software WMS was used to delineate the watershed and calculate the necessary parameters to run the model in HMS.

Data Collection

Data including soil type, land use, and LiDAR elevation was obtained from Utah's Automated Geographic Resource Center (AGRC). SURGO soil data was used to geospatially define soil types. A current land use file was used for pre-development modeling. This land use file was altered to match a development master plan provided by Herriman City to model post-development runoff. Precipitation data for the 100 year and 2 year event were collected from the National Oceanic and Atmospheric Administartion (NOAA).

Delineation

The watershed basin and sub-basins were calculated through WMS based on flow paths calculated from the LiDAR elevation data obtained from AGRC. The watershed was divided into four sub-basins based differing land use and slope as shown in Figure 2.

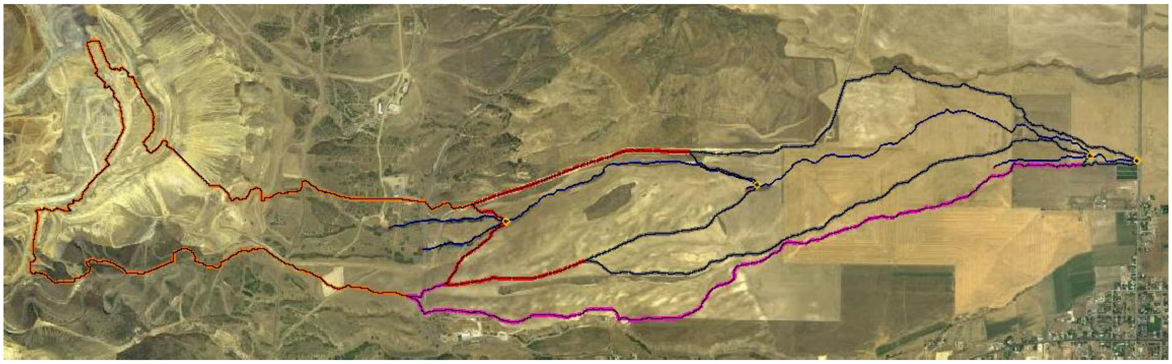

Figure 2.

Loss Method

Following general practice for Salt Lake County the SCS Curve Number method was used to determine losses in the watershed. There were two different inputs that were needed to produce a curve number that properly represents our watershed area. The first input needed was Soil Type. Soil type data obtained from AGRC was adjusted in accordance to a study performed by Bowen Collins and Associates, Inc of Salt Lake County. As detailed in the study the majority of the soil in our watershed would be classified as either a B or C type soil with a few small areas of D type soil. See "Hydrologic Soil Type" in appendix.

The second input needed for curve number was the land use. The majority of the land use we defined as "Cropland and Pasture" with SCS Curve Number values of A-59, B-64, C-78, and D-81. In order to define a post development curve number we created an over lay of the current land use with the City of Herriman 2020 development Master Plan (see **Error! Reference source not found.**) . As shown in the master plan the Copper Creek watershed will be affected by a large development planned for the southern portion of the watershed. This development is labeled as Neighborhood/Planned Community Residential. The development is described as "Residential developments with a base density of three units per acre. Density of up to five units per acre is allowable for large scale master planned communities." For this Post Development Land Use the SCS Curve Number values of A-62, B-76, C-84, and D-88 were used.

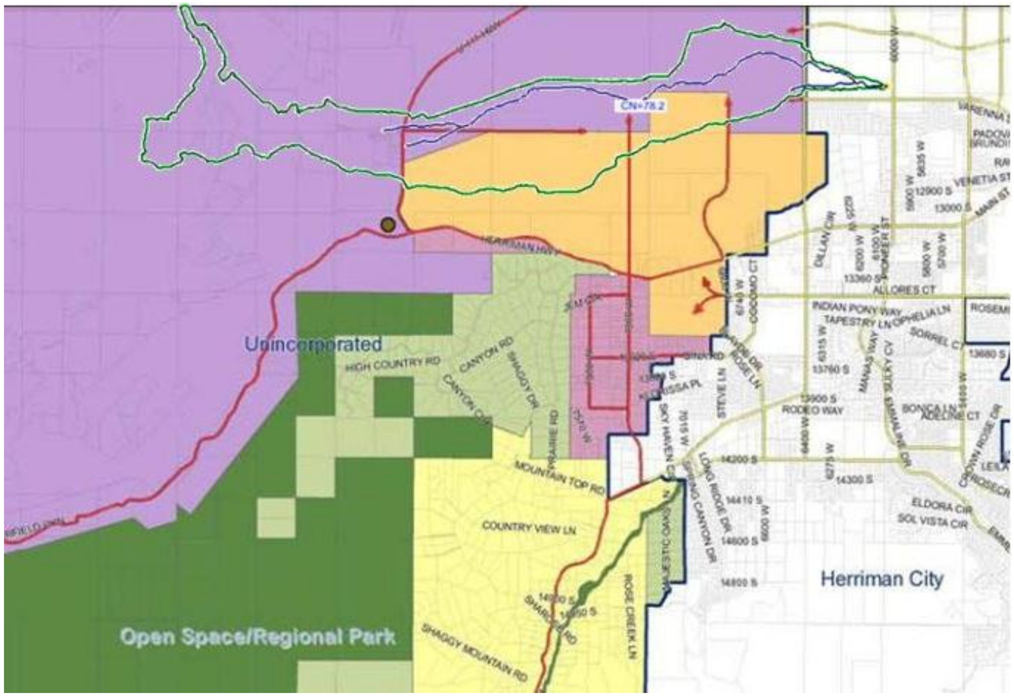

Figure 3. Master Land use plan for Herriman

Running the model with these Soil Type and Land Use inputs produced curve number values of 67.7 for the current land use and a curve number of 73.9 for the post development land use (Table below). Reports for curve numbers are in the appendix.

Condition	*CN*	*Q_p (cfs)*	*Volume (ft^3)*
Pre-Development	67.7	134	2883510
Post-Development	73.9	213.6	4141620

Transform Method

The Clark transform method was selected to be able to account for the lack of channel in the watershed basin and appropriately model the roughness. The Clark method has a storage parameter which simulates the runoff being detained by the rough surface in overland flow. Since there is no defined channel in the lower two-thirds of the watershed it is assumed that runoff spreads out over the terrain and is best simulated as overland flow. In a lumped parameter model the Clark method provides the best approximation of this behavior.

Results

The hydrographs resulting from the HMS model showed the 100 year event producing a peak flow of 134 cfs under the current condition. This peak flow is shown to increase to 213.6 cfs when the area is developed. The difference in volume of the runoff is 1,258,110 ft^3 (28.9 ac-ft). The resulting hydrographs are shown on the same plot in Figure 4.

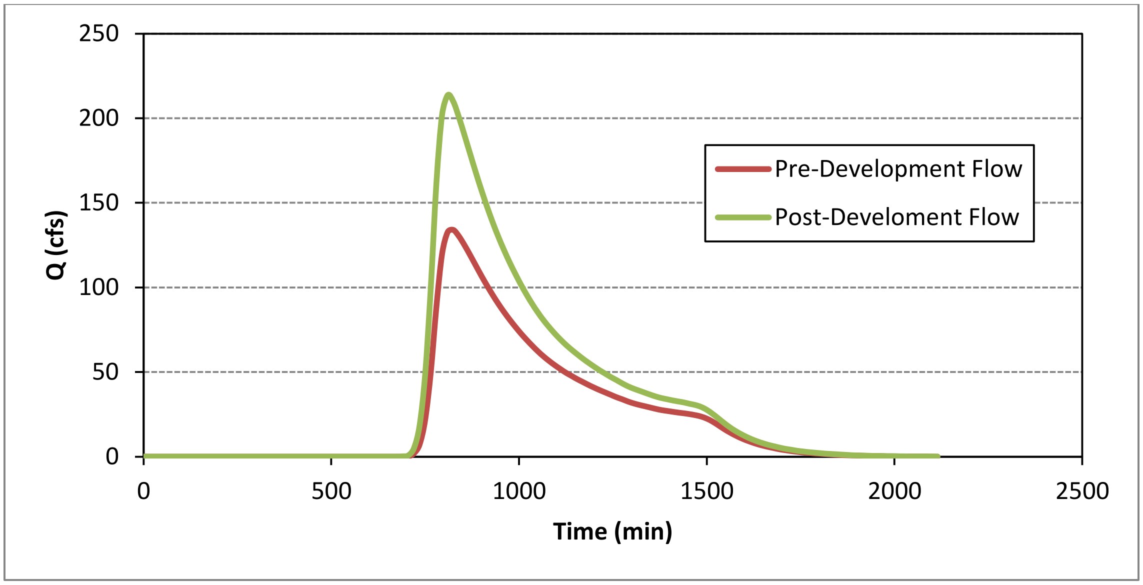

Figure 4. Pre and post development hydrographs for the 100 year storm event.

Development of different alternatives

Strategy for Identifying Alternatives

When considering all of the alternatives for this project it was concluded that there are three basic ways to move water. First was to leave it as is, and let it flow naturally. Second was to pipe the water underground, and third was to channel the water.

Reasons for Disqualification

One reason why an alternative might be disqualified is social impact. In other words, what sort of effect would the construction and the finished product have upon the surrounding society. Another reason is cost effectiveness, would the cost be worth the product. For instance, Copper Creek does not flow for most of the year, so the question becomes, would it be cost effective to spend so much money on something that essentially won't be used for most of the year. Lastly, would the alternative in question be capable of flood prevention or handle a higher flow then what it was designed for? For instance, if the 100-yr storm had a higher flow than that used for design, would the alternative be able to prevent flooding of the surrounding area.

Evaluation of alternatives

No Action

In the existing condition there is no channel in the lower part of the watershed. As runoff comes off the mountain it spreads out as it hits the flatter ground with shallower slope. This is precisely where the planned development will be located. Water spreading out over this area will cause new developments to flood. Further, the excess runoff caused by the new developments must be detained to comply with county regulation that only 0.2 cfs per acre can be let into the channel. The no action alternative, therefore does not meet the constraints of the project, and may cause expensive damages because of flooding.

Buried pipe

The cost of putting in a pipe for a 100 year flow event is extremely high compared to the other alternatives. Cost of pipe is approximately $120.00 dollars per foot. There would also need to be some excavation performed to bury the pipe. The cost of the pipe and excavation alone is almost 4 times the cost of our projected channel design cost.

Open channel

The design of an open channel begins with designing a cross section. Based upon recommendations and other channels designed in the area, the channel will consist of two parts. An inner channel to hold the 2-yr flow rate of 0.4 cfs, and an outer channel to hold the 100-yr flow of 214 cfs both will be trapezoidal in shape as shown in Figure 3. Manning's equation was used to find the minimum channel size needed to hold the flows mentioned above. The side slope of the trapezoidal channel was 2:1 and the slope of the channel used in Manning's equations was 0.03. After the minimum cross section was calculated it could be entered into HEC-RAS to make final adjustments.

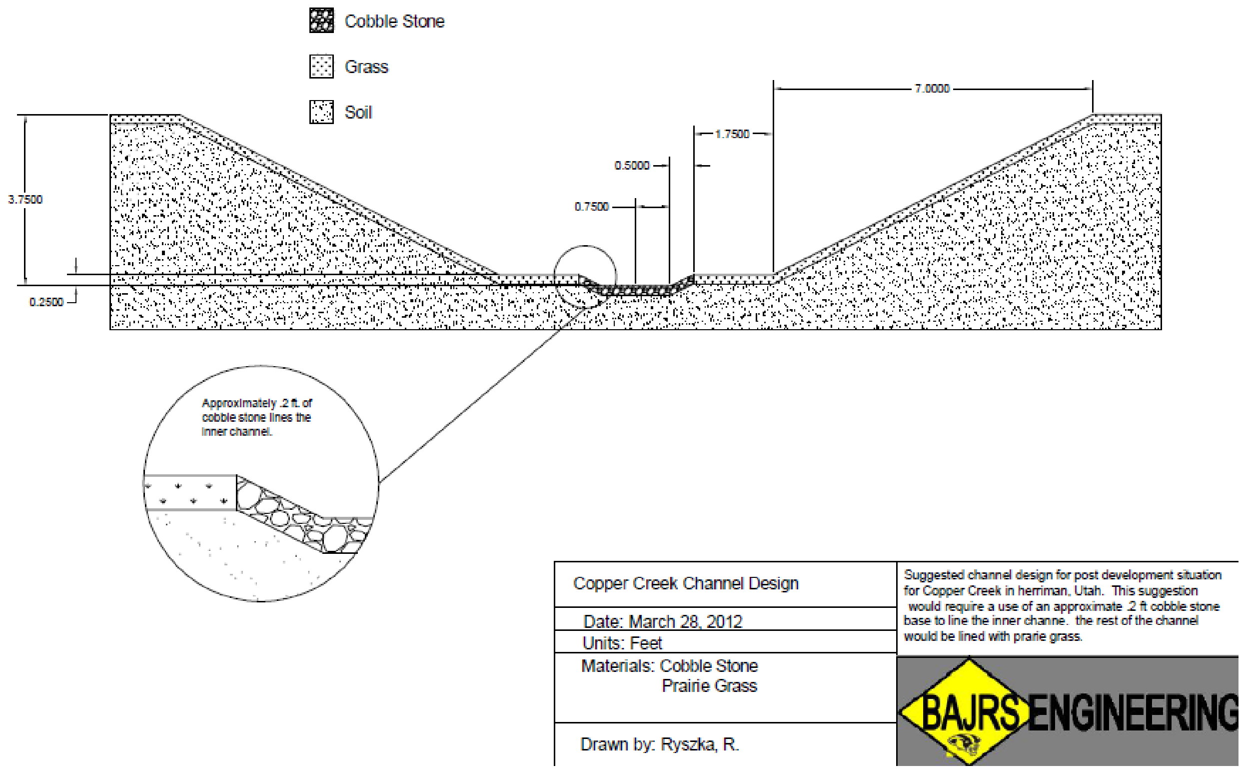

Figure 5. Channel cross section

The first step to the channel design was modeling the natural channel to find where it is not capable of holding the 100-yr flow. WMS was used to find the elevations of the land by converting a downloaded DEM into a TIN and then using the HEC-RAS interface capabilities the elevations were extracted to HEC-RAS. Figure 6 shows Copper Creek with the cross sections that are to be extracted. The HEC-RAS analysis of the extracted cross sections with the 100-yr flow was performed, a figure showing that part of the outcome is shown in Figure 7. Second was deciding where to place the channel. This was decided based upon the property boundaries in the area. The channel was designed to lie on these properties boundaries rather than cutting through them as the natural channel does, see Figure 1. Then the cross section that was designed previously was entered into HEC-RAS with the elevations based upon the current elevation of the land where the channel is to be created. From there adjustments to the cross sections were made. Those adjustments included making the outer channel taller so that it had some freeboard and contained all of the 100-yr flow. The only other adjustment that was made was making the first cross section of the channel significantly larger to account for contraction. The two different cross sections of the channel are shown in Figure 8 and Figure 9.

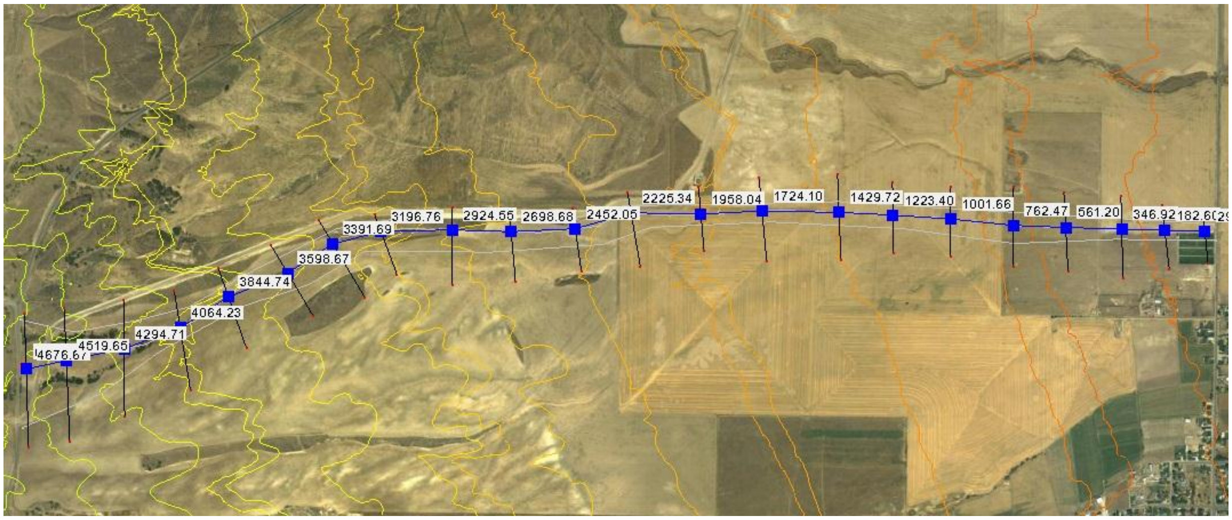

Figure 6. WMS cross section extraction

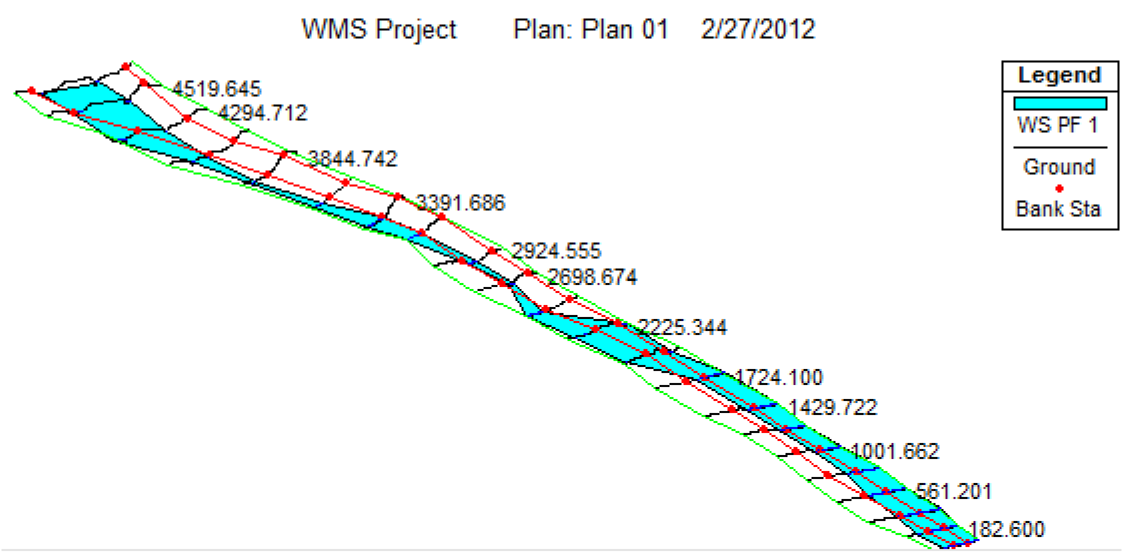

Figure 7. Natural channel model

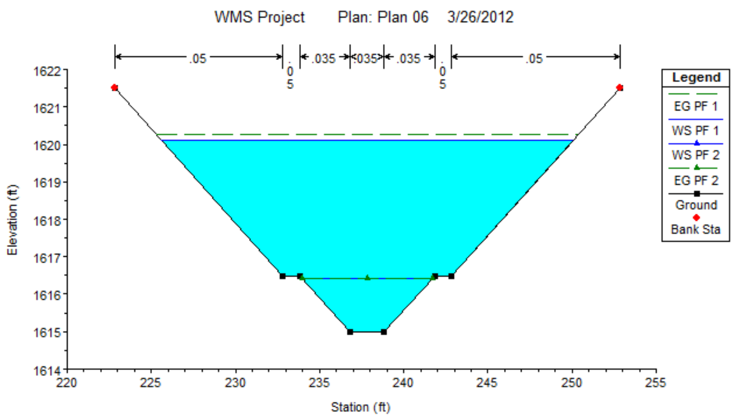

Figure 8. First cross section, larger due to contraction

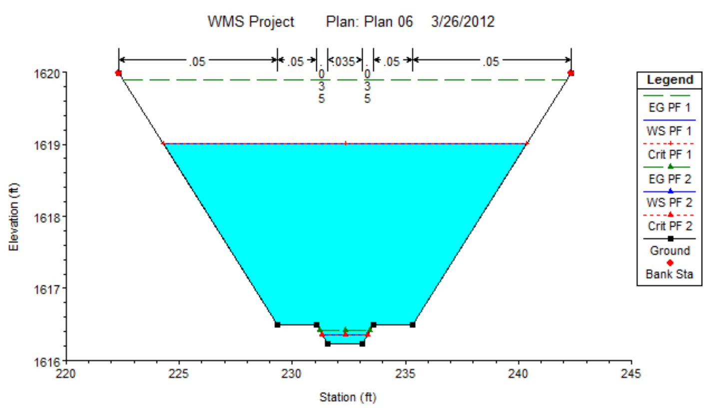

Figure 9. Main cross section for most of the channel

Detention BasinDesign

The detention basin was designed to hold the excess flows produced as a result of planned future development during the event of a 100 year 24 hour duration storm.

The design objective of the detention basin is to make the detention basin routed hydrograph peak lower than the pre-development hydrograph. One design restraint given by City of Herriman engineers was 0.2 cfs per acre detained. This allows for a maximum detention basin outlet flow of 285.5 cfs which is higher than the post-development peak flows produced by the 100 yr storm analysis.

Location

The detention basin will be located at the bottom of the Copper Creek Watershed at 6000 west. Jordan School district owns the land and a school will likely be built there in the future. The school would be an ideal location for the detention basin as it could be ergonomically integrated into the school playgrounds. An aerial view of the basin location is provided in Figure 10.

Figure 10. Aerial view of detention basin location

Geometry

It has been planned that the detention basin will be designed to accommodate for two soccer fields to be built in the bottom of it. The geometry of the basin is outlined in Table 1 and displayed in Figure 11. As displayed in Figure 11 the outlet pipe will be located at the south east corner of the detention basin, and will run to the culvert at 6000 west.

Table 1. Detention basin geometry

Geometry				
Length (ft)	Width (ft)	Height(req) (ft)	Height (design) (ft)	Side Slope (ft/ft)
420	340	6.12	7.25	2

Figure 11. Detention basin measurements

A cross section view of the detention basin is provided in Figure 12, the cross section is taken at the pipe location.

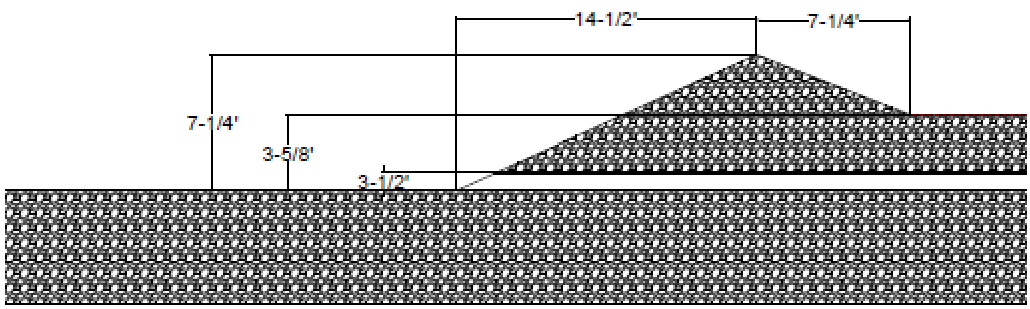

Figure 12. Cross-section of detention basin

Storage

The 100 year event peak storage requirements are presented in Table 2.

Table 2. Peak storage value

Peak Storage	
(ac-ft)	***(ft^3)***
22.8	991208.2

As displayed in Table 2 the peak storage requirement in the detention basin is 22.8 ac-ft, or roughly 100,000 ft^3. The storage curve of the detention basin is provided in Figure 13.

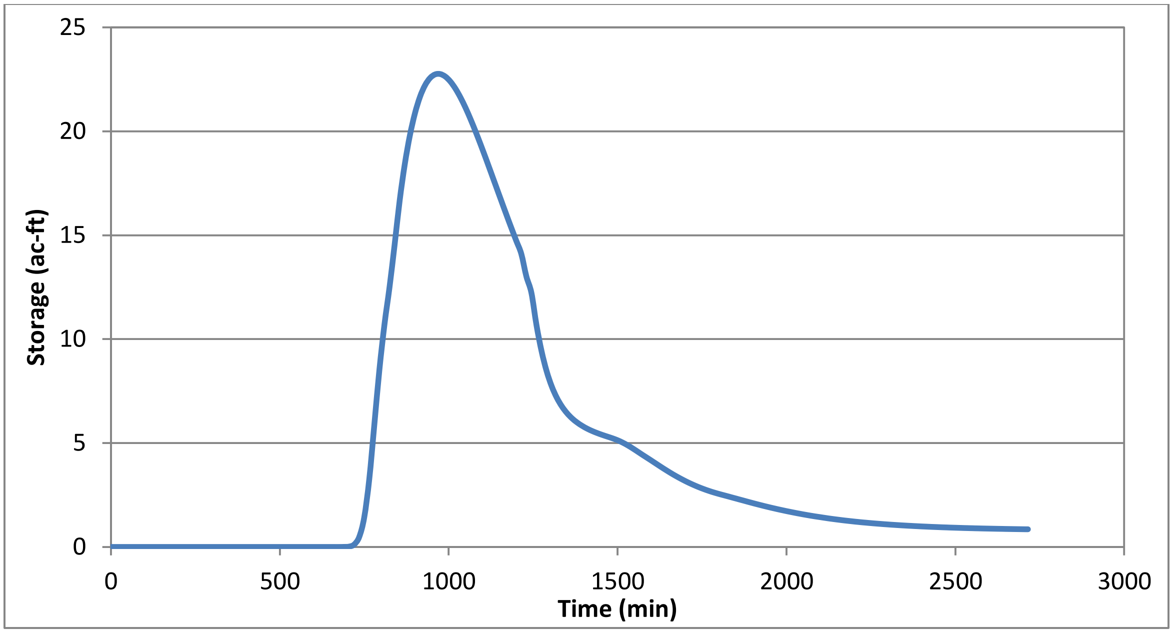

Figure 13. Basin storage curve

Outflow/Drainage Characteristic

The basin outflow structure characteristics are given in Table 3.

Table 3. Outflow structure

Outlet Pipe	
Diameter (ft)	3.75
Height above Base Elev (ft)	0
Manning's n	0.015
Slope (ft/ft)	0.01273
Orifice Coefficient	0.6
Base Elevation (ft)	4935

The basin outflow structure will be a 3.75 ft diameter concrete pipe located at the base of the drainage basin. The peak discharge out of the pipe is given in Table 4. Also, included in Table 4 are the peak discharges of the Pre and Post-Development Hydrographs.

Table 4. Peak discharge of the Routed, Pre, and Post- Development Hydrograph

Routed Peak Flow (cfs)	*Post-Development Peak Flow (cfs)*	*Pre-Development Peak Flow (cfs)*
120	213.6	134

As displayed in Table 4, the routed flow produced by the detention basin accomplishes the design objective. The routed peak flow is lower than the pre-development peak flow. The detention basin will reduce the peak flow by 56%. The hydrographs for all three flow scenarios are displayed in figure 13.

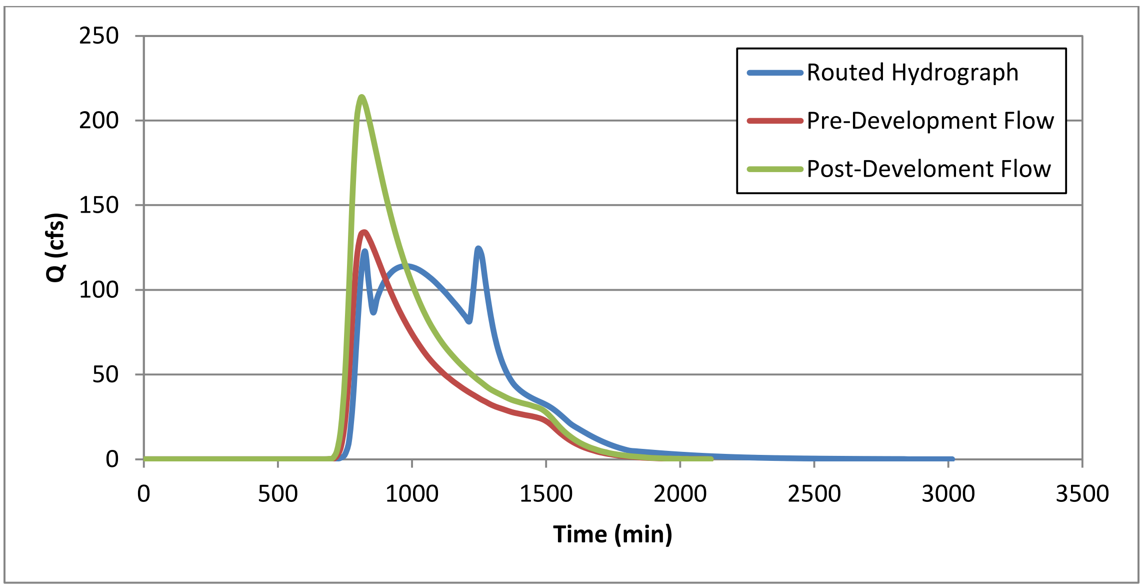

Figure 14. Routed, Pre, and Post-Development Hydrographs

Recommendations

Reason for Recommendation

We recommend the open channel design for Copper Creek because it is the most cost-effective plan to adequately channel the 100-yr flow. Piping the flow would cause a considerable monetary investment to mitigate a 100-yr flow. The channel flow's so infrequently that the pipe design is not worth considering. The no action alternative was not recommended because of the possible flooding that will occur when the area is developed. The watershed near the outlet is very flat and elevation changes are minute. If the watershed is developed and a channel is not put in place the channel will flood the housing development just south of the outlet, causing considerable monetary damages. Another reason that the open channel design was chosen over the pip design was that maintenance cost. An open channel will require very little maintenance, while a pipe that is designed to carry a 100-yr flow may not be used for a considerable amount of time. This lapse in time between construction and use will result in deterioration of the pipe system. For these reasons we recommend an open channel design.

Cost

The two main costs associated with implementing an open channel design for Copper Creek are the detention basin and channel. When considering the cost of the detention basin the cost was calculated as at function of volume using an equation from Costs of Urban Stormwater Control Practices Preliminary Report from the University of Alabama, 2006. Equations are based on 2005 US dollars but have been adjusted for current 2012 US dollars. The anticipated volume for the detention basin is 991,208 ft^3. With this volume the estimated cost of the detention basin is $288,000. This estimate includes excavation, grading, and finishing costs.

The estimated cost for the channel came from reports of similar projects in Utah County. The channel has two main costs. The first is the excavation. The estimated cost to excavate the channel is $56,500.00. The second cost was putting cobble stone down in the base of the channel and lining the outer channel area with grass. This was approximately $72,000.00. The channel would be less expensive than the piped flow by almost 3 times. This design is the most economical of the three alternatives. Table 8 shows the cost of each alternative with the open channel design as most economical.

Table 6. Estimated costs of open channel design.

Open Channel Design Cost				
Description	Number	Units	Unit Price	Total Cost
Site survey	1	None	$4,800.00	$4,800.00
Site preparatio	1	None	$8,000.00	$8,000.00
Excavation	5,133	Cubic Yard	$11.00	$56,466.67
Cobble Stone	8250	Square Feet	$8.00	$66,000.00
Grass	6,600	Square Yard	$1.00	$6,600.00
			Total Cost	$141,866.67

Table 7. Estimated costs of a piped design.

Piped Flow Design Cost				
Description	Number	Units	Unit Price	Total Cost
Site survey	1	None	$4,800.00	$4,800.00
Site preparat	1	None	$8,000.00	$8,000.00
Excavation	5,133	Cubic Yard	$11.00	$56,466.67
Landscaping	6,600	Square Feet	$1.00	$6,600.00
Pipe	3300	Feet	$123.69	$408,173.78
			Total Cost	$484,040.45

Table 8. Estimated costs of each alternative

Method	***Cost***	***Detention Basin***	***Total Cost***
Open Channel Flow	$ 142,000.00	$ 288,000.00	$ 429,000.00
Piped Flow	$ 484,000.00	$ 288,000.00	$ 772,000.00
No Action	$ 0.00	$ 0.00	$ N/A

Appendix

- Runoff Curve Number Report – Predevelopment Condition

- Runoff Curve Number Report – Postdevelopment Condition

- Hydrologic Soil Type Report – Southwest Cannal and Creek Study, Salt Lake County. Published by Bowen Collins and Associates.

- Southwest Community Landuse Plan- Salt Lake County Planning and Development Services, As estimated for the year 2020.

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================================================================================
                          Runoff Curve Number Report
                              (Generated by WMS)
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Thu Mar 29 12:29:06 2012

Runoff Curve Number Report for Basin 16B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
C	Cropland and Pasture	78	0.099	7.699
B	Cropland and Pasture	64	0.404	25.863
B	Mixed Rangeland	79	0.001	0.096
D	Cropland and Pasture	81	0.135	10.973

CN (Weighted) = Total Product \ Total Area
==
69.7906

Runoff Curve Number Report for Basin 17B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
B	Cropland and Pasture	64	0.333	21.326
C	Cropland and Pasture	78	0.014	1.055
D	Cropland and Pasture	81	0.033	2.702

CN (Weighted) = Total Product \ Total Area
==
65.9901

Runoff Curve Number Report for Basin 18B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
B	Cropland and Pasture	64	0.086	5.517
C	Cropland and Pasture	78	0.303	23.647
B	Mixed Forest Land	60	0.008	0.476
B	Sandy Areas and Other Beaches	77	0.007	0.517
D	Sandy Areas and Other Beaches	88	0.000	0.013
C	Sandy Areas and Other Beaches	85	0.000	0.013
B	Mixed Rangeland	79	0.017	1.326

CN (Weighted) = Total Product \ Total Area
==
74.825

Runoff Curve Number Report for Basin 19B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
C	Mixed Forest Land	73	0.311	22.698
D	Mixed Forest Land	79	0.068	5.384
B	Mixed Forest Land	60	0.248	14.859
B	Cropland and Pasture	64	0.150	9.580
B	Residential	72	0.006	0.449
C	Cropland and Pasture	78	0.005	0.356

CN (Weighted) = Total Product \ Total Area
==
67.7395

Runoff Curve Number Report
(Generated by WMS)

Thu Mar 29 12:31:10 2012

Runoff Curve Number Report for Basin 16B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
C	Neighborhood/Planned Res (1/4 ac)	84	0.099	8.291
B	Neighborhood/Planned Res (1/4 ac)	76	0.201	15.281
B	Mixed Rangeland	79	0.001	0.096
B	Cropland and Pasture	64	0.203	12.995
D	Cropland and Pasture	81	0.135	10.973

CN (Weighted) = Total Product \ Total Area
74.4895

Runoff Curve Number Report for Basin 17B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
B	Cropland and Pasture	64	0.064	4.098
B	Neighborhood/Planned Res (1/4 ac)	76	0.269	20.458
C	Neighborhood/Planned Res (1/4 ac)	84	0.014	1.137
D	Cropland and Pasture	81	0.033	2.702

CN (Weighted) = Total Product \ Total Area
74.702

Runoff Curve Number Report for Basin 18B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
B	Neighborhood/Planned Res (1/4 ac)	76	0.013	1.009
C	Neighborhood/Planned Res (1/4 ac)	84	0.206	17.315
B	Cropland and Pasture	64	0.073	4.667
B	Mixed Forest Land	60	0.008	0.476
C	Cropland and Pasture	78	0.097	7.569
B	Sandy Areas and Other Beaches	77	0.007	0.517
D	Sandy Areas and Other Beaches	88	0.000	0.013
C	Sandy Areas and Other Beaches	85	0.000	0.013
B	Mixed Rangeland	79	0.017	1.326

CN (Weighted) = Total Product \ Total Area
78.1402

Runoff Curve Number Report for Basin 19B

HSG	Land Use Description	CN	Area mi^2	Product CN x A
C	Mixed Forest Land	73	0.088	6.441
C	Strip Mines, Quarries, and Gravel PIts	91	0.223	20.265
D	Mixed Forest Land	79	0.042	3.293
D	Strip Mines, Quarries, and Gravel PIts	94	0.026	2.488
B	Mixed Forest Land	60	0.246	14.749
B	Strip Mines, Quarries, and Gravel PIts	86	0.002	0.157
B	Cropland and Pasture	64	0.116	7.438
B	Residential	72	0.006	0.449
B	Neighborhood/Planned Res (1/4 ac)	76	0.033	2.543
C	Neighborhood/Planned Res (1/4 ac)	84	0.005	0.383

CN (Weighted) = Total Product \ Total Area
73.9413

Salt Lake COunty/Southwest Canal & Creek Study/GIS_swcanal/swcanal/Project/swcanal_plan: existing development

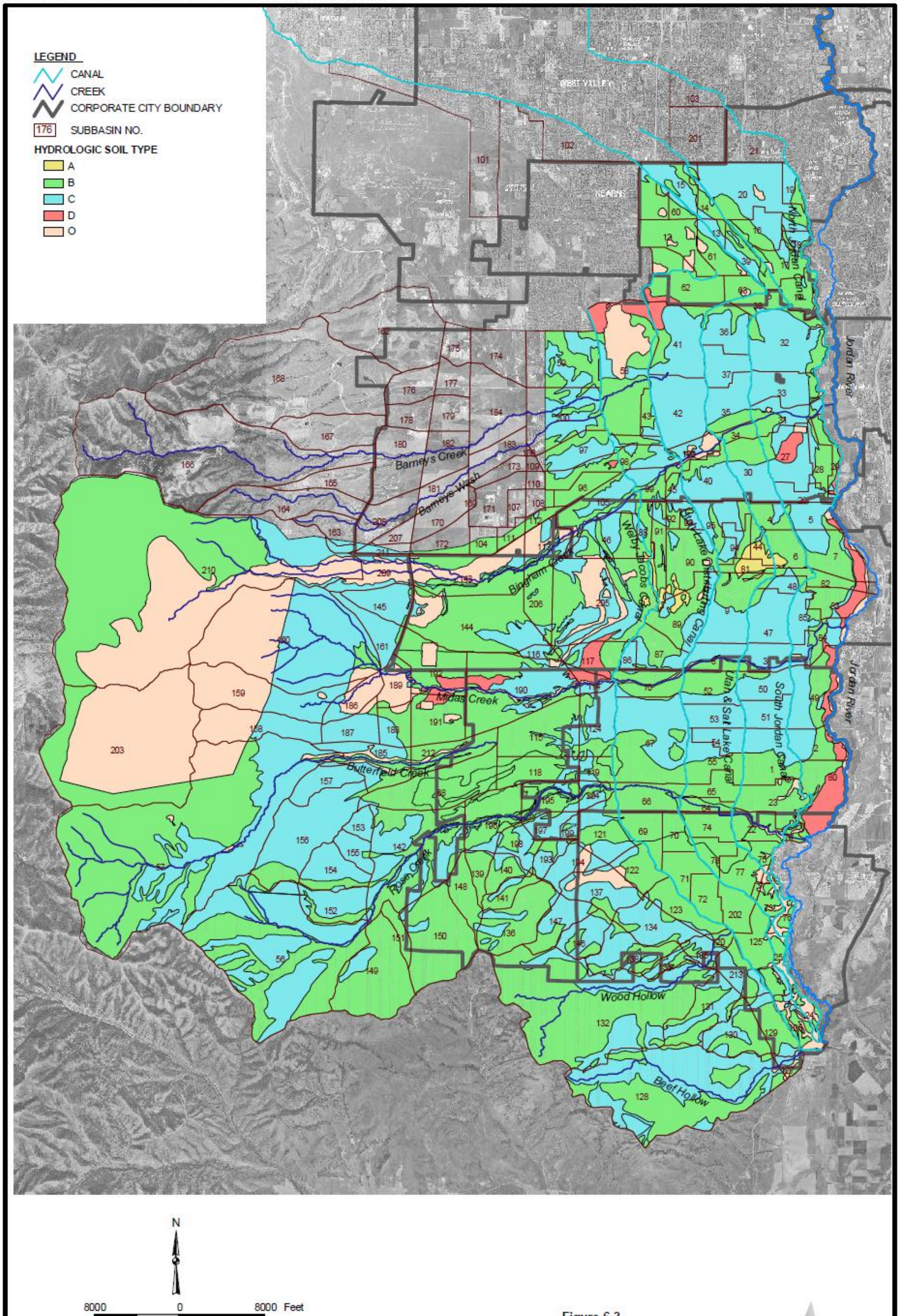
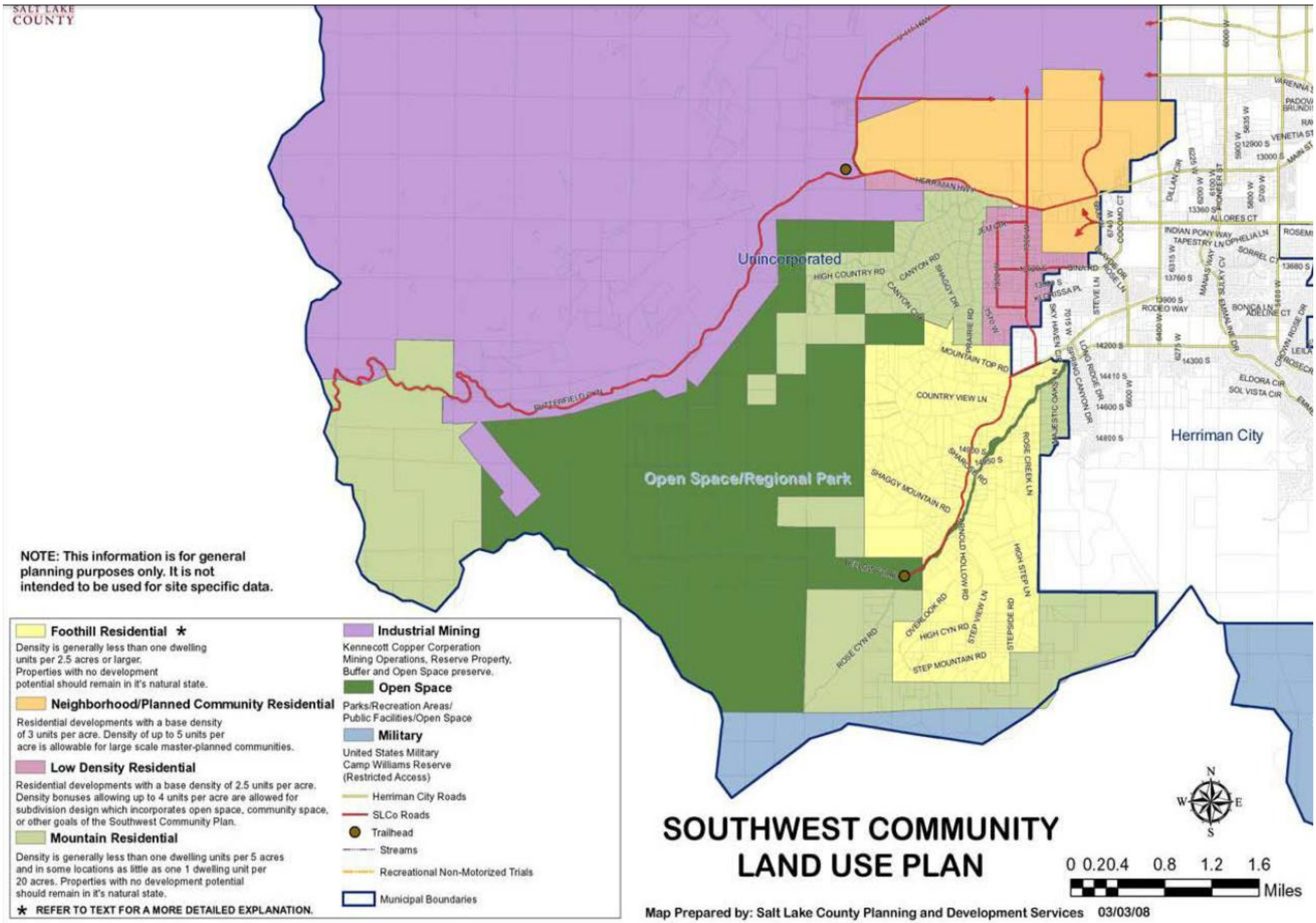


Figure 6-3
HYDROLOGIC SOIL TYPE

SOUTHWEST CANAL AND CREEK STUDY
Salt Lake County

Bowen Collins & Associates, Inc.


SALT LAKE COUNTY
Unincorporated
Open Space/Regional Park
Herriman City
NOTE: This information is for general planning purposes only. It is not intended to be used for site specific data.
Foothill Residential ★
Density is generally less than one dwelling units per 2.5 acres or larger. Properties with no development potential should remain in it's natural state.
Neighborhood/Planned Community Residential
Residential developments with a base density of 3 units per acre. Density of up to 5 units per acre is allowable for large scale master-planned communities.
Low Density Residential
Residential developments with a base density of 2.5 units per acre. Density bonuses allowing up to 4 units per acre are allowed for subdivision design which incorporates open space, community space, or other goals of the Southwest Community Plan.
Mountain Residential
Density is generally less than one dwelling units per 5 acres and in some locations as little as one 1 dwelling unit per 20 acres. Properties with no development potential should remain in it's natural state.
★ REFER TO TEXT FOR A MORE DETAILED EXPLANATION.
Industrial Mining
Kennecott Copper Corporation Mining Operations, Reserve Property, Buffer and Open Space preserve.
Open Space
Parks/Recreation Areas/ Public Facilities/Open Space
Military
United States Military Camp Williams Reserve (Restricted Access)
Herriman City Roads
SLCo Roads
Trailhead
Streams
Recreational Non-Motorized Trials
Municipal Boundaries
SOUTHWEST COMMUNITY LAND USE PLAN
0 0.20.4 0.8 1.2 1.6 Miles
N S E W
Map Prepared by: Salt Lake County Planning and Development Services 03/03/08

NOAA Atlas 14, Volume 1, Version 5
Location name: Herriman, Utah, US*
Coordinates: 40.5179, -112.0738
Elevation: 5291ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.127 (0.111–0.148)	0.161 (0.141–0.187)	0.221 (0.193–0.258)	0.276 (0.238–0.322)	0.363 (0.306–0.427)	0.445 (0.363–0.527)	0.539 (0.428–0.646)	0.651 (0.497–0.794)	0.829 (0.601–1.04)	0.993 (0.688–1.27)
10-min	0.193 (0.168–0.225)	0.245 (0.215–0.285)	0.337 (0.294–0.392)	0.421 (0.362–0.491)	0.554 (0.466–0.650)	0.677 (0.554–0.802)	0.821 (0.651–0.984)	0.990 (0.756–1.21)	1.26 (0.915–1.58)	1.51 (1.05–1.93)
15-min	0.240 (0.209–0.279)	0.304 (0.267–0.353)	0.418 (0.365–0.486)	0.522 (0.449–0.608)	0.686 (0.577–0.806)	0.839 (0.686–0.994)	1.02 (0.807–1.22)	1.23 (0.937–1.50)	1.57 (1.13–1.96)	1.87 (1.30–2.39)
30-min	0.323 (0.281–0.376)	0.409 (0.359–0.476)	0.563 (0.491–0.654)	0.703 (0.605–0.820)	0.924 (0.777–1.09)	1.13 (0.924–1.34)	1.37 (1.09–1.64)	1.65 (1.26–2.02)	2.11 (1.53–2.63)	2.52 (1.75–3.22)
60-min	0.400 (0.348–0.465)	0.507 (0.444–0.589)	0.696 (0.608–0.810)	0.869 (0.748–1.01)	1.14 (0.962–1.34)	1.40 (1.14–1.66)	1.70 (1.35–2.03)	2.05 (1.56–2.50)	2.61 (1.89–3.26)	3.12 (2.16–3.99)
2-hr	0.503 (0.452–0.570)	0.630 (0.565–0.714)	0.822 (0.733–0.933)	1.00 (0.883–1.14)	1.29 (1.11–1.48)	1.56 (1.31–1.80)	1.87 (1.52–2.19)	2.23 (1.75–2.67)	2.83 (2.10–3.47)	3.37 (2.39–4.23)
3-hr	0.584 (0.532–0.652)	0.722 (0.658–0.805)	0.912 (0.826–1.02)	1.09 (0.975–1.21)	1.36 (1.20–1.53)	1.61 (1.39–1.83)	1.91 (1.60–2.20)	2.27 (1.85–2.70)	2.86 (2.22–3.50)	3.39 (2.53–4.27)
6-hr	0.763 (0.706–0.832)	0.937 (0.865–1.02)	1.14 (1.05–1.24)	1.32 (1.21–1.44)	1.59 (1.43–1.75)	1.81 (1.61–2.00)	2.07 (1.81–2.32)	2.39 (2.03–2.71)	2.96 (2.45–3.54)	3.47 (2.79–4.32)
12-hr	0.964 (0.891–1.05)	1.18 (1.09–1.29)	1.42 (1.31–1.56)	1.63 (1.50–1.79)	1.94 (1.76–2.14)	2.19 (1.95–2.43)	2.45 (2.15–2.76)	2.76 (2.38–3.14)	3.24 (2.72–3.77)	3.64 (2.98–4.35)
24-hr	1.15 (1.06–1.25)	1.42 (1.30–1.54)	1.70 (1.56–1.84)	1.93 (1.77–2.09)	2.24 (2.05–2.43)	2.48 (2.26–2.70)	2.73 (2.48–2.96)	2.97 (2.69–3.23)	3.30 (2.96–3.81)	3.68 (3.16–4.39)
2-day	1.33 (1.22–1.45)	1.63 (1.50–1.78)	1.96 (1.80–2.14)	2.23 (2.04–2.43)	2.60 (2.38–2.83)	2.89 (2.63–3.14)	3.18 (2.88–3.47)	3.49 (3.14–3.81)	3.89 (3.47–4.27)	4.19 (3.71–4.62)
3-day	1.44 (1.33–1.57)	1.77 (1.63–1.93)	2.13 (1.96–2.33)	2.44 (2.23–2.66)	2.86 (2.61–3.11)	3.18 (2.90–3.47)	3.52 (3.19–3.85)	3.87 (3.49–4.24)	4.34 (3.88–4.77)	4.71 (4.17–5.20)
4-day	1.55 (1.43–1.70)	1.91 (1.76–2.09)	2.31 (2.12–2.52)	2.64 (2.43–2.88)	3.11 (2.85–3.39)	3.48 (3.17–3.79)	3.86 (3.50–4.22)	4.26 (3.84–4.66)	4.80 (4.28–5.28)	5.23 (4.62–5.78)
7-day	1.83 (1.69–2.01)	2.26 (2.08–2.47)	2.73 (2.51–2.98)	3.11 (2.87–3.39)	3.63 (3.34–3.96)	4.04 (3.70–4.41)	4.46 (4.06–4.88)	4.89 (4.42–5.34)	5.46 (4.90–6.00)	5.90 (5.26–6.50)
10-day	2.09 (1.92–2.26)	2.56 (2.37–2.78)	3.08 (2.84–3.33)	3.49 (3.22–3.78)	4.03 (3.72–4.37)	4.45 (4.09–4.82)	4.87 (4.46–5.28)	5.28 (4.81–5.74)	5.83 (5.27–6.35)	6.24 (5.60–6.81)
20-day	2.74 (2.55–2.96)	3.37 (3.13–3.64)	4.02 (3.73–4.33)	4.52 (4.19–4.86)	5.15 (4.77–5.55)	5.62 (5.20–6.05)	6.08 (5.61–6.55)	6.52 (5.99–7.03)	7.07 (6.46–7.66)	7.47 (6.79–8.12)
30-day	3.29 (3.07–3.52)	4.05 (3.77–4.33)	4.81 (4.48–5.15)	5.41 (5.03–5.78)	6.19 (5.75–6.63)	6.78 (6.27–7.26)	7.35 (6.78–7.89)	7.91 (7.26–8.51)	8.62 (7.87–9.32)	9.15 (8.30–9.91)
45-day	4.13 (3.87–4.41)	5.06 (4.75–5.41)	5.98 (5.61–6.39)	6.70 (6.28–7.15)	7.63 (7.14–8.14)	8.30 (7.75–8.87)	8.96 (8.34–9.58)	9.59 (8.89–10.3)	10.4 (9.57–11.2)	10.9 (10.0–11.8)
60-day	4.92 (4.60–5.26)	6.04 (5.65–6.47)	7.12 (6.67–7.62)	7.96 (7.44–8.51)	9.02 (8.42–9.65)	9.78 (9.11–10.5)	10.5 (9.77–11.3)	11.2 (10.4–12.1)	12.1 (11.1–13.0)	12.7 (11.6–13.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.