CITYWIDE DRAINAGE ANALYSIS
PROJECT ID: CEEN_2018CPST_007

by

Team SHOF
Ryan Smart
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A Capstone Project Final Report

Submitted to

Ted Mickelson
The City of Woodland Hills

Department of Civil and Environmental Engineering
Brigham Young University

April 11, 2019

Executive Summary

PROJECT TITLE: CITYWIDE DRAINAGE ANALYSIS
PROJECT ID: CEEn_2018CPST_007
PROJECT SPONSOR: City of Woodland Hills
TEAM NAME: SHOF

The City of Woodland Hills is a mountainous community with little storm drain infrastructure. The project is to maintain the feel of the community while better understanding the drainage patterns and improvements that would help prevent debris flows in city streets and mitigate flooding potential.

Our team determined the drainage basins and basin flows for the City of Woodland Hills. In addition, we mapped the steam network, drainage basin, and outlet points using ArcGIS Pro. The project was divided into three tasks: data collection, system analysis, and recommendations. Deliverables include an ArcGIS map indicating drainage basins, input and output points, city boundaries, watershed delineation, and the existing drainage capacity. Further, descriptions and conceptual drawings of recommended LID improvements with probable cost estimates and recommendations for culvert and rip rap sizing will be included.

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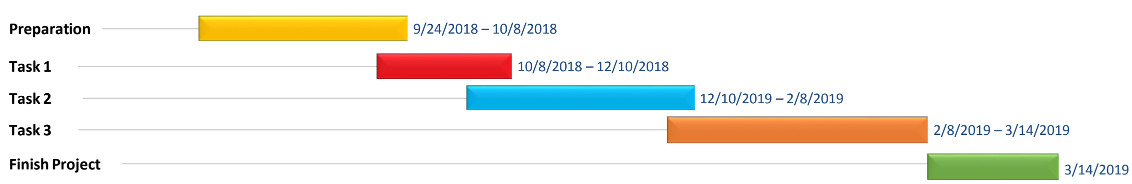
Introduction

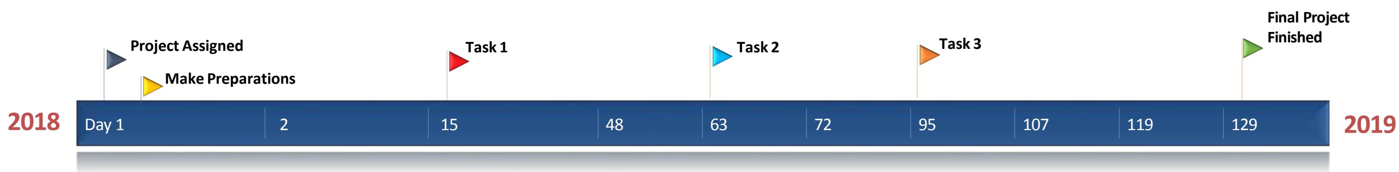
Team SHOF worked in collaboration with Jones & DeMille Engineering and the City of Woodland Hills to assess the existing snow-runoff drainage impacts to the City and suggest drainage improvements and sizing that complement the character of the City. The analysis was completed using a combination of analysis tools for the 10-year storm event return interval.

Dr. Dan Ames from the Department of Civil and Environmental Engineering at Brigham Young University helped provide technical and academic support to the team throughout the course of the project. The project was divided into three tasks: data collection, system analysis, and recommendations. Deliverables include a GIS map indicating drainage basins, input and output points, city boundaries, watershed delineation, and the existing drainage capacity.

The results of the project are included in this report with drainage facilities recommendations that include culvert sizing and a typical drainage channel section. Typical design drawings and probable costs are also provided in the report.

Schedule





- Weekly team meetings on Fridays at 12pm
- Biweekly meetings with Dr. Ames on Fridays at 10am
- Biweekly meetings with Ted Mickelsen

Milestones and Accomplishments

- Site visit with Ted Mickelsen on November 30th, 2018 to visually see the drainage basins that will have the most effect on the city.
- Finalizing the map in ArcGIS Pro.
- Starting Task 2 of determining and analyzing the drainage flows.
- Site visit on March 9, 2019 to get slope measurements of drainage inlet points.
- Final report to the Woodland Hills city council

Assumptions & Limitations

The following limitations and assumptions were made throughout the duration of the project.

Due to limited data collection capabilities and equipment, all watersheds, stream paths, and flow data for this project were acquired from streamstats.usgs.gov. The data was then entered into ArcGIS Pro in order to create the drainage basin map, Figure 2. The team was not practiced in using GIS nor with watershed analysis, and therefore relied on the expertise of Dr. Ames, Dr. Hotchkiss, and Ted Mickelsen in providing relevant data and creating figures pertaining to the project.

In addition, it was determined that three major water sheds impact the city (North, Central, and South); all data and design of culverts and channels were based off of these three watersheds and measured slopes of respective crossings.

When designing the culverts, it was necessary to measure the slope of the existing channels. There were a couple feet of snow on the ground on the day that the measurements were taken which made it difficult to get accurate readings. We did our best to clear out the snow down to the bottom of the existing channels and culverts to get the best reading possible. We believe that our measurements provide relevant results and they have been verified to be within two degrees of the invert channel slope.

The elevations found in the HY-8 files for this design do not reflect actual geographical elevations; they were used simply for determining the slopes of channels and culverts.

Per suggestion of Ted Mickelsen, culvert sizing was designed for the 10-year storm event.

Design, Analysis & Results

Task One: Creating the GIS Map

To delineate the watersheds, we used a variety of methods to identify critical drainage areas and estimate the flow. Initially, five main watersheds were identified with the public software, StreamStats, using five approximated outlet points. These watersheds are shown in Figure 1 outlined as white polygons together with debris flow lines shown in purple.

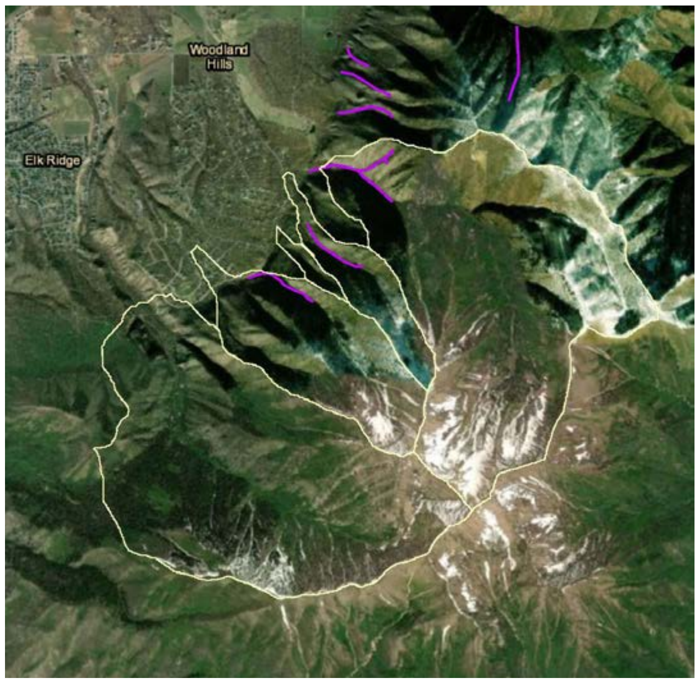


Figure 1: Preliminary Watersheds

With these watersheds as a basemap, we met with Ted Mickelson from Jones and DeMille Engineering in Woodland Hills to become familiar with the feel of the community and identify specific outlet points. The north and south watersheds were deemed irrelevant to the study since their drainage paths enter Maple and Loafer Canyons, respectively. The three, smaller watersheds drain into the City and will be assessed for improvements. They will be referred to as the North, Central, and South Basins. We traveled to Woodland Hills to meet with Ted and determine an outlet point was identified for each basin. These points were identified based on where the flow typically entered the city from the mountains and caused flooding on streets. Figure 2 shows a GIS map with the identified outlet points and relevant watershed basins.

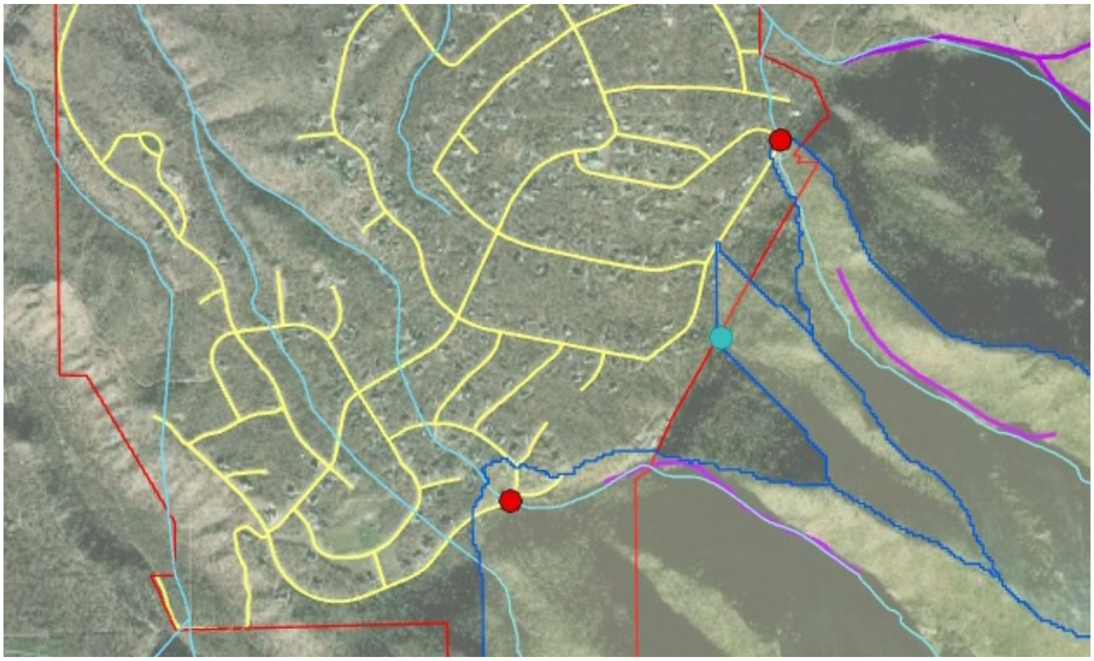


Figure 2: Watershed Basin Outlet Locations

Task Two: Determining Flow Design Parameters

Data was downloaded from StreamStats[1] for each outlet point. The data was used to create monthly flow duration curves for 20, 50 and 80 percent exceedances, average monthly flow curves, and storm event plots. These figures will be presented to Ted and city personnel to determine flow design criteria that mitigates risk of overflow and economy for culverts at critical locations. Figures 3, 4, and 5 show sample curves of the mean monthly flow, storm event flow, and the March flow duration for the South Basin. Spreadsheets containing the complete data have been submitted in conjunction with this report.

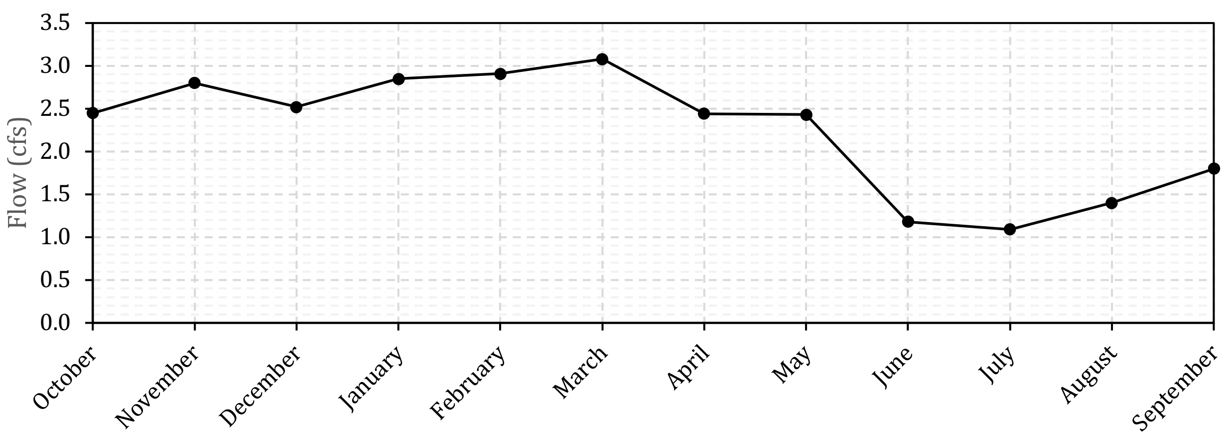


Figure 3: South Basin Mean Monthly Flow (streamstats.usgs.gov)

[1] U.S. Geological Survey, 2016, The StreamStats program, online at http://streamstats.usgs.gov, accessed on December 3, 2018.

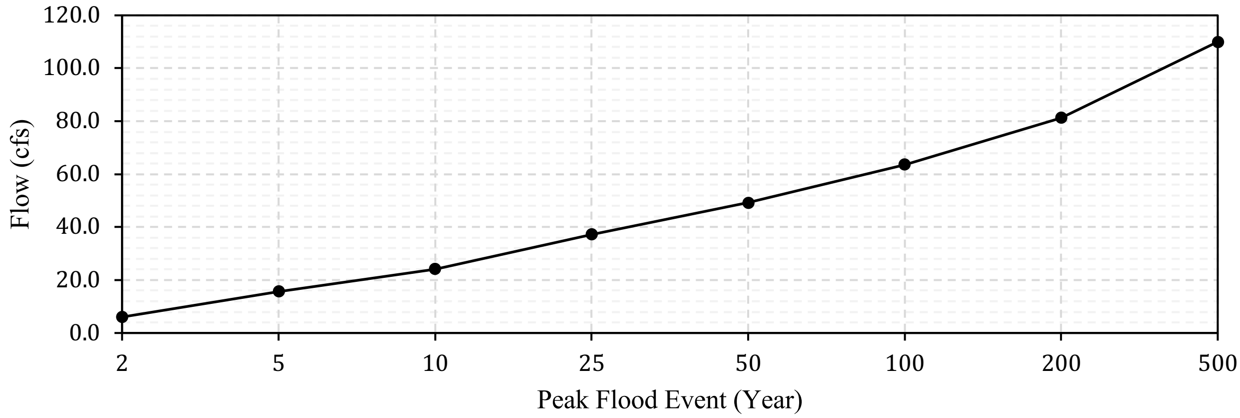


Figure 4: South Basin Storm Event Flow (streamstats.usgs.gov)

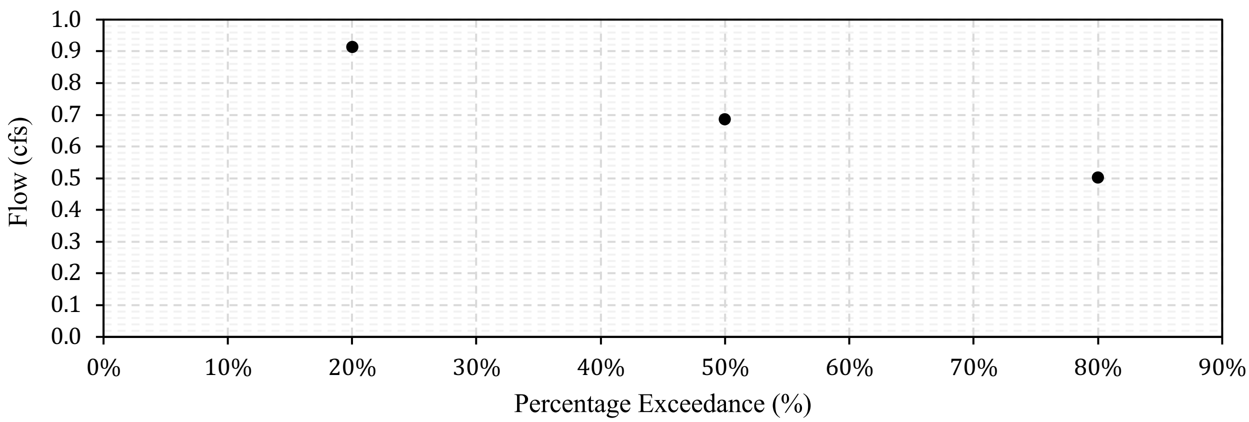


Figure 5: South Basin March Flow Duration Curve (streamstats.usgs.gov)

After consulting with Ted, we decided to use the 10-year storm event flow as the culvert flow design capacity for several reasons. First, the data used to generate the flow duration curves was typically much lower than other reported flows. Designing with these parameters could severely underestimate the actual flows in the future. Additionally, the data from StreamStats only includes percentage exceedance up to 20% whereas 10% would be preferred. Finally, StreamStats reported that several figures did not conform to expected values and could have errors. Figures 6, 7, and 8 present the Peak Flood Events for the North, Central, and South Basins, respectively.

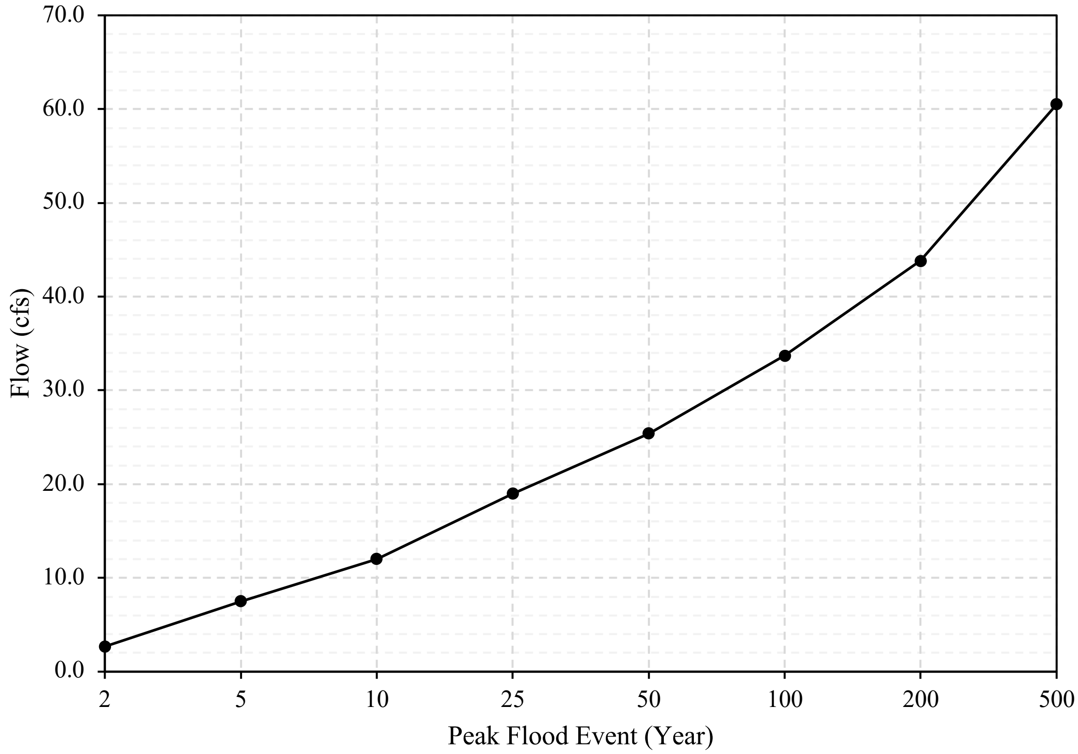


Figure 6: North basin peak flood events.

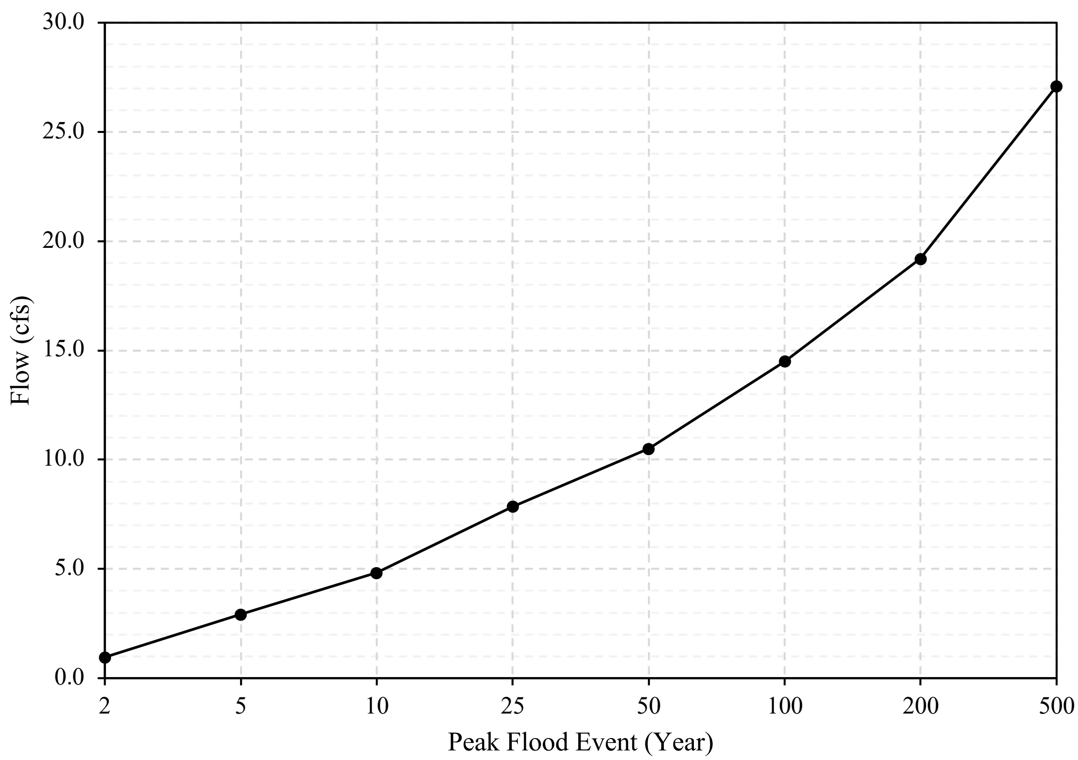


Figure 7: Central basin peak flood events.

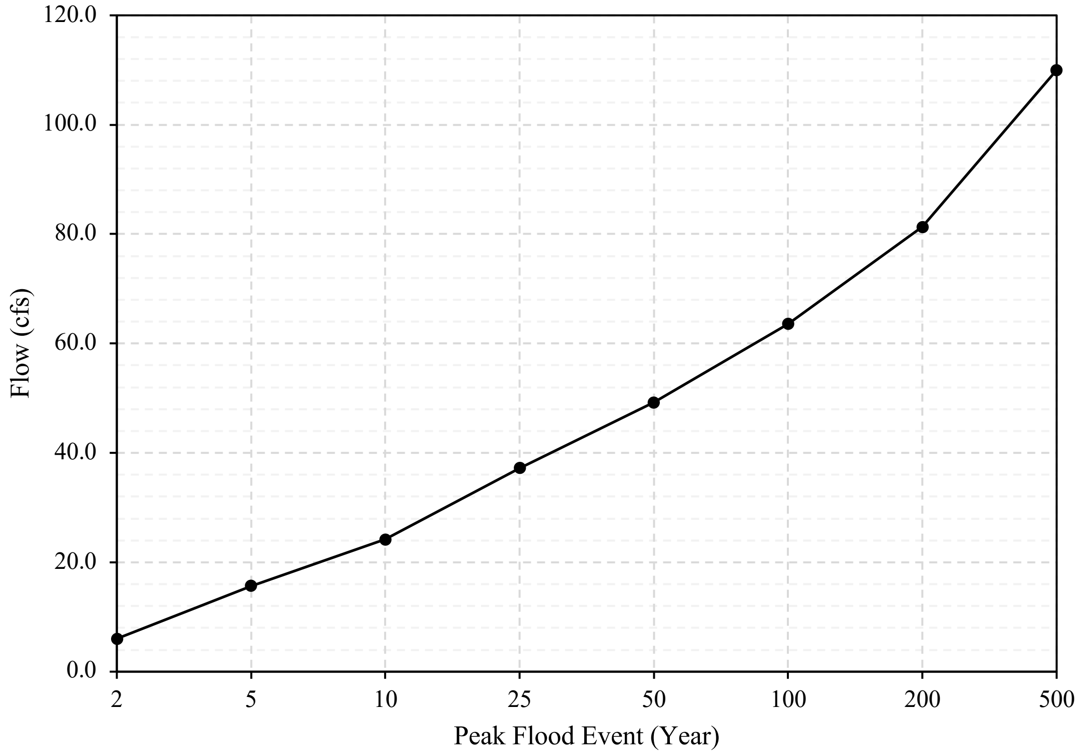


Figure 8: South basin peak flood events.

Since the design flows are going to be used for culverts in the city as well as at the foothills, we calculated the additional flow that would accumulate as the water moved throughout the city. This additional flow was determined for each drainage basin in several steps. First, the surface area of the city was divided into two regions based on the topography and the anticipated flow patterns. Next, the area of each region was estimated and added to the area of the mountain basin that drained into the region. These new drainage areas were used to recalculate the total 10-year storm flow using the following equation provided by StreamStats.

$$PK10 = 18.4 * DRNAREA^{0.55} * (HERBUPLND + 1)^{0.388}$$

The area calculations and design flows for each basin are presented in Table 1.

Table 1: Drainage Basin Areas and Design Flows

Basin	Mountain DRNAREA (sq miles)	City DRNAREA (sq miles)	Total DRNAREA (sq miles)	HRBUPLND	PK10 (cfs)
North	0.4500	0.4600	0.9100	0.0426	**17.747**
Central	0.0895	0.0000	0.0895	0.0000	**4.8200**
South	1.2500	0.5600	1.8100	0.4700	**29.699**

Task 3: Channel and Culvert Design and Recommendations

Once the design flows were determined for each basin, we entered Task 3, designing channels and culverts. After consulting with Jones and DeMille and BYU faculty, we decided to use the software programs Hydraulic Toolbox and HY-8 for channel and culvert designs, respectively. Both programs required longitudinal slope measurements for channel design and tailwater flow calculations. To determine the slopes, we explored various options including LiDAR scans, digital topology maps, and field measurements. Ultimately it was decided to go out and measure slopes using a digital level borrowed from the Department of Civil Engineering. Slopes were measured at three locations corresponding to areas that are prone to road over-topping: the transition from Skylake Drive to E Highline Drive (North Basin); the transition from Broad Hollow Drive and Skylake Drive (Central Basin); and the intersection of Grizzly Road with E Loafer Drive (South Basin).

Figure 9: Measuring longitudinal slopes for channel design inputs.

Once we had gathered slope measurements for each location, we began to design channels for the inlets and outlets of the culverts. After consulting Open-Channel Hydraulics by Ven Te Chow, we chose a Manning's n value of 0.035 corresponding to "stony bottom and weedy banks". We started by designing trapezoidal channels with a side slope of 2:1. However, to handle the design flows in the South Basin, the top widths were coming out to be approximately 6-8 feet. After discussing other options to conserve space, we analyzed triangular channels with a side slope of 2:1 per UDOT Drainage Manual of Instruction 5.4 Channel Stabilization. These channels were narrower, with top widths presented below in Table 2 Channel Designs. All channels were analyzed for Class 1 Riprap (D_{50} of 6 inches) and a minimum freeboard of 6 inches.

Table 2: Channel Designs

Field Location	10-year Peak Flow (cfs)	Channel Shape	Riprap D_{50}	Top Width (ft)	Depth of Flow (ft)	Cross-sectional Average Velocity (ft/s)
N Skylake Loop (North)	17.7	Triangular (2:1)	Class I	5.34	0.585	7.274
Broad Hollow (Central)	4.82	Triangular (2:1)	Class I	2.74	0.686	5.126
Grizzly (South)	29.7	Triangular (2:1)	Class I	6.53	1.632	5.572

Once we designed channels, we consulted with Dr. Hotchkiss and began to analyze culvert design alternatives using HY-8. Alternatives using corrugated aluminum pipe (Corr. Al), corrugated polyethylene pipe (Corr. PE), and concrete pipe were compared according to flow capacity and relative material costs. While concrete box culverts were also assessed in the initial analysis, typical cost estimations for concrete box culverts begin at spans of 6 feet, which are much larger than those sized for these culverts. Since smaller sizes are not as common nor as cost effective, we decided to compare concrete pipe instead. Table 3 presents the culvert alternatives and their respective overtop flow capacity.

Table 3: Culvert Design Alternatives

Field Location	10-year Peak Flow (cfs)	Tailwater Channel Slope	Culvert Type	Culvert Size (in)	Inlet Configuration	Overtop Flow (cfs)
N Skylake Loop (North)	17.7	0.0890	Corr. PE	24	Square Edge w/ Headwall	**22.38**
		(max 0.110)	Corr. Al	24	Square Edge w/ Headwall	**22.38**
			Concrete Pipe	24	Square Edge w/ Headwall	**22.20**
Broad Hollow (Central)	4.82	0.0705	Corr. PE	18	Square Edge w/ Headwall	**8.34**
			Corr. Al	18	Square Edge w/ Headwall	**8.33**
Grizzly (South)	29.7	0.0262	Corr. PE	30	Square Edge w/ Headwall	**31.6**
			Corr. Al	30	Square Edge w/ Headwall	**30.92**
			Concrete Pipe	30	Square Edge w/ Headwall	**31.40**

Tables 4, 5, and 6 show probable costs for the North, Central, and South Basins, respectively, according to the 2019 BNi Construction Costbook provided by Jones and DeMille and Advanced Drainage System 2019 product inventory for corrugated high-density polyethylene pipe. These estimates are to provide a comparison between culvert material alternatives and do not represent the actual costs of construction.

Table 4: North Basin Probable Costs

Category	Item	Size	Price Estimate	Unit	Quantity	Probable Total Cost
Channel Site Prep	Channel and Ditch Excavation	-	$ 9.80	cubic yard	-	-
		-	$ 0.64	linear foot	40ft	$ 25.41
Channel Riprap	Riprap (Class I)	6in	$ 346.85	cubic yard	-	-
		-	$ 22.48	linear foot	40ft	$ 899.24
Culvert Site Prep	Excavating, Backfilling, Compaction	-	$ 6.90	cubic yard	-	-
		-	$ 0.45	linear foot	40ft	$ 17.89
Culvert Material	Corrugated Polyethylene	24in	$ 25.43	linear foot	18ft	$ 457.74
	Corrugated Aluminum	24in	$ 64.00	linear foot	18ft	$ 1,152.00
	Concrete Pipe (Class V)	24in	$ 68.50	linear foot	18ft	$ 1,233.00

Table 5: Central Basin Probable Costs

Category	Item	Size	Price Estimate	Unit	Quantity	Probable Total Cost
Channel Site Prep	Channel and Ditch Excavation	-	$ 9.80	cubic yard	-	-
		-	$ 0.36	linear foot	40ft	$ 14.52
Channel Riprap	Riprap (Class I)	6in	$ 346.85	cubic yard	-	-
		-	$ 12.85	linear foot	40ft	$ 513.85
Culvert Site Prep	Excavating, Backfilling, Compaction	-	$ 6.90	cubic yard	-	-
		-	$ 0.26	linear foot	40ft	$ 10.22
Culvert Material	Corrugated Polyethylene	18in	$ 16.34	linear foot	24ft	$ 392.16
	Corrugated Aluminum	18in	$ 44.00	linear foot	24ft	$ 1,056.00

Table 6: South Basin Probable Costs

Category	Item	Size	Price Estimate	Unit	Quantity	Probable Total Cost
Channel Site Prep	Channel and Ditch Excavation	-	$ 9.80	cubic yard	-	-
		-	$ 1.00	linear foot	40ft	$ 39.93
Channel Riprap	Riprap (Class I)	6in	$ 346.85	cubic yard	-	-
		-	$ 35.33	linear foot	40ft	$ 1,413.09
Culvert Site Prep	Excavating, Backfilling, Compaction	-	$ 6.90	cubic yard	-	-
		-	$ 0.70	linear foot	40ft	$ 28.11
Culvert Material	Corrugated Polyethylene	30in	$ 41.56	linear foot	40ft	$ 1,662.40
	Corrugated Aluminum	30in	$ 86.00	linear foot	40ft	$ 3,440.00
	Concrete Pipe (Class V)	30in	$ 94.00	linear foot	40ft	$ 3,760.00

In all sizes, polyethylene pipe is the least expensive design alternative. In selecting a culvert material, we recommend that the City also consider debris mitigation. While the design alternatives presented utilize an inlet configuration of square edge with headwall, concrete culverts can also be constructed with wingwalls and multiple barrels. Especially in the case of Grizzly Road where debris has been a problem in the past, it may be more sustainable to explore the option of a concrete culvert with wingwalls and debris mitigation. In addition, there is the potential to divide the flow at Grizzly Road by installing two road-crossing culverts: one beneath Grizzly Road and another beneath Loafer Drive. Depending on excavation and labor costs, it may be more economical to install two smaller culverts.

Lessons Learned

At the initial stages of the project, the greatest challenge was defining the scope and process of the project. Our team has only taken the introductory GIS course and two members of our team have taken Hydraulics, so at first it was difficult to understand what the deliverables would be. As we met with the client, developed the Statement of Work, and met with Dr. Ames, we became familiar with the expectations of the project and the scope that would be presented. A valuable lesson has been to develop regular communication with the client and mentor to have a united understanding of expectations and status. This communication has considerably supplemented our inexperience in the area and by so doing we have learned how to use ArcGIS Pro, watershed delineation, and flow determination.

Determining the appropriate GIS software to use was another challenge. Initially, we tried to use ArcGIS 10.6 downloaded to our personal computers through the licensure provided by the University. However, the software was slow and made sharing data difficult even when saved on the shared J-drive. We have since transitioned to using ArcGIS Pro through the Citrix network and saving files on dropbox, so they are easily accessible to each team member. In addition to GIS software challenges, we had to learn to use StreamStats software in delineating watersheds and identifying flow quantities. While we initially used Hydroshare to delineate the watersheds, StreamStats provided flow data associated with the basins for analysis. As we have collected data from StreamStats, it became apparent that some of the data (in particular the flow duration) is unreliable and should not be used for culvert design.

Other hydraulic modeling software was also needed in addition to ArcGIS Pro, StreamStats, and Hydroshare. These programs were HY-8 and Hydraulic Toolbox, which helped with the design process of the riprap channels and culverts. We were appreciative to have the expertise of Dr. Hotchkiss who knows how to size culverts and knew how to run HY-8. Our team was unfamiliar with this program, so it was convenient to have someone who was willing to show us the basics of the program. Budgeting our time during the transition points from one task to another was another lesson we learned.

In summary, during the duration of the two semesters working on the project we have learned many great lessons and takeaways. We learned that communication is key in updating the client about the project or seeking advice and help from the mentor. Also, asking questions to be able to understand the scope and process of the project. There were many programs that were needed to in successfully completing the project. Another lesson, we learned was to budget our time wisely especially when we were not sure what steps to take moving forward.

Conclusions

It has been determined that three main watersheds (North, Central, and South) enter the city from the mountain; those watersheds merge into two as they move through the city. We located three critical crossings where water draining from the mountain will heavily impact the city. These crossings are denoted N Skylake, S Skylake, and Grizzly. In order to best keep drainage off the streets during the 10-year storm event, we designed channels and culverts for the three critical crossings.

From the StreamStats data, we found the North basin has a 10-year flow of 17.7 cfs. Per the slope of N Skylake Road and flow for this region, we designed the culvert to be 24 inches diameter. This will allow for adequate drainage capacity. Similarly, we designed the culvert under the S Skylake and Grizzly crossings to be 18 and 30 inch diameters, respectively.

The existing culverts in these locations are severely undersized. As stated in the Recommendations section of this report, we propose Woodland Hills to implement upgrades to these locations, so as to prepare for future drainage from rainfall and snow-pack.

When determining upgrade options, we looked at the material type (polyethylene, aluminum, concrete), size of culverts, and cost of material. While each different material required similar culverts sizes, we found that polyethylene pipe is the least expensive option; it was less than half the cost of other materials.

Recommendations

Our recommendation for Woodland Hills is polyethylene corrugated pipe culverts with Class I rip rap. This option is the least expensive option for the various culvert sizes. The map in Appendix B is separated into three regions. Each region has an associated culvert and channel design according to the 10-year storm event flow that was measured. Based on the unit price estimates in Tables 5 and 6, the Corrugated PE pipe culvert is the most economical option. Details for the channel sizing are included with descriptions and conceptual drawings of the recommended Low Impact Development (LID) improvements in Appendix B. It is recommended to use Class I LID rip rap that is similar to what is currently being used in the newer developments. Figures 10, 11, 12, and 13 are examples of existing LID rip rap that we based our design on.

Figure 10: Existing riprap entered a mitered culvert.

Figure 11: Existing riprap channel.

Figure 12: Example of a recommended channel and headwall culvert.

Figure 13: Example of a recommended triangular channel lined with riprap.

We recommend that wingwalls and or debris mitigation, such as grates, are installed at the outlet points indicated on the GIS map. These points show the locations where runoff from the mountain region carry heavy volume of debris into the city. Wingwalls help prevent bank erosion, and can also help slow down the flow as it enters the city. Grates will help to keep the culverts free of debris. For all culverts we recommend using a mitered or square edge with headwall inlet configuration.

Due to the higher flow in the South Basin, we recommend the possibility of constructing two channels (one on either side of the road). This will divide the flow and decrease volumes and the chance of erosion.

Lastly, we recommend the City begin developing a mitigation plan to accommodate the 25- and 50-year storm events. This report is based on the 10-year storm event which will handle more typical flows, but will overtop under heavier flows.

Appendix A

Nicole Hastings

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Education

April 2019
Provo, Utah

B.S. Civil and Environmental Engineering *Brigham Young University*
Relevant courses:
Hydraulic Engineering, Foundation Engineering, Reinforced Concrete Design, Structural Analysis, Fluid Mechanics, Concrete and Steel Properties

Experience

June 2018 - Present
Provo, Utah

Research Assistant
Brigham Young University – C-UAS ROAM Lab
- Learning to pilot unmanned aerial vehicles (UAV's) to further research
- Creating 3D models of buildings and areas using Agisoft PhotoScan and Bentley ContextCapture from pictures and videos taken by UAV's
- Traveled to Italy in June 2018 to survey and fly UAV's over landslides and city ruins caused by the earthquakes in 2016

Feb 2018 - June 2018
Provo, Utah

Civil Engineering Intern
Brigham Young University – Physical Facilities
- Surveyed storm drains and manholes for storm drain inventory and analysis project
- Created topographic surfaces for project planning
- Updated master utility and site plans to maintain validity

May 2016 - Feb 2018
Provo, Utah

Computer Technician
Brigham Young University – Physical Facilities
- Assisted with 7+ service calls a day for network and hardware problems
- Communicated with coworkers and clients about computer issues daily
- Kept printers operational by exchanging toner or parts

Skills

Computer
- Working proficiency in Bentley ContextCapture and Agisoft PhotoScan
- Working proficiency in Microsoft Word and Excel
- Working proficiency in AutoCAD Civil 3D
- Basic proficiency in Revit and ArcGIS
- Basic knowledge of C++, Python and VBA
- Working proficiency in Troubleshooting

General
- Organizational skills
- Learn new programs quickly
- Moderate proficiency in modern surveying
- Passed Utah FE Exam in March 2018
- Licensed Amateur Ham Radio Operator

Ryan A. Smart

1209 E 1040 N Orem, UT 84097 | 801-319-9297 | ryan.smart22@gmail.com | www.linkedin.com/in/rasmart/

Career Objective

A Civil Engineering student at Brigham Young University interested in Structural Engineering. I like to solve problems and enjoy the sense of accomplishment in building, translating plans into reality, and creating new things.

Education

B.S., CIVIL AND ENVIRONMENTAL ENGINEERING | BRIGHAM YOUNG UNIVERSITY | DEC. 2019

- Member of ASCE
- Complete classes in Mechanics of Materials, Reinforced Concrete, Hydraulics, Statics and Dynamics, Revit and AutoCAD, etc.
- Capstone project of citywide drain analysis and design for the city of Woodland Hills in Utah

Skills & Abilities

- Revit and AutoCAD skills
- Construction Experience
- Woodworking skills
- Graphic Design and Wiki Pages

Experience

STUDENT ASSISTANT | LDS PHILANTHROPIES | MAY 2016-PRESENT

- Support the Executive Assistant to the Managing Director of LDS Philanthropies by completing various tasks on MS Word, Excel, and PowerPoint

LABORER - CARPENTRY | ARTISAN BUILDERS & CONSTRUCTORS | SEPT. 2015 – MAY 2016

- Constructed various remodels and basement finishing in Utah county
- Learned various finish carpentry skills

LABORER | CHRISTENSEN BROS. CONSTRUCTION | JUNE 2015 – SEPT. 2015

- Prepared and installed a radiant heating system for a driveway remodel
- Assisted the project lead in constructing paver driveway

INSULATION INSTALLER | SUNROC BUILDING MATERIALS | NOV. 2014 – MAY 2015

- Installed insulation in Utah and Salt Lake counties
- Learned the process installing insulation at different job sites

VOLUNTEER SERVICE| CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS | JUNE 2012 – MAY 2014

- Volunteered in the Philippines and learned to speak Tagalog
- Led other volunteers in creating goals and becoming more effective in their volunteer service

References available upon request

HANNA OPDAHL

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EDUCATION

- **B.S. Civil Engineering, Brigham Young University; Provo, UT** — **April 2019**
  -Cumulative GPA 3.93/4.00
- **Materials Engineering Research, University of Cambridge; Cambridge, UK** — **July 2018**
- **Tau Beta Pi; Engineering Honors Society**

WORK

TA/Lab Director, Civil Engineering Department, BYU; Provo, UT — **Jan 2018-Current**

- Tutor a junior level course covering properties of engineering materials
- Lead weekly lab of 10 students testing metals, wood, concrete and asphalt

Engineering Intern, Lower Columbia Engineering; St Helens, OR — **2014-Current**

- Research and compile a Water System Master Plan for a population of 2,200
- Technical calculations for lateral and vertical engineering
- Civil site development and field surveying using Total Station and RTK equipment
- Reference: Andrew Niemi (503) 366-0399

MEP Drafter, Electrical Engineering Department, BYU; Provo UT — **Oct 2016-April 2017**

- AutoDesk software (Visual, REVIT and AutoCAD)
- Prepare cost estimates for commercial projects of value up to $500,000
- Develop software program for team communication and project status

VOLUNTEER

Global Engineering Outreach, BYU & Navajo Nations; Bluff, UT — **March 2018**

- Construct a community center from rammed earth methods

ASCE Member, BYU Student Chapter; Provo, UT — **Sept 2013-Current**

- Residential building projects with Habitat for Humanity
- Provide engineering activities for children through Provo Community Action

Full-time Representative, ASPERSUD; Trujillo, Peru — **Feb 2015-Aug 2016**

- Provide 12-week training to new volunteers
- Record and follow-up with the individual progress of 15+ clients
- Develop strategies, manuals, and goals for 150 volunteers

QUALIFICATIONS

- Fluent in Spanish
- Structural Analysis using SAP2000
- Computer Programing with VBA
- HAM radio certified

Daniel Fiso

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EDUCATION

Aug ‘16 – Dec ‘19
Provo, UT

BRIGHAM YOUNG UNIVERSITY
Bachelor of Science, Civil Engineering
Minor, Mandarin Chinese

- Related Courses: Structural Steel Design, Reinforced Concrete Design, Structural Analysis, Aircraft Structures, Revit, AutoCAD, Statics, Material Science, Fluid Mechanics, Soil Mechanics, Transportation Engineering
- Capstone Project: Woodland Hills Snow-runoff Drainage Study
- Extra-Curricular: ASCE member
- Passed FE Exam

EXPERIENCE

Jan ‘19 – Present
Provo, UT

BRIGHAM YOUNG UNIVERSITY
Soil Mechanics Lab TA

- Taught and supervised students on the use of testing equipment during laboratory exercises
- Tutored students on class assignments to assist their understanding of the material
- Reviewed and graded technical reports while meeting grade deadlines

May ‘18 – Aug ‘18
Pleasant Grove, UT

HORROCKS ENGINEERS
Structural Engineering Intern

- Analyzed details meticulously when checking shop drawings for compliance to structural drawings
- Designed retaining wall using Enercalc
- Calculated cost estimates for multiple projects
- Drafted various details in response to RFIs using AutoCAD and Revit

Aug ‘15 – Sept ‘17
Provo, UT

NU SKIN ENTERPRISES
Mandarin Distributor Support Representative

- Maintained excellent customer service ratings over the phone in Mandarin
- Solved problems for 25+ customers daily
- Consulted customers on how to maximize income
- Composed detailed and organized notes regarding interactions with customers

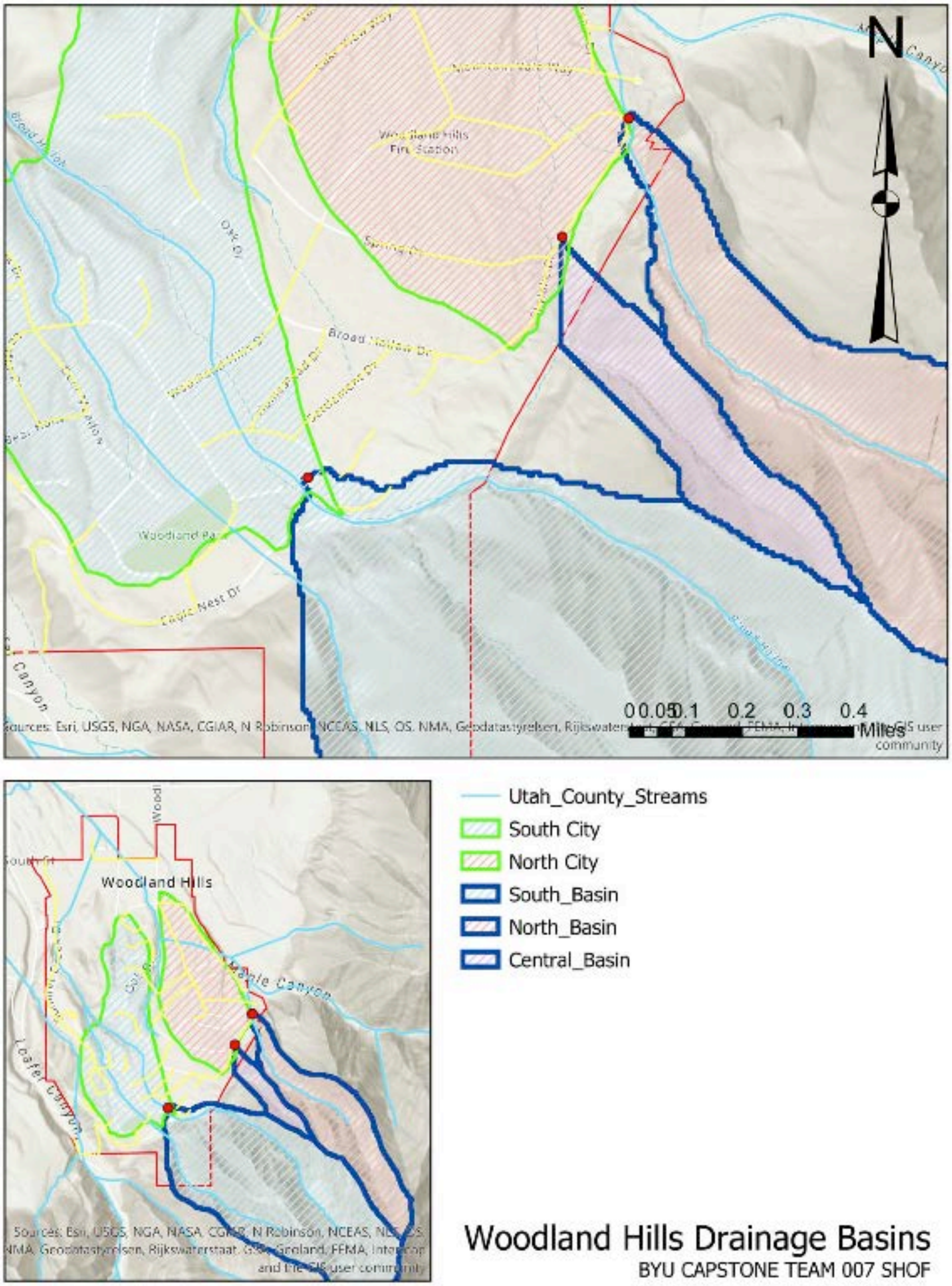
SERVICE

- 2-year Religious Mission in Taiwan
    - Established standards as a leader of 40+ missionaries
    - Professionally speak, read, and write Mandarin Chinese
- Eagle Scout Project
    - Organized clothing drive for families in need

SKILLS

- Working proficiency in AutoCAD and Revit
- Reliable, independent worker

Appendix B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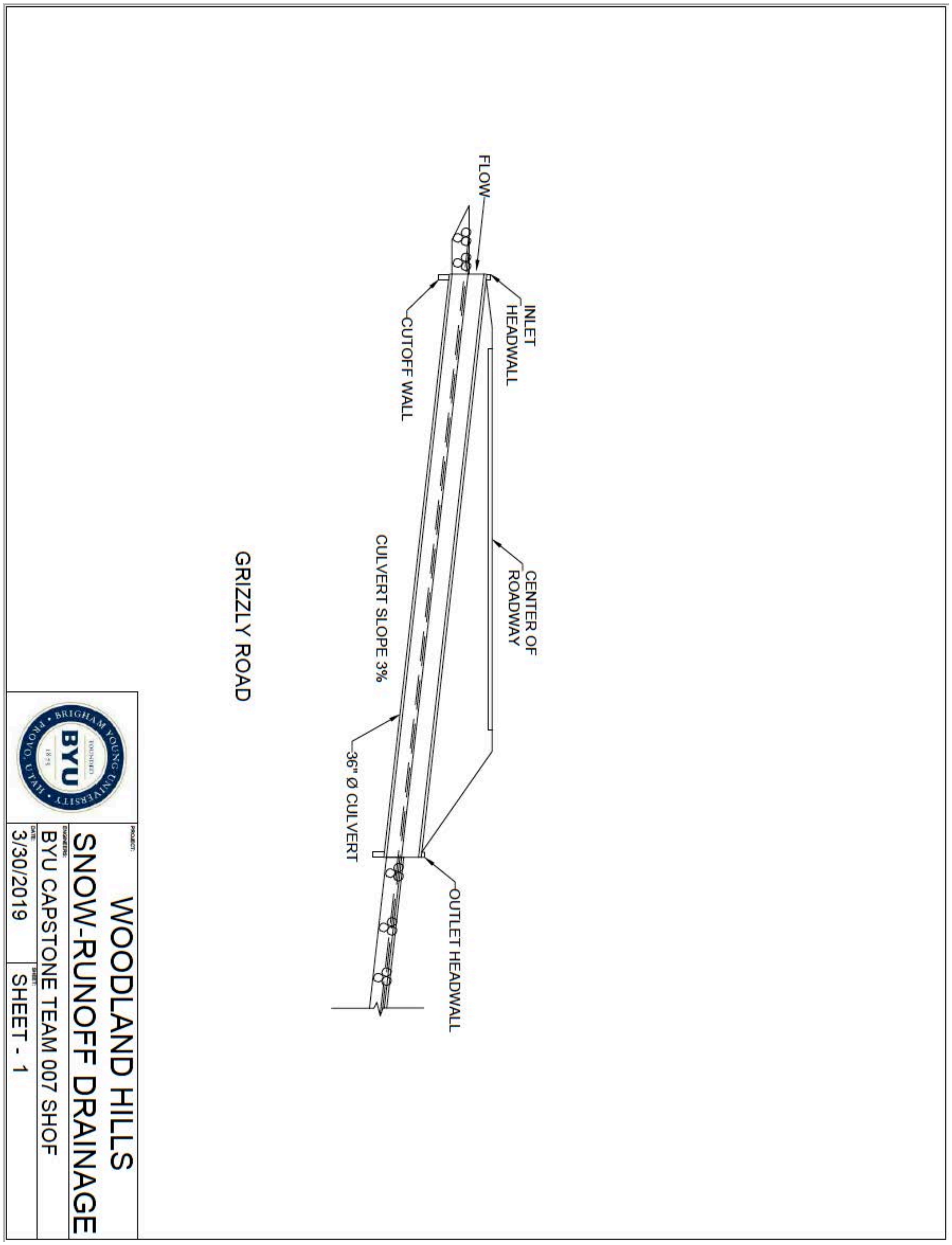
Eagle Nest Dr
Woodland Park
Woodland Hills
0 0.05 0.1 0.2 0.3 0.4
Miles
Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community
Utah_County_Streams
South City
North City
South_Basin
North_Basin
Central_Basin
Woodland Hills Drainage Basins
BYU CAPSTONE TEAM 007 SHOF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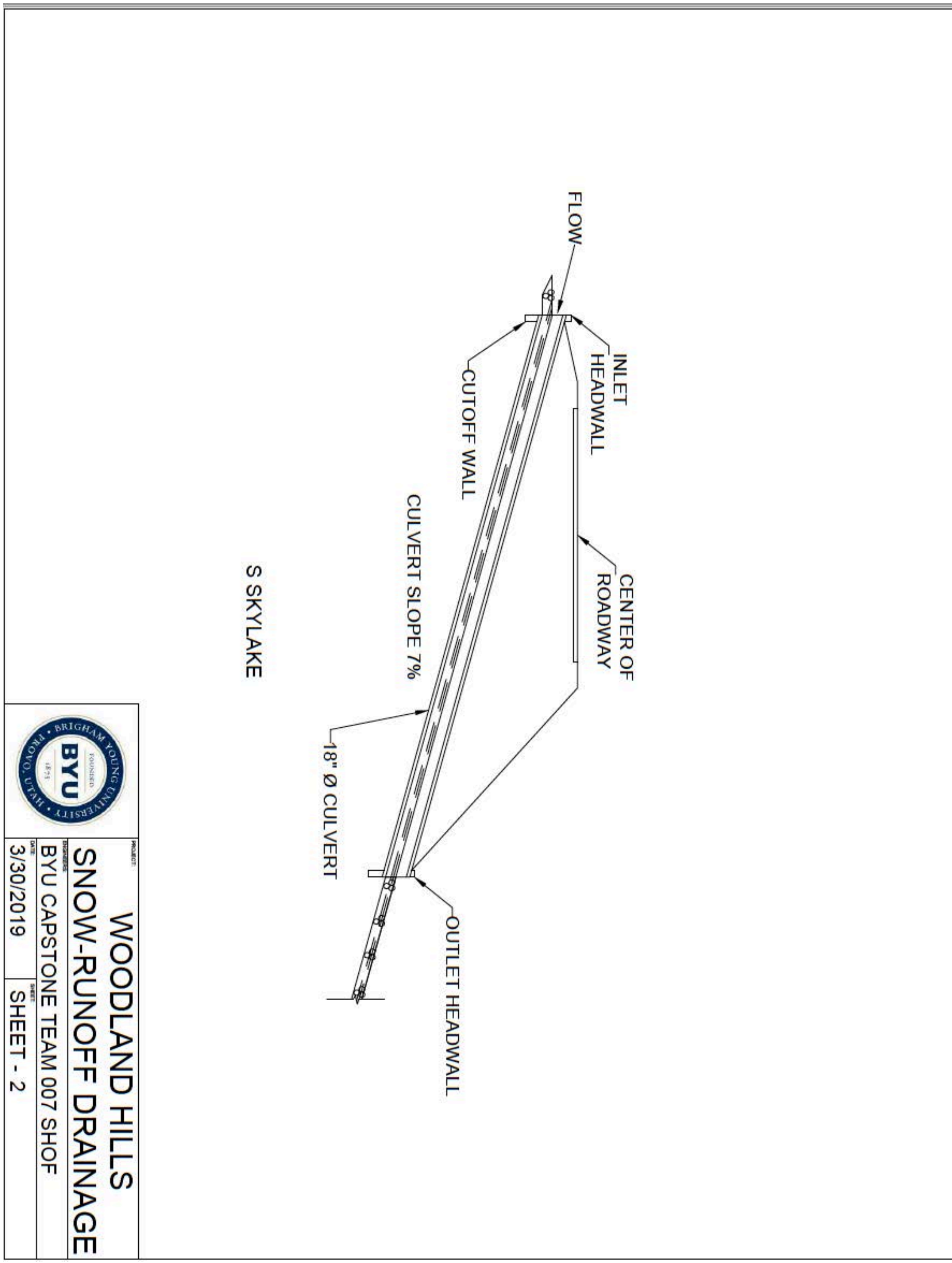
INLET HEADWALL
CUTOFF WALL
CENTER OF ROADWAY
CULVERT SLOPE 3%
GRIZZLY ROAD
36" Ø CULVERT
OUTLET HEADWALL
PROJECT:
WOODLAND HILLS
SNOW-RUNOFF DRAINAGE
ENGINEERS:
BYU CAPSTONE TEAM 007 SHOF
DATE:
3/30/2019
SHEET:
SHEET - 1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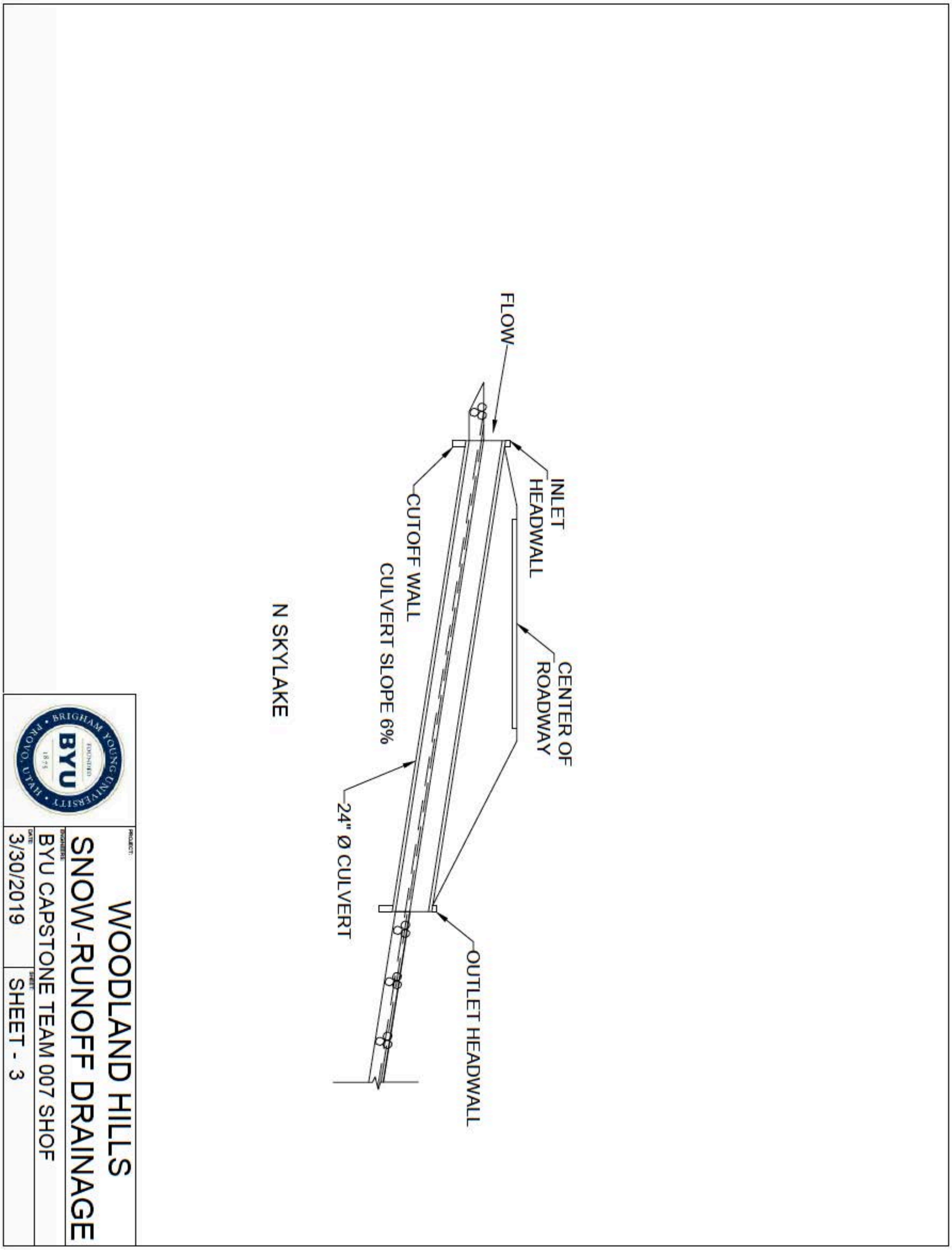
CUTOFF WALL
CENTER OF ROADWAY
CULVERT SLOPE 7%
S SKYLAKE
18" Ø CULVERT
OUTLET HEADWALL
PROJECT:
WOODLAND HILLS
SNOW-RUNOFF DRAINAGE
ENGINEERS:
BYU CAPSTONE TEAM 007 SHOF
DATE:
3/30/2019
SHEET:
SHEET - 2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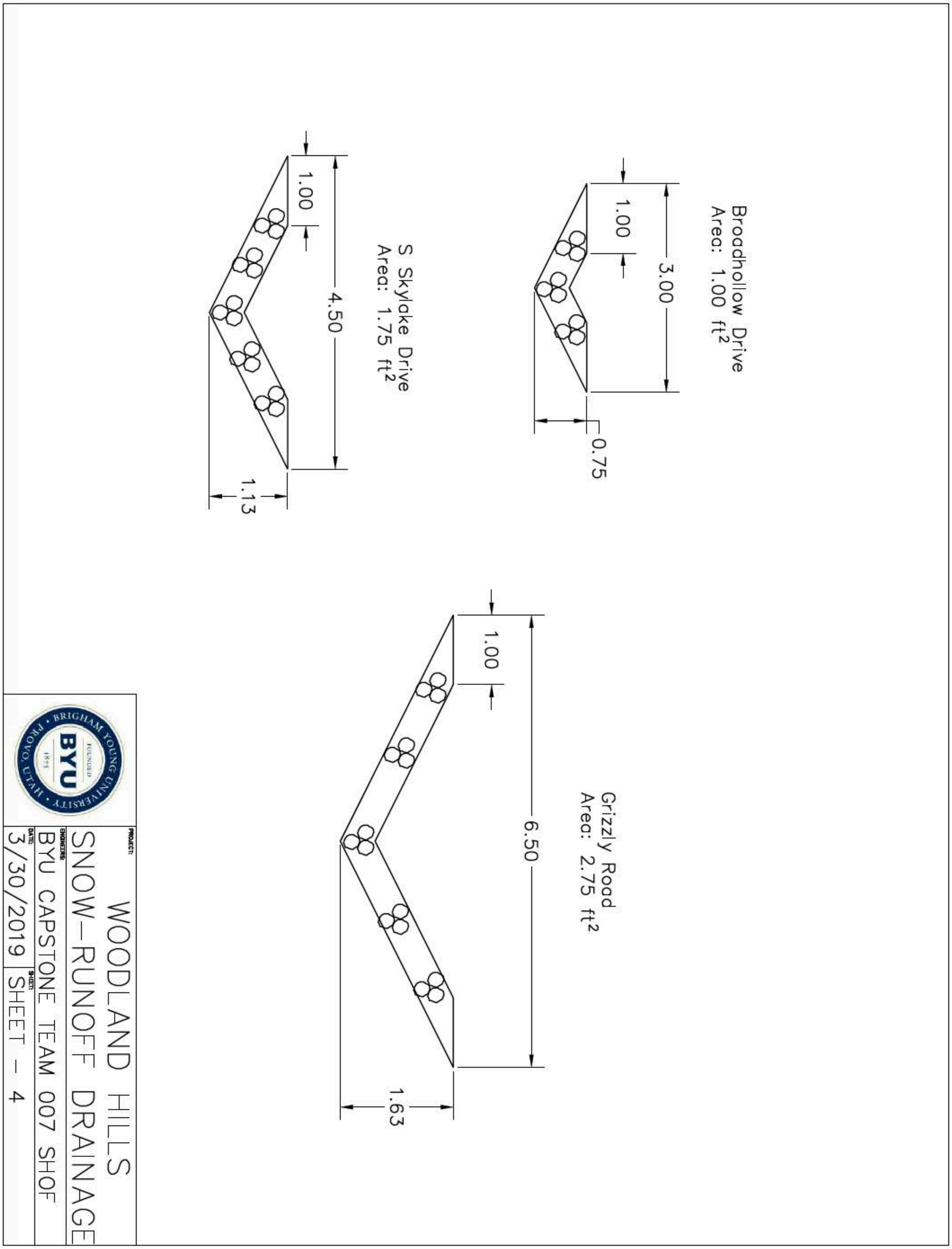
CENTER OF ROADWAY
CULVERT SLOPE 6%
N SKYLAKE
24" Ø CULVERT
OUTLET HEADWALL
WOODLAND HILLS
SNOW-RUNOFF DRAINAGE
BYU CAPSTONE TEAM 007 SHOF
3/30/2019
SHEET - 3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3.00
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S Skylake Drive
Area: 1.75 ft²
1.00
4.50
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Grizzly Road
Area: 2.75 ft²
1.00
6.50
1.63
PROJECT:
WOODLAND HILLS
SNOW-RUNOFF DRAINAGE
ENGINEERS:
BYU CAPSTONE TEAM 007 SHOF
DATE:
3/30/2019
SHEET:
SHEET - 4

Appendix C

StreamStats Output Report for Central Basin

State/Region ID	UT	
Workspace ID	UT20181203234053241000	
Latitude	40.00924	
Longitude	-111.64354	
Time	12/3/2018	4:41:06 PM

Basin Characteristics for Central Basin

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0895	square miles
OCTAVPRE	Mean October Precipitation	2.39	inches
NOVAVPRE	Mean November Precipitation	2.53	inches
DECAVPRE	Mean December Precipitation	2.23	inches
JANAVPRE	Mean January Precipitation	2.43	inches
FEBAVPRE	Mean February Precipitation	2.55	inches
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	0	percent
FOREST	Percentage of area covered by forest	99.9	percent
ELEV	Mean Basin Elevation	6860	feet
PRECIP	Mean Annual Precipitation	27.7	inches
SEPAVPRE	Mean September Precipitation	1.7	inches
APRAVPRE	Mean April Precipitation	2.36	inches
AUGAVPRE	Mean August Precipitation	1.26	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	55.4	percent
JULAVPRE	Mean July Precipitation	0.94	inches
JUNAVPRE	Mean June Precipitation	1.16	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.00906	percent
MARAVPRE	Mean March Precipitation	2.73	inches
MAYAVPRE	Mean May Precipitation	2.49	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	94.4	percent

October Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
OCTAVPRE	Mean October Precipitation	2.39	inches	1.71	2.78

***** October Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

October Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
October 80 Percent Duration	0.113	ft^3/s
October 50 Percent Duration	0.105	ft^3/s
October 20 Percent Duration	0.106	ft^3/s

November Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
NOVAVPRE	Mean November Precipitation	2.53	inches	1.7	3.23

***** November Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

November Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
November 80 Percent Duration	0.101	ft^3/s
November 50 Percent Duration	0.0831	ft^3/s

November 20 Percent Duration	0.0765	ft^3/s

December Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
DECAVPRE	Mean December Precipitation	2.23	inches	1.45	2.83

***** December Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

December Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
December 80 Percent Duration	0.0892	ft^3/s
December 50 Percent Duration	0.0861	ft^3/s
December 20 Percent Duration	0.0875	ft^3/s

January Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
JANAVPRE	Mean January Precipitation	2.43	inches	1.65	3.25

***** January Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

January Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
January 80 Percent Duration	0.04	ft^3/s
January 50 Percent Duration	0.051	ft^3/s

January 20 Percent Duration	0.0565	ft^3/s

February Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
FEBAVPRE	Mean February Precipitation	2.55	inches	1.67	3.11

***** February Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

February Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
February 80 Percent Duration	0.032	ft^3/s
February 50 Percent Duration	0.0393	ft^3/s
February 20 Percent Duration	0.0525	ft^3/s

March Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0	percent	0.21	19

***** March Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

March Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
March 80 Percent Duration	0.0315	ft^3/s
March 50 Percent Duration	0.0435	ft^3/s
March 20 Percent Duration	0.0521	ft^3/s

April Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450

***** April Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

April Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
April 80 Percent Duration	0.167	ft^3/s
April 50 Percent Duration	0.197	ft^3/s
April 20 Percent Duration	0.257	ft^3/s

May Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
FOREST	Percent Forest	99.9	percent	8.26	90.4

***** May Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

May Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
May 80 Percent Duration	0.451	ft^3/s
May 50 Percent Duration	1.2	ft^3/s
May 20 Percent Duration	2.35	ft^3/s

June Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
ELEV	Mean Basin Elevation	6860	feet	5990	9570

***** June Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

June Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
June 80 Percent Duration	0.0807	ft^3/s
June 50 Percent Duration	0.172	ft^3/s
June 20 Percent Duration	0.271	ft^3/s

July Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
PRECIP	Mean Annual Precipitation	27.7	inches	19.1	31.7

***** July Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

July Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
July 80 Percent Duration	0.0474	ft^3/s
July 50 Percent Duration	0.139	ft^3/s
July 20 Percent Duration	0.287	ft^3/s

August Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
PRECIP	Mean Annual Precipitation	27.7	inches	19.1	31.7

***** August Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

August Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
August 80 Percent Duration	0.102	ft^3/s
August 50 Percent Duration	0.141	ft^3/s
August 20 Percent Duration	0.197	ft^3/s

September Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450
SEPAVPRE	Mean September Precipitation	1.7	inches	1.4	2.11

***** September Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

September Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
September 80 Percent Duration	0.0563	ft^3/s
September 50 Percent Duration	0.0632	ft^3/s
September 20 Percent Duration	0.0833	ft^3/s

Annual Flow Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	1.98	450

***** Annual Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Annual Flow Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
Mean Annual Flow	0.239	ft^3/s

Peak-Flow Statistics Parameters **100 Percent Region 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0895	square miles	0.91	629
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0	percent	2.14	15.6

***** Peak-Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report **100 Percent Region 5**

Statistic	Value	Unit
2 Year Peak Flood	0.96	ft^3/s
5 Year Peak Flood	2.92	ft^3/s
10 Year Peak Flood	4.82	ft^3/s
25 Year Peak Flood	7.86	ft^3/s
50 Year Peak Flood	10.5	ft^3/s
100 Year Peak Flood	14.5	ft^3/s
200 Year Peak Flood	19.2	ft^3/s
500 Year Peak Flood	27.1	ft^3/s

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Application Version: 4.2.1

StreamStats Output Report for Northern Basin

State/Region ID	UT	
Workspace ID	UT20181203234644473000	
Latitude	40.01232	
Longitude	-111.64135	
Time	12/3/2018	4:46:57 PM

Basin Characteristics for Northern Basin

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.45	square miles
OCTAVPRE	Mean October Precipitation	2.49	inches
NOVAVPRE	Mean November Precipitation	2.87	inches
DECAVPRE	Mean December Precipitation	2.62	inches
JANAVPRE	Mean January Precipitation	2.92	inches
FEBAVPRE	Mean February Precipitation	2.98	inches
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	0.0426	percent
FOREST	Percentage of area covered by forest	90.4	percent
ELEV	Mean Basin Elevation	8030	feet
PRECIP	Mean Annual Precipitation	27.1	inches
SEPAVPRE	Mean September Precipitation	1.88	inches
APRAVPRE	Mean April Precipitation	2.5	inches
AUGAVPRE	Mean August Precipitation	1.41	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	60.7	percent
JULAVPRE	Mean July Precipitation	1.11	inches
JUNAVPRE	Mean June Precipitation	1.22	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.0163	percent
MARAVPRE	Mean March Precipitation	3.15	inches
MAYAVPRE	Mean May Precipitation	2.48	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	97.2	percent

October Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
OCTAVPRE	Mean October Precipitation	2.49	inches	1.71	2.78

***** October Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

October Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
October 80 Percent Duration	0.379	ft^3/s
October 50 Percent Duration	0.386	ft^3/s
October 20 Percent Duration	0.411	ft^3/s

November Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
NOVAVPRE	Mean November Precipitation	2.87	inches	1.7	3.23

***** November Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

November Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
November 80 Percent Duration	0.438	ft^3/s
November 50 Percent Duration	0.391	ft^3/s
November 20 Percent Duration	0.374	ft^3/s

December Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
DECAVPRE	Mean December Precipitation	2.62	inches	1.45	2.83

***** December Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

December Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
December 80 Percent Duration	0.403	ft^3/s
December 50 Percent Duration	0.394	ft^3/s
December 20 Percent Duration	0.4	ft^3/s

January Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
JANAVPRE	Mean January Precipitation	2.92	inches	1.65	3.25

***** January Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

January Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
January 80 Percent Duration	0.23	ft^3/s
January 50 Percent Duration	0.267	ft^3/s
January 20 Percent Duration	0.292	ft^3/s

February Flow-Duration Statistics Parameters 100 Percent Mean Flow SIR08 5230 Regions 3 and 5

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
FEBAVPRE	Mean February Precipitation	2.98	inches	1.67	3.11

***** February Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

February Flow-Duration Statistics Flow Report 100 Percent Mean Flow SIR08 5230 Regions 3 and 5

Statistic	Value	Unit
February 80 Percent Duration	0.182	ft^3/s
February 50 Percent Duration	0.212	ft^3/s
February 20 Percent Duration	0.258	ft^3/s

March Flow-Duration Statistics Parameters 100 Percent Mean Flow SIR08 5230 Regions 3 and 5

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0.0426	percent	0.21	19

***** March Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

March Flow-Duration Statistics Flow Report 100 Percent Mean Flow SIR08 5230 Regions 3 and 5

Statistic	Value	Unit
March 80 Percent Duration	0.172	ft^3/s
March 50 Percent Duration	0.236	ft^3/s
March 20 Percent Duration	0.301	ft^3/s

April Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450

***** April Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

April Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
April 80 Percent Duration	0.48	ft^3/s
April 50 Percent Duration	0.622	ft^3/s
April 20 Percent Duration	0.901	ft^3/s

May Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
FOREST	Percent Forest	90.4	percent	8.26	90.4

***** May Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

May Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
May 80 Percent Duration	1.21	ft^3/s
May 50 Percent Duration	3	ft^3/s
May 20 Percent Duration	5.83	ft^3/s

June Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
ELEV	Mean Basin Elevation	8030	feet	5990	9570

***** June Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

June Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
June 80 Percent Duration	0.49	ft^3/s
June 50 Percent Duration	1.07	ft^3/s
June 20 Percent Duration	1.83	ft^3/s

100 Percent Mean Flow SIR08 5230 Regions 3 and 5

Parameter Name	Value	Units	Min Limit	Max Limit
Drainage Area	0.45	square miles	1.98	450
Mean Annual Precipitation	27.1	inches	19.1	31.7

***** July Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

July Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
July 80 Percent Duration	0.182	ft^3/s
July 50 Percent Duration	0.464	ft^3/s
July 20 Percent Duration	0.893	ft^3/s

August Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
PRECIP	Mean Annual Precipitation	27.1	inches	19.1	31.7

***** August Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

August Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
August 80 Percent Duration	0.293	ft^3/s
August 50 Percent Duration	0.419	ft^3/s
August 20 Percent Duration	0.591	ft^3/s

September Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450
SEPAVPRE	Mean September Precipitation	1.88	inches	1.4	2.11

***** September Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

September Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
September 80 Percent Duration	0.27	ft^3/s
September 50 Percent Duration	0.319	ft^3/s
September 20 Percent Duration	0.407	ft^3/s

Annual Flow Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	1.98	450

***** Annual Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Annual Flow Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
Mean Annual Flow	0.744	ft^3/s

Peak-Flow Statistics Parameters **100 Percent Region 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.45	square miles	0.91	629
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0.0426	percent	2.14	15.6

***** Peak-Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report **100 Percent Region 5**

Statistic	Value	Unit
2 Year Peak Flood	2.68	ft^3/s
5 Year Peak Flood	7.52	ft^3/s
10 Year Peak Flood	12	ft^3/s
25 Year Peak Flood	19	ft^3/s
50 Year Peak Flood	25.4	ft^3/s
100 Year Peak Flood	33.7	ft^3/s
200 Year Peak Flood	43.8	ft^3/s
500 Year Peak Flood	60.5	ft^3/s

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StreamStats Output Report for Southern Basin

State/Region ID	UT	
Workspace ID	UT20181203232837091000	
Latitude	40.00305	
Longitude	-111.65206	
Time	12/3/2018	4:28:50 PM

Basin Characteristics for Southern Basin

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.25	square miles
OCTAVPRE	Mean October Precipitation	2.45	inches
NOVAVPRE	Mean November Precipitation	2.8	inches
DECAVPRE	Mean December Precipitation	2.52	inches
JANAVPRE	Mean January Precipitation	2.85	inches
FEBAVPRE	Mean February Precipitation	2.91	inches
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	0.47	percent
FOREST	Percentage of area covered by forest	88.2	percent
ELEV	Mean Basin Elevation	8190	feet
PRECIP	Mean Annual Precipitation	27.2	inches
SEPAVPRE	Mean September Precipitation	1.8	inches
APRAVPRE	Mean April Precipitation	2.44	inches
AUGAVPRE	Mean August Precipitation	1.4	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	59.3	percent
JULAVPRE	Mean July Precipitation	1.09	inches
JUNAVPRE	Mean June Precipitation	1.18	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0	percent
MARAVPRE	Mean March Precipitation	3.08	inches
MAYAVPRE	Mean May Precipitation	2.43	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	95.1	percent

October Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
OCTAVPRE	Mean October Precipitation	2.45	inches	1.71	2.78

***** October Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

October Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
October 80 Percent Duration	0.707	ft^3/s
October 50 Percent Duration	0.77	ft^3/s
October 20 Percent Duration	0.857	ft^3/s

November Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
NOVAVPRE	Mean November Precipitation	2.8	inches	1.7	3.23

***** November Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

November Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
November 80 Percent Duration	0.806	ft^3/s
November 50 Percent Duration	0.787	ft^3/s
November 20 Percent Duration	0.8	ft^3/s

December Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
DECAVPRE	Mean December Precipitation	2.52	inches	1.45	2.83

***** December Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

December Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
December 80 Percent Duration	0.72	ft^3/s
December 50 Percent Duration	0.749	ft^3/s
December 20 Percent Duration	0.799	ft^3/s

January Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
JANAVPRE	Mean January Precipitation	2.85	inches	1.65	3.25

***** January Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

January Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
January 80 Percent Duration	0.472	ft^3/s
January 50 Percent Duration	0.56	ft^3/s
January 20 Percent Duration	0.63	ft^3/s

February Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
FEBAVPRE	Mean February Precipitation	2.91	inches	1.67	3.11

***** February Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

February Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
February 80 Percent Duration	0.405	ft^3/s
February 50 Percent Duration	0.481	ft^3/s
February 20 Percent Duration	0.584	ft^3/s

March Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0.47	percent	0.21	19

***** March Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

March Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
March 80 Percent Duration	0.503	ft^3/s
March 50 Percent Duration	0.686	ft^3/s
March 20 Percent Duration	0.913	ft^3/s

April Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450

***** April Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

April Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
April 80 Percent Duration	0.937	ft^3/s
April 50 Percent Duration	1.29	ft^3/s
April 20 Percent Duration	1.99	ft^3/s

May Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
FOREST	Percent Forest	88.2	percent	8.26	90.4

***** May Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

May Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
May 80 Percent Duration	2.34	ft^3/s
May 50 Percent Duration	5.62	ft^3/s
May 20 Percent Duration	11	ft^3/s

June Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
ELEV	Mean Basin Elevation	8190	feet	5990	9570

***** June Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

June Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
June 80 Percent Duration	1.14	ft^3/s
June 50 Percent Duration	2.44	ft^3/s
June 20 Percent Duration	4.25	ft^3/s

July Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
PRECIP	Mean Annual Precipitation	27.2	inches	19.1	31.7

***** July Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

July Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
July 80 Percent Duration	0.452	ft^3/s
July 50 Percent Duration	1.04	ft^3/s
July 20 Percent Duration	1.91	ft^3/s

August Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
PRECIP	Mean Annual Precipitation	27.2	inches	19.1	31.7

***** August Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

August Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
August 80 Percent Duration	0.603	ft^3/s
August 50 Percent Duration	0.873	ft^3/s
August 20 Percent Duration	1.24	ft^3/s

September Flow-Duration Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450
SEPAVPRE	Mean September Precipitation	1.8	inches	1.4	2.11

***** September Flow-Duration Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

September Flow-Duration Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
September 80 Percent Duration	0.466	ft^3/s
September 50 Percent Duration	0.576	ft^3/s
September 20 Percent Duration	0.753	ft^3/s

Annual Flow Statistics Parameters **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	1.98	450

***** Annual Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Annual Flow Statistics Flow Report **100 Percent Mean Flow SIR08 5230 Regions 3 and 5**

Statistic	Value	Unit
Mean Annual Flow	1.52	ft^3/s

Peak-Flow Statistics Parameters **100 Percent Region 5**

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.25	square miles	0.91	629
LU92HRBN	Percent Nat Herb Upland from NLCD1992	0.47	percent	2.14	15.6

***** Peak-Flow Statistics Disclaimers *****

Warnings One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report **100 Percent Region 5**

Statistic	Value	Unit
2 Year Peak Flood	6.03	ft^3/s
5 Year Peak Flood	15.7	ft^3/s
10 Year Peak Flood	24.2	ft^3/s
25 Year Peak Flood	37.2	ft^3/s
50 Year Peak Flood	49.2	ft^3/s
100 Year Peak Flood	63.6	ft^3/s
200 Year Peak Flood	81.3	ft^3/s
500 Year Peak Flood	110	ft^3/s

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