TETRA TECH

MEMO

To:	Paul Geiger, Summit County Engineer; Robert Jacobs, Summit County Engineer
Cc:	Greg Lemon, Oz Architecture; Scott Russell, One River Run Acquisitions, LLC/GRR Development
From:	Keaton Scanlan, Chris Durloo
Date:	June 25, 2020
Subject:	One River Run – Drainage Report Update

This report presents updates to the drainage plan and design for the development of the One River Run project and is being submitted as a part of the Summit County development review process. This report and analyses have been prepared in conformance with the Summit County Land Use and Development Code criteria and requirements to meet the overall water quality protection strategy for the River Run area. This report includes modifications to previously proposed basin delineations and associated runoff rates for the drainage system for proposed conditions.

Project Location

The One River Run project location is unchanged from the time the One River Run Preliminary Drainage Report dated February 29, 2008 was initially submitted.

Existing Conditions

The existing conditions on the project site are unchanged from the time the One River Run Preliminary Drainage Report, dated February 29, 2008 was initially submitted, with the exception of the relocation of the gondola and removal of the existing ski rental/locker building.

Proposed Conditions

The proposed project is unchanged from the time the One River Run Preliminary Drainage Report, dated February 29, 2008 was initially submitted. However, the proposed drainage basin delineations and associated peak flow rates have been modified based on further development of the project's design. The updated basin delineations are shown in the Proposed Drainage Plan attached to this memo. The updated proposed basins were delineated differently than in the original drainage report to reflect the current site design, and some basins lost or gained acreage. This plan shows the delineation of the proposed project site into six drainage basins.

- Basin A – This basin includes the proposed building, driveways, walkways and landscape areas. Runoff from Basin A is captured in a storm sewer system and treated for water quality prior to discharge to the Snake River.
- Basin B – A small portion of this basin includes proposed driveways, walkways and landscape, however the majority of the basin includes existing buildings, roadway and landscape areas. Runoff from Basin B is ultimately captured in a storm sewer system and

Tetra Tech
130 Ski Hill Road, Suite 140, PO Box 1659, Breckenridge, CO 80424
Tel 970-453-6394 Fax 970-453-4579 www.tetratech.com

conveyed to an existing water quality pond at the southeast corner of the site prior to discharging to the Snake River.

- Basin C – This basin is a small drainage area on the southeast side of the site that sheet flows directly to the Snake River.
- Basin D – The majority of Basin D is comprised of proposed buildings, landscape and paved plaza areas. Basin D drains from the center of the site to the south. Runoff from Basin D is captured by the garage mechanical storm system and a storm sewer system and treated for water quality prior to discharging to the Snake River. The area of Basin D has increased and accounts for the previous location of Basin E.
- Basin E – The runoff from Basin E is comprised of proposed buildings and paved plaza areas. Basin E discharges to and existing storm sewer system that was previously design carry a larger capacity from the One River Run site.
- Basin F – The runoff from Basin F is captured by both storm sewer system and curb and gutter. Runoff from Basin F is conveyed to a water quality pond at southwest side of the site prior to discharging into the North Fork of the Snake River.

For information on the proposed drainage design including surface conveyance, storm sewer and inlets, see Sheets C-106 to C-108 Detailed Grading & Drainage Plan and Sheets C-215 to C-219 Storm Sewer Plan & Profiles.

Runoff Calculations

The Rational Method was originally used to estimate the peak flow rate and volume of runoff for the proposed drainage basins for the project site. The same methodology was used to modify the estimates from the original drainage report, where applicable, to account for the changes in the proposed basin acreages and land use characteristics. The results are shown below:

Basin	Area (ac)	Runoff Coeff. (C_{25})	Tc (min)	Q_{25} (cfs)	Q_{100} (cfs)
Basin A	1.83	0.83	5.00	8.28	10.45
Basin B	0.71	0.86	5.00	3.33	4.20
Basin C	0.20	0.75	5.00	0.82	1.03
Basin D	1.58	0.90	5.00	7.75	9.78
Basin E	0.28	0.90	5.00	1.37	1.73
Basin F	0.77	0.62	5.00	2.60	3.28

Per the letter from Wright Water Engineers included in the original drainage report, detention will not be required for this project and water quality vaults will be used to remove sediment from the runoff before entering the Snake River.

Water Quality

One water quality vault was previously installed and one additional water quality vault is still proposed on site, which is in conformance with the original drainage report. A Contech Vortechnics Model 5000 was previously installed as a part of the One River Run Infrastructure Phase in 2008. This existing water quality vault is sized to treat approximately 8.28 cfs of runoff from Basin A. Basin D will include a water quality vault sized to treat approximately 7.75 cfs of flow. Basin E ties to an existing storm sewer system to the south of the plaza with an existing water quality vault. The existing system and water quality vault were sized to carry future runoff from the In addition to the

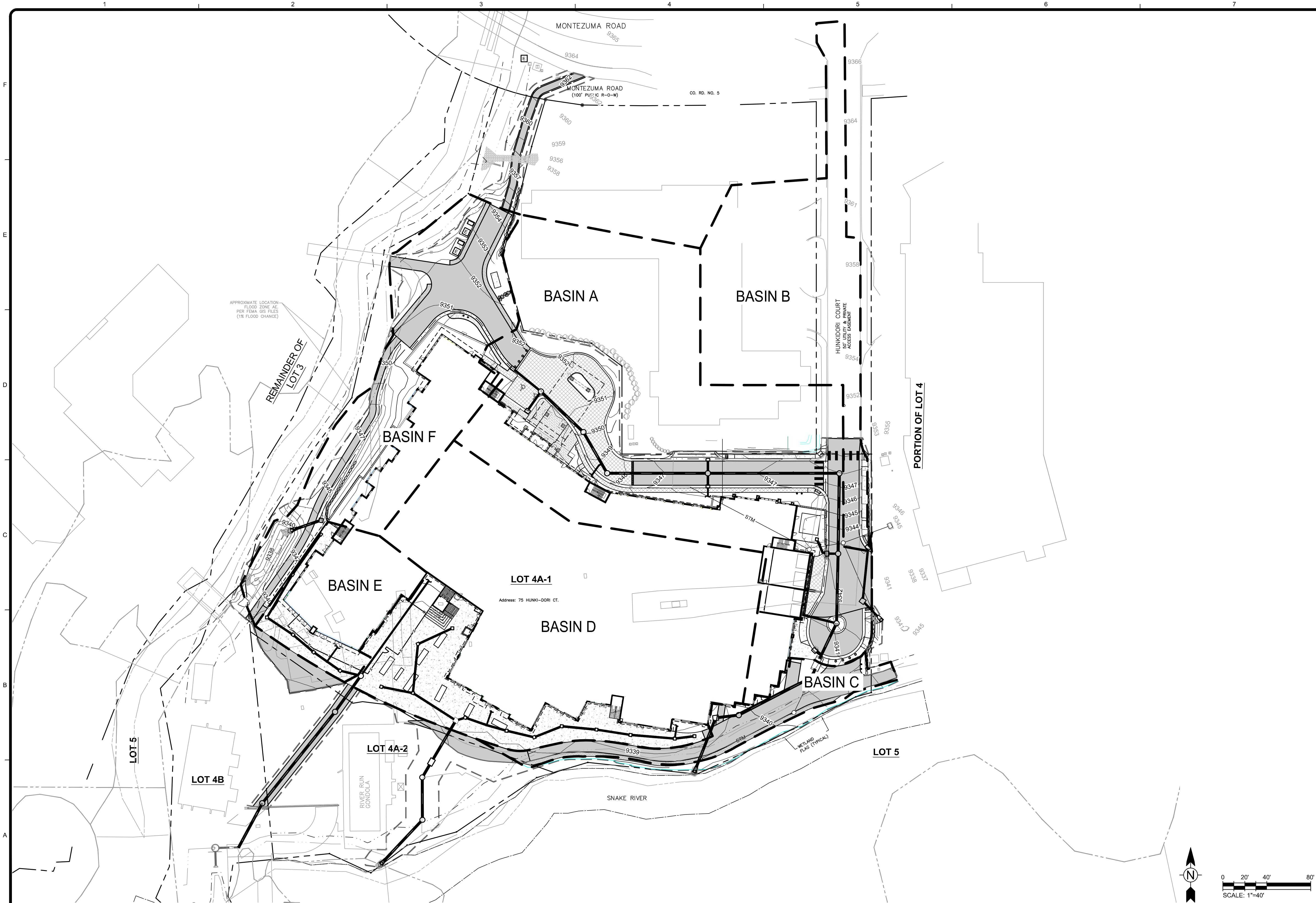
two water quality vaults, a water quality pond located at the southwest side of the site is proposed to treat runoff from Basin F, prior to discharging into the North Fork of the Snake River. An existing water quality pond will treat runoff from Basin B, before discharging to the Snake River.

Drainage in the parking garage will be captured by the mechanical storm system and treated by an oil/sand/water separator before discharging to the Snake River.

Based on the current effective Flood Insurance Rate Map information provided on the survey by Peak Land Consultants, Inc., the project site is completely outside of the 100-yr floodplain for the Snake River and North Fork of the Snake River.

Summary

This memo provides updated analysis of the proposed hydrologic conditions to the One River Run Preliminary Drainage Report, dated February 29, 2008. The updated drainage plan and design for the One River Run project is in conformance with the requirements and general strategy for water quality and drainage for the project site as determined in the original drainage report.



TETRA TECH

www.tetratech.com
130 SKI HILL ROAD, SUITE 140 | P.O. BOX 1659
BRECKENRIDGE, CO 80424
PHONE: (970) 453-6394

MARK	DATE	DESCRIPTION	BY
	06/25/20	FINAL DRAINAGE REPORT	

OZ ARCHITECTURE
ONE RIVER RUN
DRAINAGE REPORT

PROPOSED DRAINAGE PLAN

PROJ:	200-23526-20001
DESN:	KGS
DRWN:	KGS
CHKD:	CDD

EX - C

Bar Measures 1 inch, otherwise drawing not to scale

6/22/2020 11:31:04 AM - P:\23526\200-23526-20001\CAD\SHEETFILES\DRAINAGE\PROPOSED DRAINAGE PLAN.DWG - SCANLAN, KEATON

PRELIMINARY
DRAINAGE REPORT

ONE RIVER RUN
KEYSTONE , COLORADO

Prepared for:
OZ ARCHITECTURE
3012 Huron Street
Denver, CO 80202

Prepared by:
TETRA TECH, INC.
410 South French Street
P.O. Box 1659
Breckenridge, CO 80424

FEBRUARY 29, 2008

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report and supporting calculations is to present the preliminary drainage analysis for the proposed development of the One River Run project located in Keystone, CO. This report and analysis has been prepared in conformance with Summit County's drainage criteria and includes the following:

- Determination of runoff rates for the major drainage system for existing and developed conditions
- Design of onsite drainage facilities
- Review of regulatory floodplains

1.2 Location of Project

The One River Run project is located in Keystone, CO in Summit County, just south of Highway 6. The site occupies Lot 4A of Keystone, Base 1, Filing No. 2 and is bordered by Hunkidori Court to the east, the North Fork of the Snake River to the west, The Springs development to the North, and the Snake River to the south. See Figure 1, Vicinity Map.

1.3 Existing Conditions

The existing conditions on the project site include three skier service buildings, a gravel parking lot, and asphalt pathways. There is very little vegetation aside from the areas adjacent to the creeks. The majority of the site is covered by a gravel parking. The site general slopes from the north to the south with grades an average slope of approximately 3%.

There is an existing stormwater management pond on the east side of the site just below the Red Hawk Lodge condominium building. The pond is approximately 1423 SF on the surface. The pond mainly captures runoff from Hunkidori Court and Red Hawk lodge. The majority of the existing drainage from the proposed One River Run site sheet flows into the Snake River and to the North Fork of the Snake River and does not flow to this existing pond.

1.4 Proposed Conditions

The Keystone One River Run project proposes three mixed use (commercial and residential) buildings on top of a proposed parking structure. The proposed conditions will include removal of the three existing skier services buildings. Adjacent to the One River Run site, the existing River Run gondola base will be moved across the Snake River and directly south of the proposed project site and is proposed to occur in 2008.

The proposed site is located out of the 100 year floodplain. The floodplain is shown on the Existing and Proposed Drainage Plans, Exhibits A and B in Appendix B.

Drainage on the site will be conveyed through a storm sewer system and will ultimately discharge into the North Fork of the Snake River. To conservatively estimate the proposed drainage on the site, it is assumed that the drainage on top of the garage lid will be captured on the lid and routed through a garage storm system. The mechanical garage storm system will outlet and tie into the two proposed civil storm systems on the northeast and northwest sides of the site. Upon entering the storm sewer systems, the runoff will be treated through a water quality structure prior to discharging to the receiving water bodies.

The floor drains in the garage will be captured in a garage mechanical storm system. The floor drain runoff is assumed to be treated through an oil/sand/water separator. The mechanical system for the floor drains will then discharge to the outside of the garage on the south side of the site and drain directly into the Snake River.

1.5 Summit County Standards

Calculations and plans were prepared for this project in accordance with the regulations and criteria set forth in the Summit County Land Use and Development Code (May 2007). The Rational Method was used to determine the 25-year and 100-year flow rates for the existing and proposed conditions on the site. Calculations are attached in Appendix A.

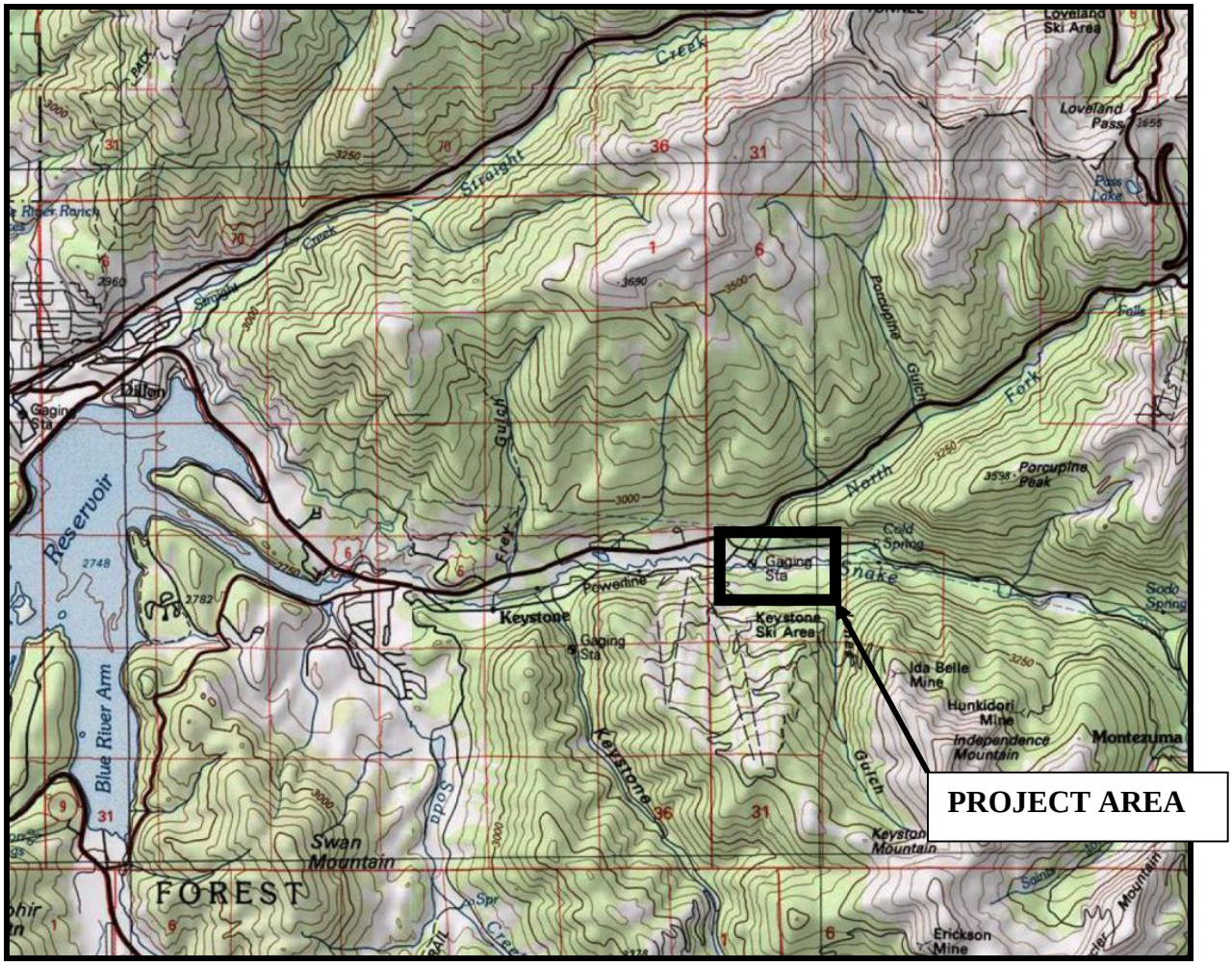


Figure 1. One River Run Vicinity Map

2.0 Hydrology

Runoff Methodology

The requirement for analyzing runoff is to determine the peak 25- year and 100-year runoff rates for the site. Runoff rates were determined using Hyrdaflow Hydrographs® 2002 software utilizing the Rational Method. The weighted coefficient of runoff values were determined for each basin using Table 5-10 from the Summit County Land Use and Development Code. Next, the time of concentration was determined within each basin using the TR-55 method which included a combination of overland flow times, shallow concentrated flow, and channelized flow times. The supporting documentation for the methodology and the drainage calculations are included in Appendix A.

2.1 Existing Conditions

Under existing conditions, three sub-basins, 1, 2, and 3 are delineated with each draining offsite. See Appendix B, Exhibit A- Existing Drainage Plan**.** Basins 1 and 2 drain from north to south and onto the future gondola site to the south. Basin 3 drains to the south and onto Lot 5 and eventually into the Snake River. Under existing conditions the site does not contain any on-site detention or water quality devices. The runoff from the site generally flows directly into the North Fork of the Snake River and/or the Snake River.

2.2 Proposed Conditions

Under proposed conditions, the site is divided into six basins as shown in Appendix B, Exhibit B, Proposed Drainage Plan. Basins A and B are captured in a storm sewer system and treated for water quality prior to discharge into the North Fork of the Snake River. The storm sewer systems will be design to convey 100-year storm flows to prevent flooding in the adjacent buildings. Water quality vaults are located near the outlet of these storm sewer systems to treat the runoff from basins A and B. Basin C is a small area of drainage on the southeast side of the site that sheet flows directly to the Snake River. Basins D and E drain from the center of the site to the south and onto the adjacent new gondola site. Basin F generally drains to the west and flows into the North Fork of the Snake River. The basins were delineated differently than in pre-developed conditions and some basins lost or gained acreage. See Appendix B, Exhibit B, Proposed Drainage Plan.

No detention is proposed for the project site based on the previous site plan approval and updated design criteria as identified in a letter from Wright Water Engineers to Summit County where this requirement has been waived. See Appendix C- Letter from Wright Water Engineers. The reason this requirement has been waived, as explained in the letter is due to the short time of concentration on the project site and it's close proximity to the North Fork of the Snake River as described in Item 4 of the letter.

Runoff Results

Runoff rates for existing and proposed conditions were calculated for the 25-year and the 100-year storms using the Rational Method. The results are shown in Table 1 below:

TABLE 1: RUNOFF SUMMARY

EXISTING CONDITIONS

Basin	Area (ac)	Area (ac)	Runoff Coeff. (C_{25})	T_C (min)	Q_{25} (cfs)	Q_{100} (cfs)
Basin 1	**72976**	1.68	0.66	6.33	5.29	6.70
Basin 2	**87478**	2.01	0.67	5.51	6.97	8.80
Basin 3	**28424**	0.65	0.63	5.00	2.23	2.82

PROPOSED CONDITIONS

Basin		Area (ac)	Runoff Coeff. (C_{25})	T_C (min)	Q_{25} (cfs)	Q_{100} (cfs)
Basin A	**49772**	1.14	0.83	5.00	5.15	6.51
Basin B	**85400**	1.96	0.86	5.00	9.18	11.60
Basin C	**13397**	0.31	0.75	5.00	1.27	1.60
Basin D	**25504**	0.59	0.89	5.00	2.86	3.61
Basin E	**31540**	0.72	0.97	5.00	3.80	4.81
Basin F	**24677**	0.57	0.71	5.00	2.20	2.78

Detention will not be required as referenced by Appendix C- Letter from Wright Water Engineers. However water quality vaults will be utilized on the site to remove sediment from the runoff before the flows enter the North Fork of the Snake River.

3.0 Water Quality

Permanent and temporary water quality measures will be implemented on site in order to meet Summit County water quality requirements.

3.1 Permanent Facilities

Two water quality vaults are proposed on site as part of the storm sewer systems on the northeast and northwest areas of the site. The vaults will be sized to treat runoff from the 25-year, 24 hr storm (2.2 inches) post development flows and remove suspended solids from the runoff. Stormceptor® or Contech Vortechs® vaults will be utilized as the water

quality vaults. The vaults will be located on the downstream portion of the storm sewer just upstream of the discharge point.

Basin A will include a water quality vault sized to treat approximately 5.15 cfs of flow and basin B will include a water quality vault to treat 9.18 cfs of flow. These 2 basins produce a majority of the runoff from the proposed site and include the proposed parts of the site that have vehicular uses. The other basins are generally landscape and pedestrian areas with snowmelt and will not contribute as significant source of particulate pollutants. The existing site did not contain any water quality measures for the runoff.

3.2 Temporary Construction Facilities

During the construction period, temporary measures will be provided to comply with Summit County water quality requirements. The construction is broken into three phases and each phase will utilize its own BMP's for water quality.

In each phase of construction silt fence, vehicle tracking pads, inlet protection, and temporary detention ponds will be used to meet water quality standards. The temporary detention ponds will be sized to detain the 25 year, 24-hr storm (2.2 inches) and remove sediment before discharging to the adjacent water bodies. See sheets C106-C108 of the civil plans for further detailing.

4.0 Summary

This report and analysis demonstrates compliance with Summit County's drainage criteria. On the existing site no water quality treatment or detention exists. For the proposed project water quality vaults will be installed in the major storm sewer systems to remove suspended solids from the runoff and comply with Summit County water quality standards.

This report was prepared by or under the direct supervision of Chris D. Durloo, a licensed engineer in the State of Colorado.

5.0 References

Alpine Engineering, Inc. *Preliminary Drainage Report, Grand Residences at Keystone, Colorado.* October , 2005. Prepared for Marriot Vacation Club International, Orlando, Florida.

National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Volume III-Colorado Precipitation Frequency Atlas, 1973.

Summit County, Colorado. 10/11/2007. *Land Use and Development Codes.* At http://www.co.summit.co.us/Planning/DevCodes/devtable.html

Urban Storm Drainage Criteria Manual (USDCM). June 2002. Criteria Manual, Volumes 1-3. Urban Drainage and Flood Control District. Denver, Colorado.

APPENDIX A- Drainage Calculations

Table 5-10 Coefficient of Runoff

Type of Surface	Vegetation Density	Value of C= (Rainfall)
Roofs		.97
Pavements		
Concrete or Asphalt		.97
Gravel from clean and loose, to clayey and compact		.60
Earth Surfaces		
Sand from uniform grain size, no fines to well graded, some, clay or silt	Bare	.60
	Light Vegetation	.45
	Dense Vegetation	.35
Clay, from course sandy or silty, to pure colloidal clay	Bare	.70
	Light Vegetation	.50
	Dense Vegetation	.40

Table 5-11 Maximum Permissible Velocities

Channel Material	"n"	Velocity (feet/sec)
Lines or well established grass	.05	5
Bunched grasses with exposed soil	.04	3
Fine sand or silt	.02	1
Al other bare soils	.03	2

Manning's N-Values

Surface	Manning's "n"
Pipes	
Reinforced concrete	0.013
Vitrified clay pipe	0.013
Smooth welded pipe	0.011
Corrugated metal pipe	0.023
Polyvinyl chloride (PVC)	0.010
Natural Channels	
Gravel beds, Straight	0.025
Gravel beds, large boulders	0.040
Earth, straight, some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding	0.050
TR-55 Sheet Flow	
Smooth surfaces (concrete, asphalt, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils	
Residue cover <= 20%	0.06
Residue cover > 20%	0.17
Short grass	0.15
Dense grass	0.24
Bermuda grass	0.41
Light underbrush woods	0.40
Dense underbrush woods	0.80

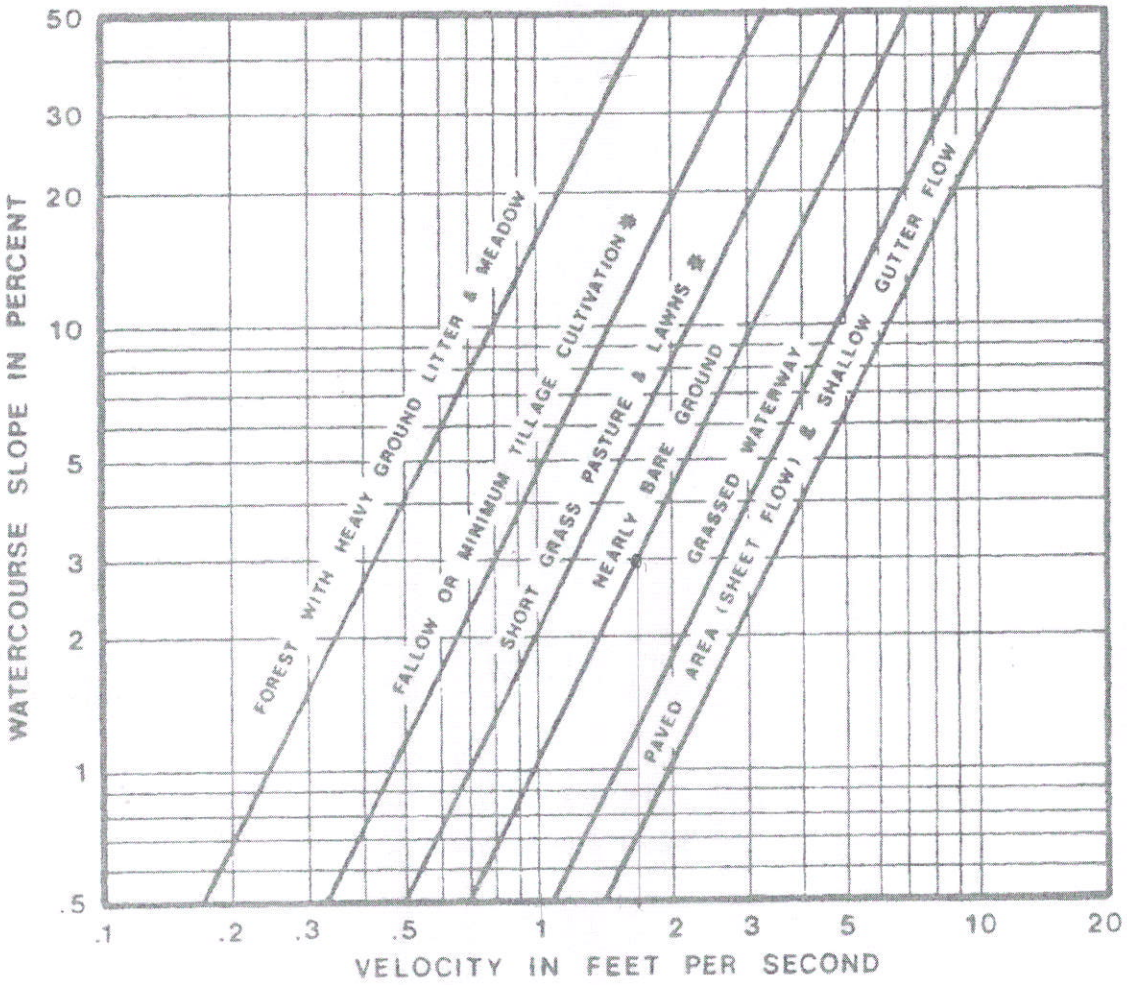


FIGURE RO-1

Estimate of Average Overland Flow Velocity for Use With the Rational Formula

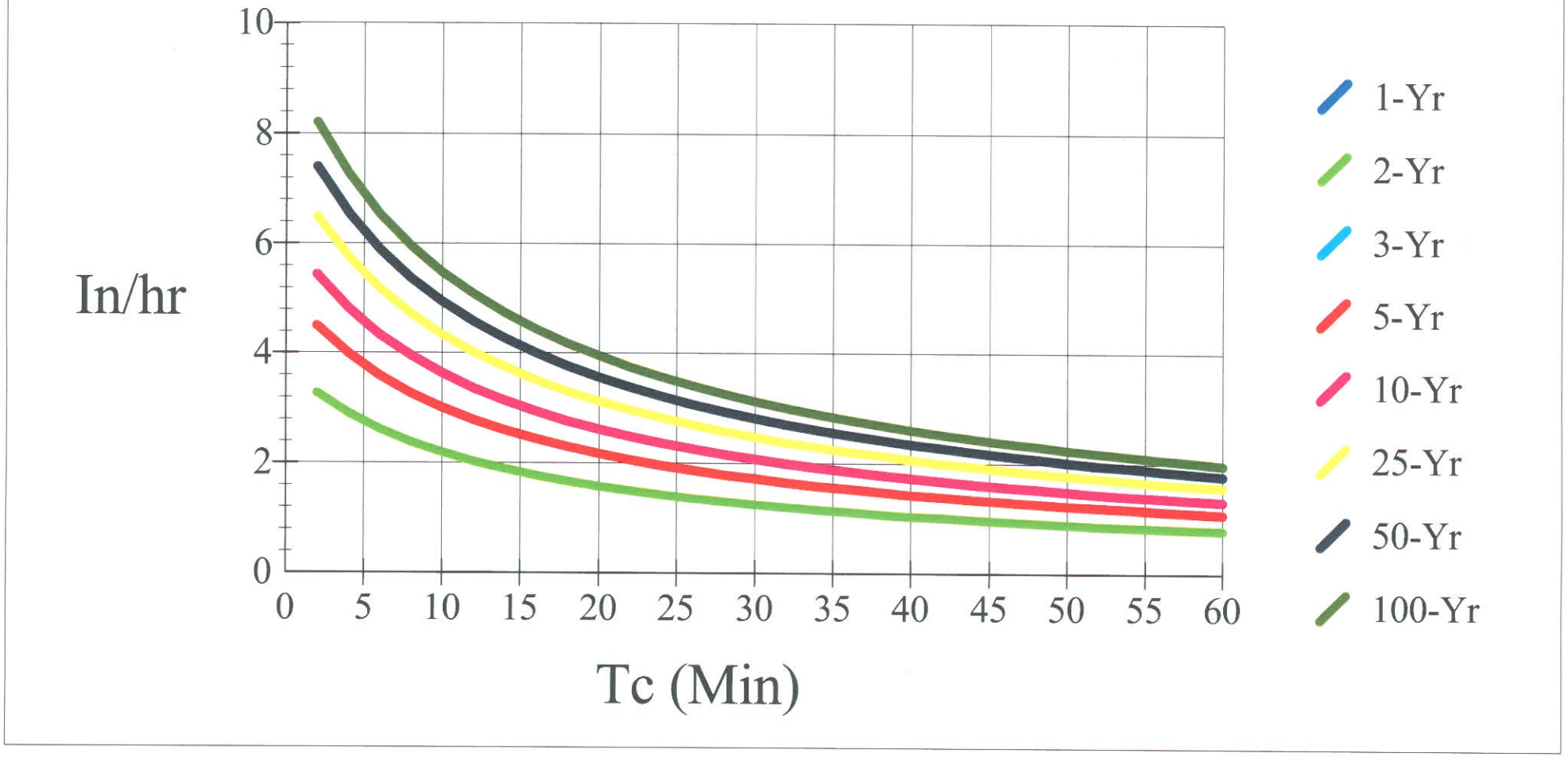
Precipitation Frequency Data Output

NOAA Atlas 2
Colorado 39.600?N 105.93?W
Site-specific Estimates

Map	Precipitation (inches)	Precipitation Intensity (in/hr)
2-year 6-hour	0.96	0.16
2-year 24-hour	1.30	0.05
100-year 6-hour	2.13	0.36
100-year 24-hour	2.93	0.12

Hydrometeorological Design Studies Center - NOAA/National Weather Service
1325 East-West Highway - Silver Spring, MD 20910 - (301) 713-1669
Tue Feb 26 15:59:39 2008

I-D-F Curve - 08KEYTONE.IDF



Hydraflow IDF Report

Return Period (Yrs)	Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	26.8867	10.7000	0.8283	--------
3	0.0000	0.0000	0.0000	--------
5	36.9562	10.7000	0.8283	--------
10	44.6321	10.7000	0.8283	--------
25	53.2985	10.7000	0.8283	--------
50	60.7268	10.7000	0.8283	--------
100	67.3297	10.7000	0.8283	--------

P:\PROJECTS - WATER RESOURCES\GRAPHWIN\08KEYTONE.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.75	2.19	1.83	1.58	1.39	1.25	1.13	1.04	0.96	0.90	0.84	0.79
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	3.78	3.00	2.51	2.17	1.91	1.72	1.56	1.43	1.32	1.23	1.15	1.09
10	4.56	3.63	3.03	2.62	2.31	2.07	1.88	1.73	1.60	1.49	1.39	1.31
25	5.45	4.33	3.62	3.13	2.76	2.47	2.25	2.06	1.91	1.78	1.66	1.57
50	6.21	4.94	4.13	3.56	3.14	2.82	2.56	2.35	2.17	2.02	1.90	1.78
100	6.88	5.47	4.57	3.95	3.48	3.13	2.84	2.61	2.41	2.24	2.10	1.98

Tc = time in minutes

ONE RIVER RUN SUMMARY

USE RATIONAL METHOD TO CALCULATE PEAK FLOWS"
Q = CIA

EXISTING CONDITIONS

Basin	Area (ac)	Area (ac)	Runoff Coeff. (C_{25})	T_C (min)	Q_{25} (cfs)	Q_{100} (cfs)
Basin 1	**72976**	1.68	0.66	6.33	5.29	6.70
Basin 2	**87478**	2.01	0.67	5.51	6.97	8.80
Basin 3	**28424**	0.65	0.63	5.00	2.23	2.82

PROPOSED CONDITIONS

Basin		Area (ac)	Runoff Coeff. (C_{25})	T_C (min)	Q_{25} (cfs)	Q_{100} (cfs)
Basin A	**49772**	1.14	0.83	5.00	5.15	6.51
Basin B	**85400**	1.96	0.86	5.00	9.18	11.60
Basin C	**13397**	0.31	0.75	5.00	1.27	1.60
Basin D	**25504**	0.59	0.89	5.00	2.86	3.61
Basin E	**31540**	0.72	0.97	5.00	3.80	4.81
Basin F	**24677**	0.57	0.71	5.00	2.20	2.78

ONE RIVER RUN
DRAINAGE REPORT

2/25/2008

EXISTING CONDITIONS

BASIN 1		
EXISTING CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	8209	0.97
GRAVEL PARKING	43972	0.60
ASPHALT PATH	7899	0.97
TREES	9732	0.45
LANDSCAPE AREA	3164	0.45
TOTAL AREA	**72976**	**0.66**

BASIN 2		
EXISTING CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	12445	0.97
GRAVEL PARKING	63351	0.60
ASPHALT PATH	6948	0.97
TREES	1024	0.45
LANDSCAPE AREA	3710	0.45
TOTAL AREA	**87478**	**0.67**

BASIN 3		
EXISTING CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
GRAVEL PARKING	25847	0.60
ASPHALT PATH	2577	0.97
TOTAL AREA	**28424**	**0.63**

PROPOSED CONDITIONS

BASIN A		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	26970	0.97
ASPHALT PATH	9845	0.97
LANDSCAPE AREA	12957	0.45
TOTAL AREA	**49772**	**0.83**

BASIN B		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	37186	0.97
ASPALT-DRIVEWAYS & ROADS	30306	0.97
EARTH-SAND, LIGHT VEGETATION	17908	0.45
	85400	**0.86**

PROPOSED CONDITIONS

BASIN C		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	4258	0.97
ASPHALT PATH	3351	0.97
LANDSCAPE AREA	5788	0.45
TOTAL AREA	**13397**	**0.75**

PROPOSED CONDITIONS

BASIN D		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	16331	0.97
ASPHALT PATH	5384	0.97
LANDSCAPE AREA	3789	0.45
TOTAL AREA	**25504**	**0.89**

PROPOSED CONDITIONS

BASIN E		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	21100	0.97
ASPHALT PATH	10440	0.97
TOTAL AREA	**31540**	**0.97**

PROPOSED CONDITIONS

BASIN F		
PROPOSED CONDITIONS	*AREA (ft^2)*	*Runoff Coeffcient, C Value**
ROOFS	9552	0.97
ASPHALT PATH	2927	0.97
LANDSCAPE AREA	12198	0.45
TOTAL AREA	**24677**	**0.71**

* from Summit County Land Use and Dev. Code: Table 5-10

TIME OF CONCENTRATION CALCULATIONS

EXISTING CONDITIONS

BASIN 1

Sheet Flow (minutes)

Flow Length (ft)	300
Manning n	0.011
Average Land Slope	0.034
2-year 24 hour Rainfall (in)	1.3
Sheet Flow Travel Time (min)	3.70

Shallow Concentrated Flow (minutes)

Channel Length (ft)	276
Average Slope	0.03
Average Velocity (ft/s)	1.75
Channel Travel Time	2.63

Open Channel Flow (minutes)

Open Channel Length (ft)	
Assumed Hydraulic Radius (ft)	
Slope	
Manning n	
Average Velocity (ft/s)	
Open Channel Travel Time	

Time of Conc. (minutes)	**6.33**

BASIN 2

Sheet Flow (minutes)

Flow Length (ft)	300
Manning n	0.011
Average Land Slope	0.031
2-year 24 hour Rainfall (in)	1.3
Sheet Flow Travel Time (min)	3.86

Shallow Concentrated Flow (minutes)

Channel Length (ft)	173
Average Slope	0.03
Average Velocity (ft/s)	1.75
Channel Travel Time	1.65

Open Channel Flow (minutes)

Open Channel Length (ft)	
Assumed Hydraulic Radius (ft)	
Slope	
Manning n	
Average Velocity (ft/s)	
Open Channel Travel Time	

Time of Conc. (minutes)	**5.51**

TIME OF CONCENTRATION CALCULATIONS

EXISTING CONDITIONS

BASIN 3

Sheet Flow (minutes)

Flow Length (ft)	300
Manning n	0.011
Average Land Slope	0.030
2-year 24 hour Rainfall (in)	1.3
Sheet Flow Travel Time (min)	3.89

Shallow Concentrated Flow (minutes)

Channel Length (ft)	56
Average Slope	0.02
Average Velocity (ft/s)	1.4
Channel Travel Time	0.67

Open Channel Flow (minutes)

Open Channel Length (ft)	
Assumed Hydraulic Radius (ft)	
Slope	
Manning n	
Average Velocity (ft/s)	
Open Channel Travel Time	

Time of Conc. (minutes)	**4.56**

PROPOSED CONDITIONS

BASIN A

Sheet Flow (minutes)

Flow Length (ft)	180
Manning n	0.011
Average Land Slope	0.100
2-year 24 hour Rainfall (in)	1.3
Sheet Flow Travel Time (min)	1.60

Shallow Concentrated Flow (minutes)

Channel Length (ft)	
Average Slope	
Average Velocity (ft/s)	
Channel Travel Time	

*Open Channel Flow **1** (minutes)*

Open Channel Length (ft)	52
Assumed Hydraulic Radius (ft)	0.020
Slope	0.026538
Manning n	0.013
Average Velocity (ft/s)	1.4
Open Channel Travel Time	0.63

Open Channel Flow (minutes)

Open Channel Length (ft)	210
Assumed Hydraulic Radius (ft)	0.167
Slope	0.01581
Manning n	0.01
Average Velocity (ft/s)	5.7
Open Channel Travel Time	0.62

Time of Conc. (minutes)	**2.23**

Tc<5, USE 5.0 MIN

BASIN B

Sheet Flow (minutes)

Flow Length (ft)	173
Manning n	0.011
Average Land Slope	0.1
2-year 24 hour Rainfall (in)	1.3
Sheet Flow Travel Time (min)	1.55

Shallow Concentrated Flow (minutes)

Channel Length (ft)	
Average Slope	
Average Velocity (ft/s)	
Channel Travel Time	

Open Channel Flow 1 (minutes)

Open Channel Length (ft)	135
Assumed Hydraulic Radius (ft)	0.02
Slope	0.02
Manning n	0.013
Average Velocity (ft/s)	1.322341
Open Channel Travel Time	1.70

Open Channel Flow (minutes)

Open Channel Length (ft)	342
Assumed Hydraulic Radius (ft)	0.167
Slope	0.03
Manning n	0.01
Average Velocity (ft/s)	8.29
Open Channel Travel Time	0.69

Time of Conc. (minutes)	**3.25**

Tc<5, USE 5.0 MIN

Hydrograph Plot

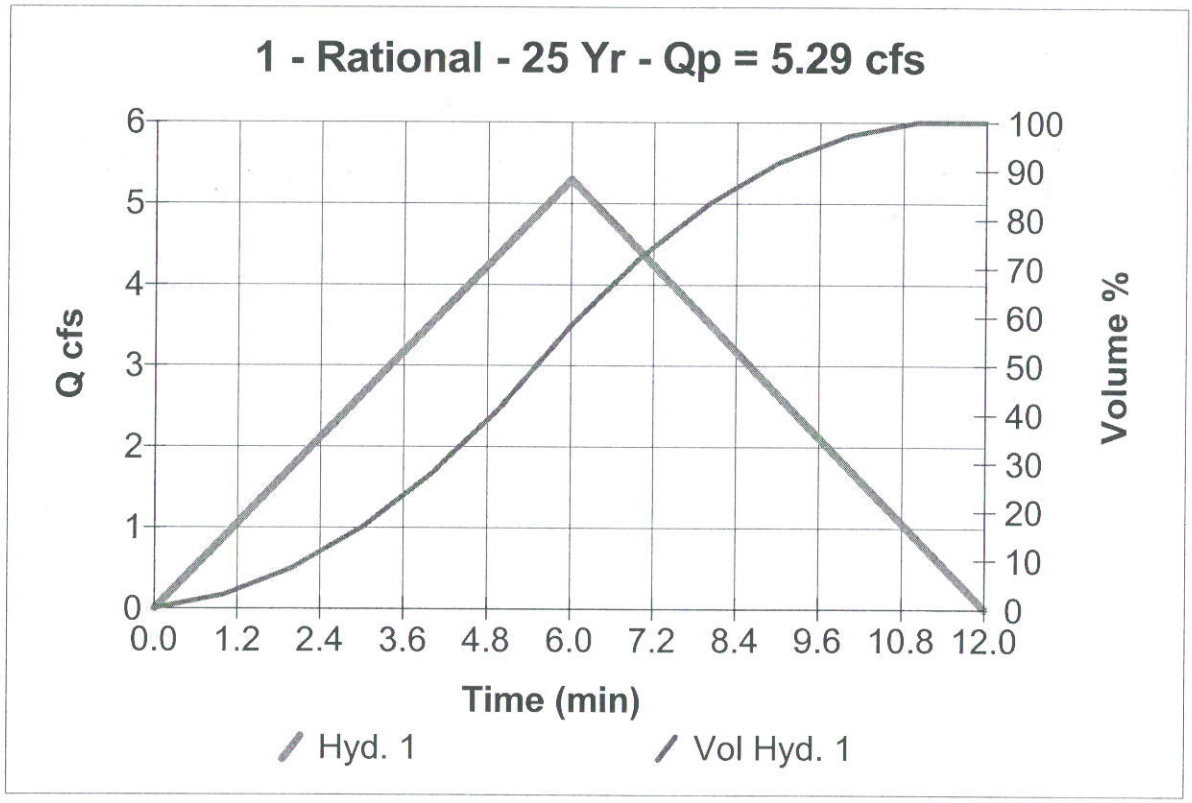
Hyd. No. 1

EX BASIN 1

Hydrograph type	= Rational	Peak discharge	= 5.29 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 1.7 ac	Runoff coeff.	= 0.66
Intensity	= 4.775 in/hr	Time of conc. (Tc)	= 6 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,906 cuft

Ex BASIN 1



Hydrograph Plot

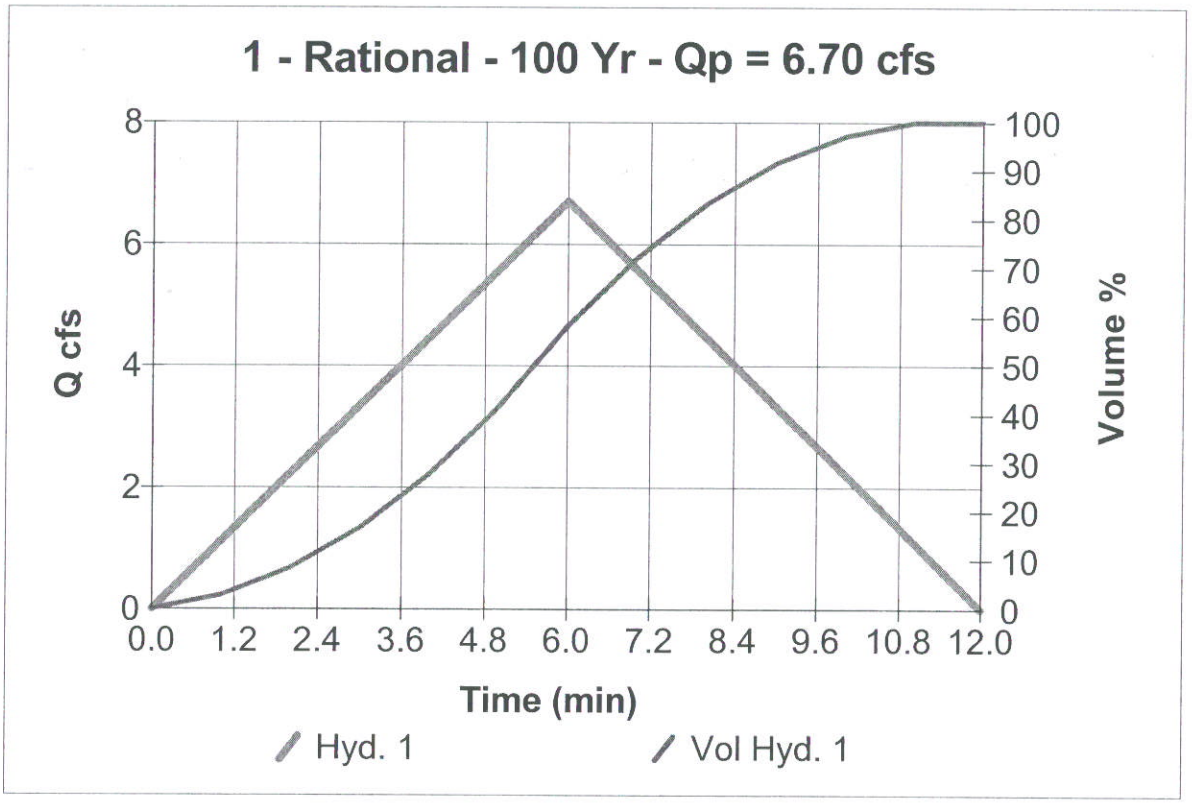
Hyd. No. 1

EX BASIN 1

Hydrograph type	= Rational	Peak discharge	= 6.70 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.7 ac	Runoff coeff.	= 0.66
Intensity	= 6.046 in/hr	Time of conc. (Tc)	= 6 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 2,413 cuft

EX BASIN 1



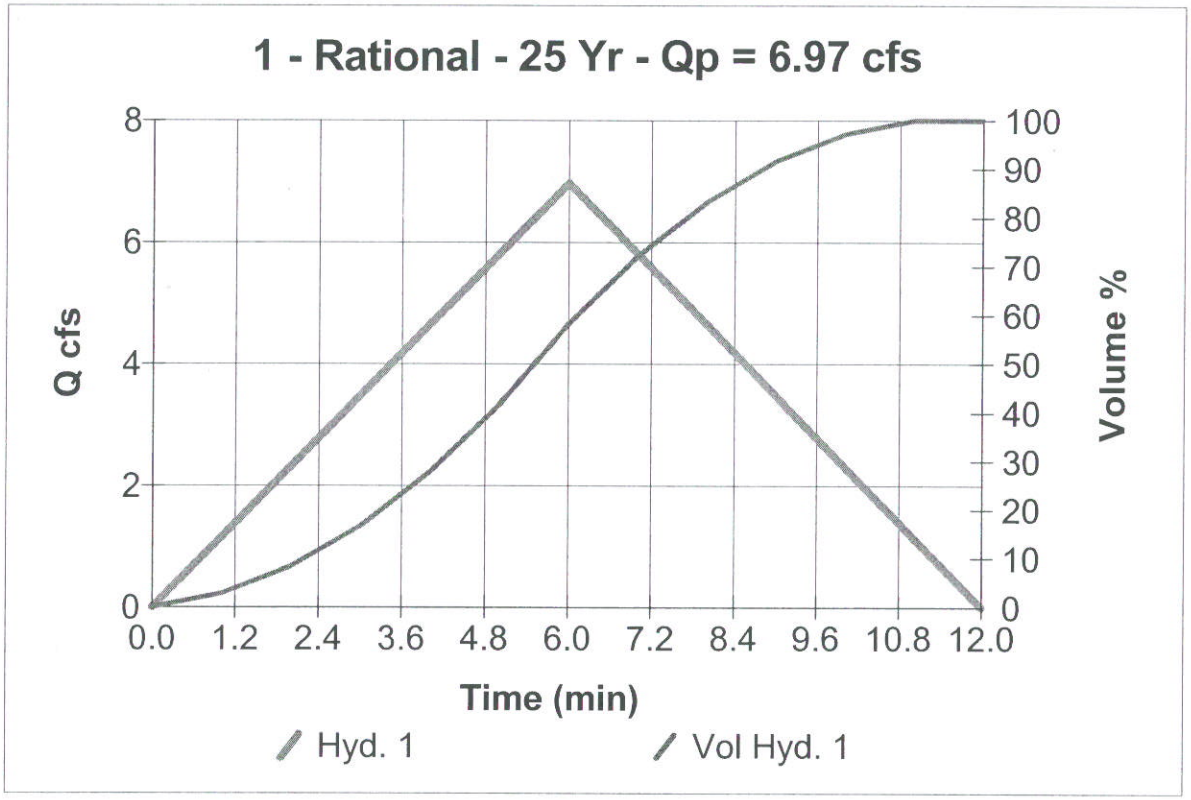
Hydrograph Plot

Hyd. No. 1

EX BASIN 2

Hydrograph type	= Rational	Peak discharge	= 6.97 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.67
Intensity	= 5.175 in/hr	Time of conc. (Tc)	= 6 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 2,509 cuft



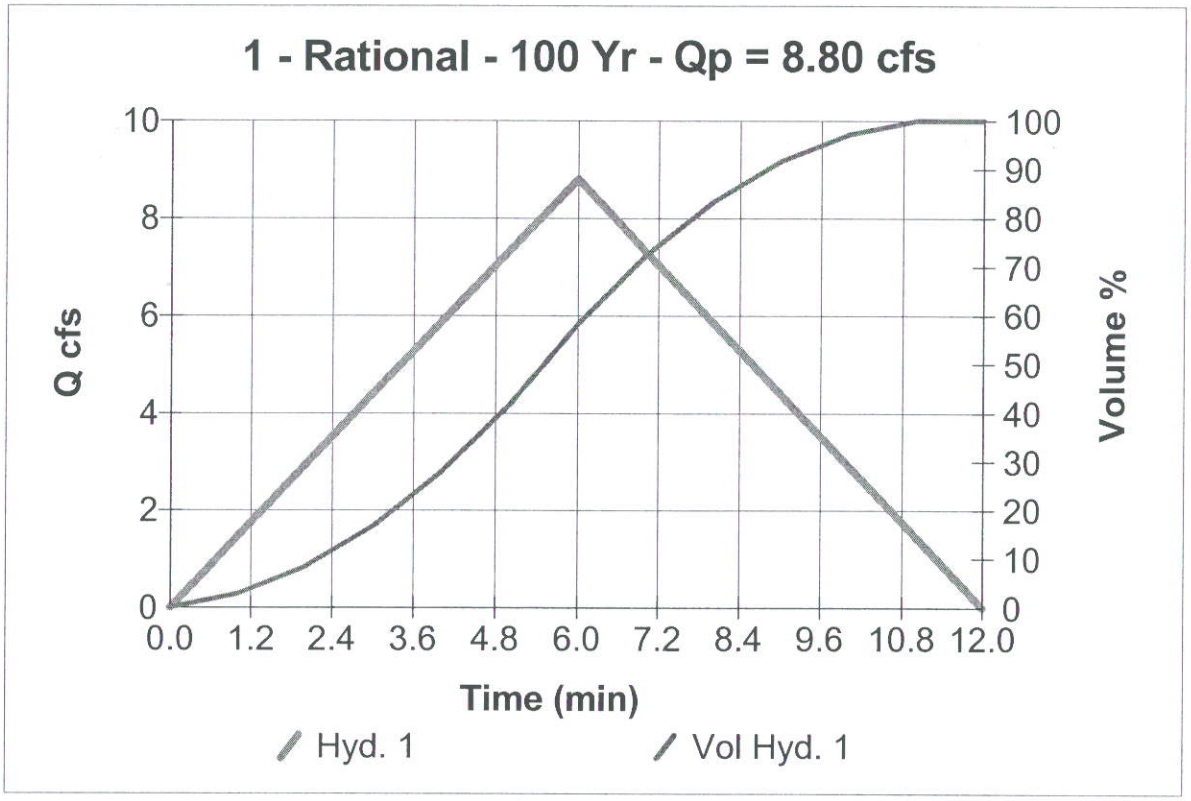
Hydrograph Plot

Hyd. No. 1

EX BASIN 2

Hydrograph type	= Rational	Peak discharge	= 8.80 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.67
Intensity	= 6.537 in/hr	Time of conc. (Tc)	= 6 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 3,169 cuft



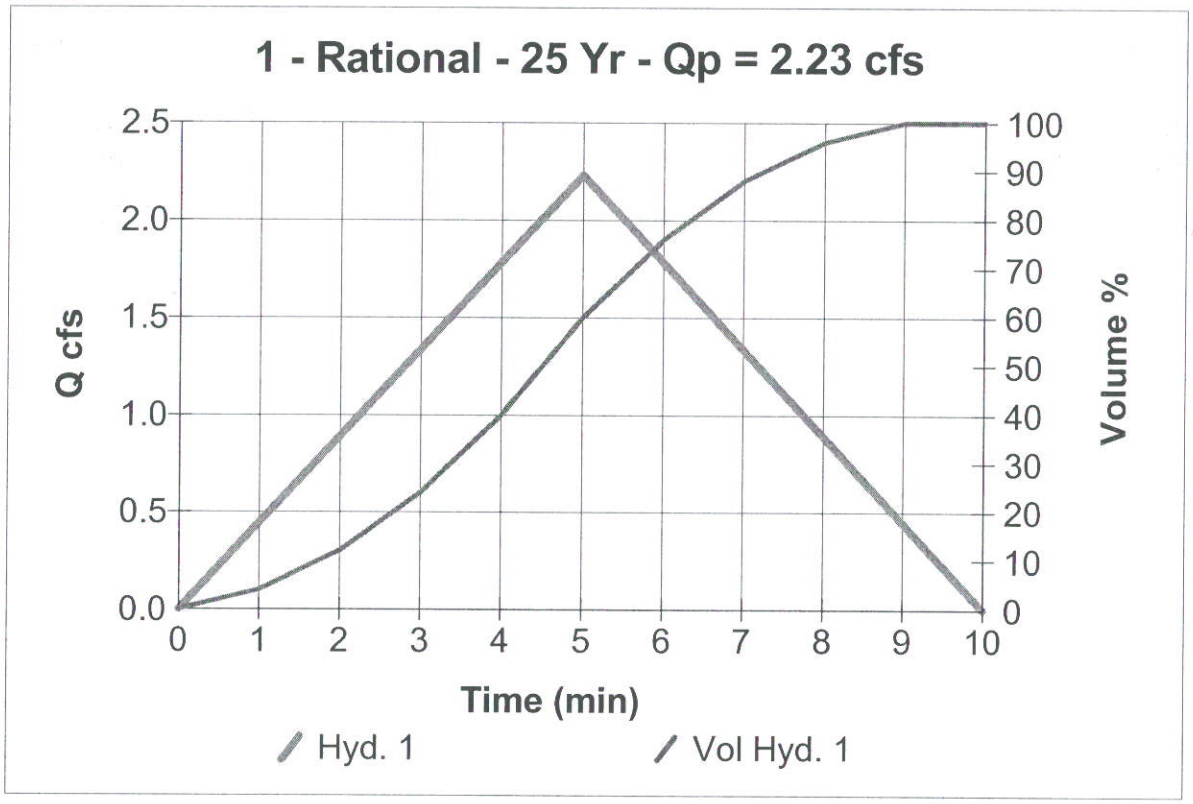
Hydrograph Plot

Hyd. No. 1

EX BASIN 3

Hydrograph type	= Rational	Peak discharge	= 2.23 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.63
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 669 cuft



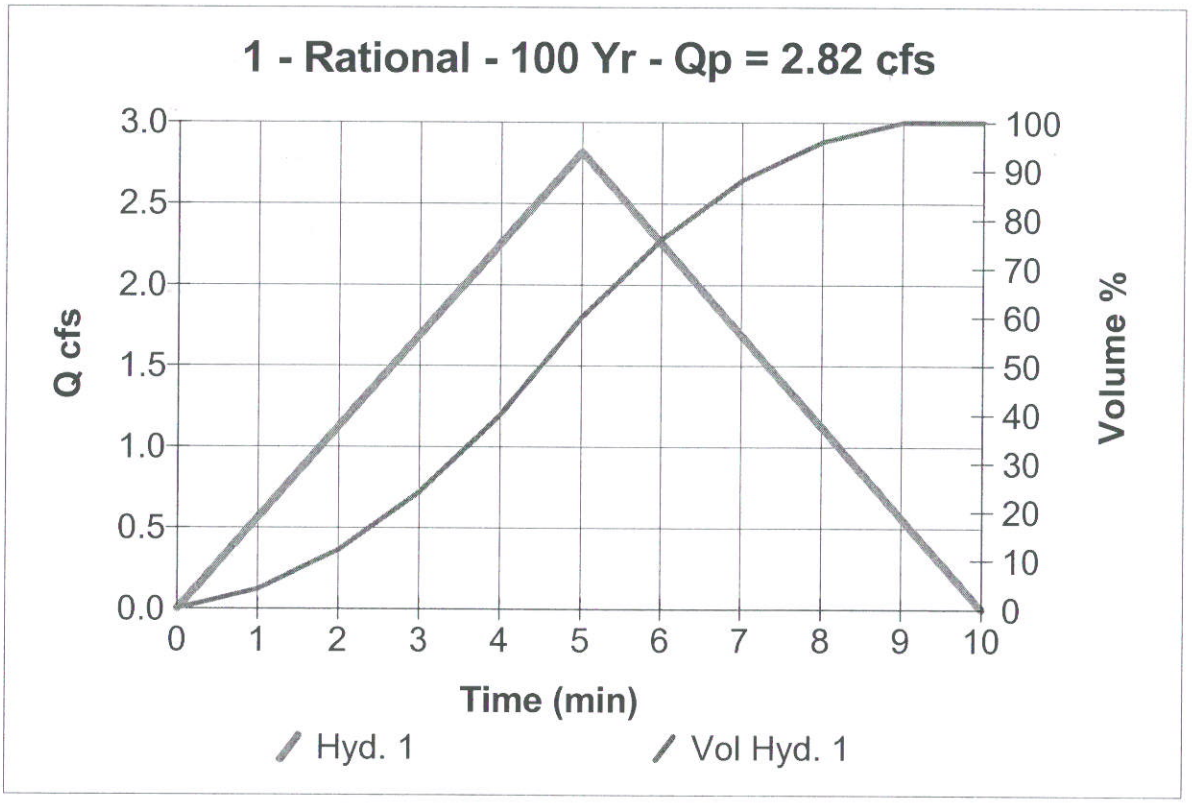
Hydrograph Plot

Hyd. No. 1

EX BASIN 3

Hydrograph type	= Rational	Peak discharge	= 2.82 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.63
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 845 cuft



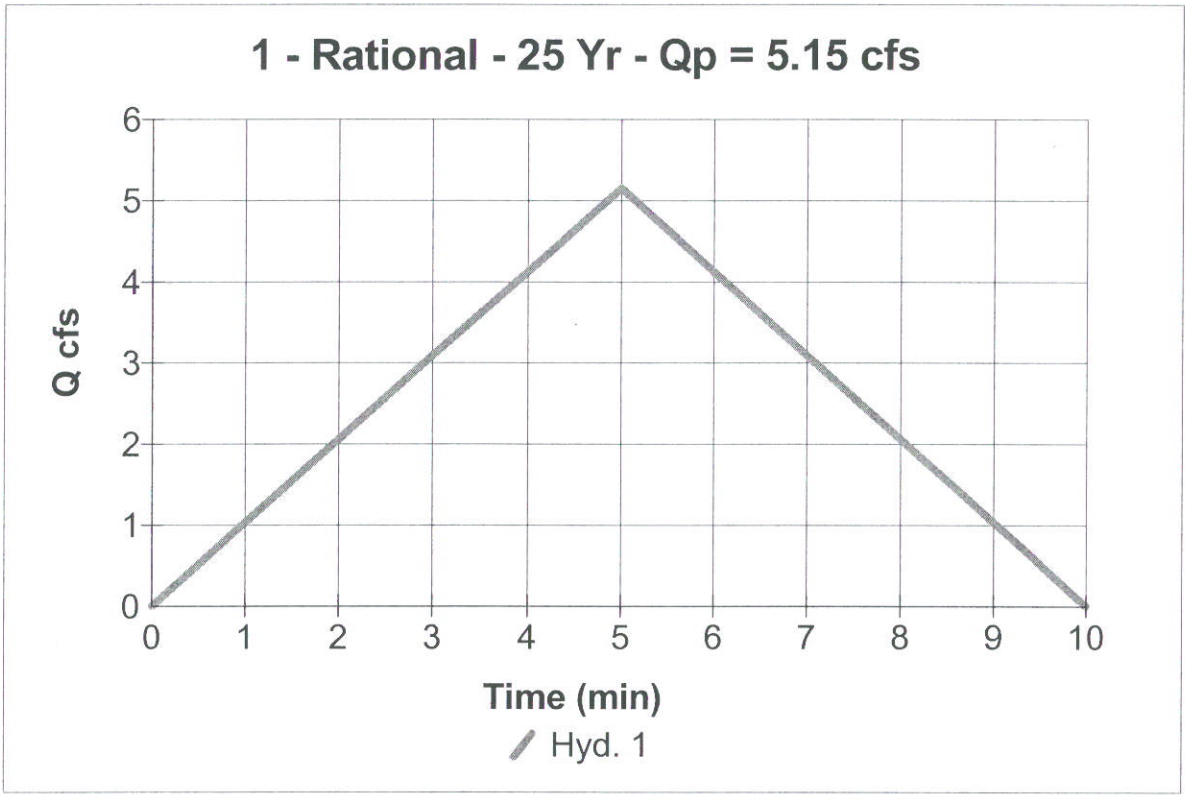
Hydrograph Plot

Hyd. No. 1

PRO BASIN A

Hydrograph type	= Rational	Peak discharge	= 5.15 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 1.1 ac	Runoff coeff.	= 0.83
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,546 cuft



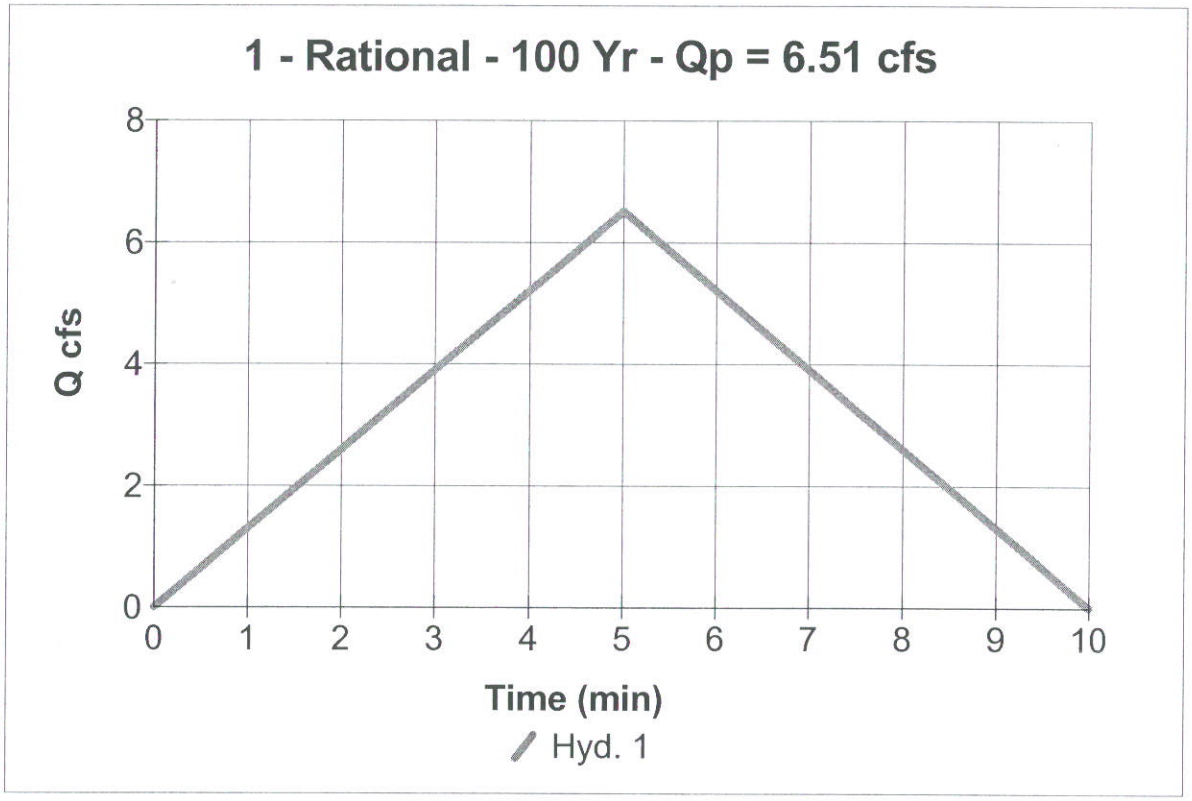
Hydrograph Plot

Hyd. No. 1

PRO BASIN A

Hydrograph type	= Rational	Peak discharge	= 6.51 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 1.1 ac	Runoff coeff.	= 0.83
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,953 cuft



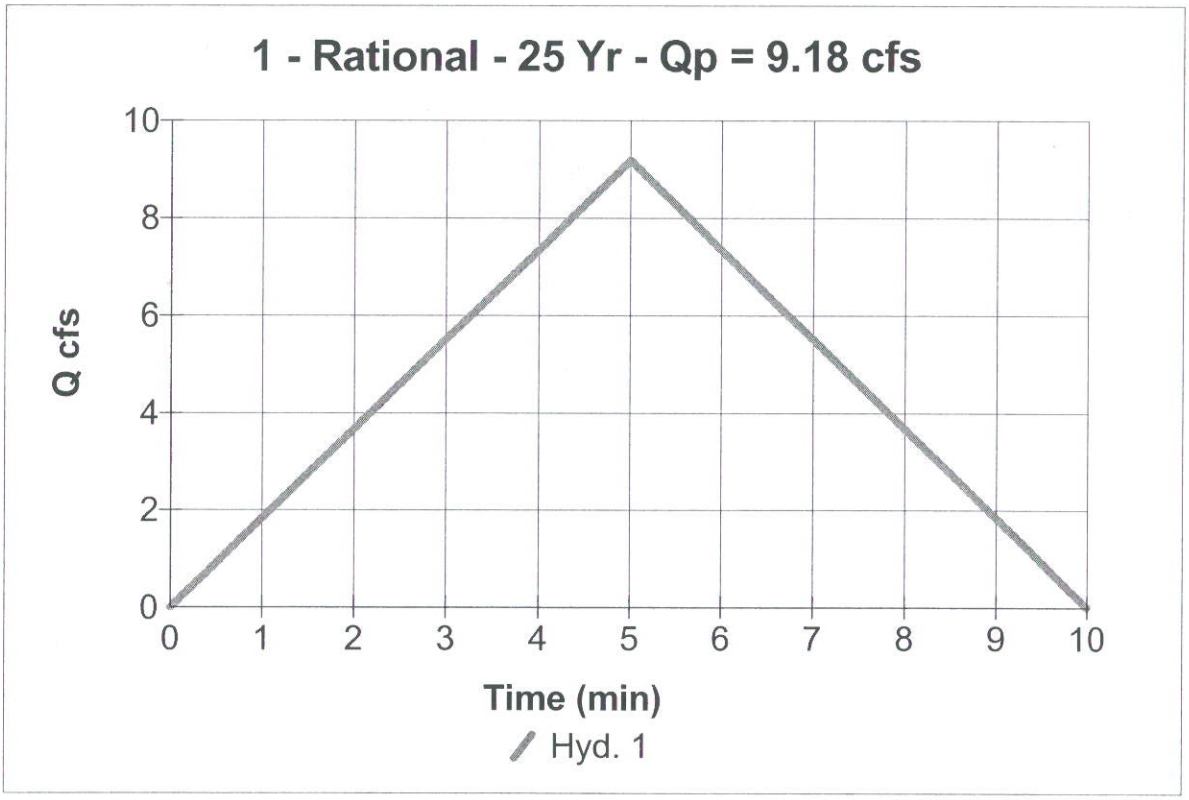
Hydrograph Plot

Hyd. No. 1

PRO BASIN B

Hydrograph type	= Rational	Peak discharge	= 9.18 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.86
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 2,754 cuft



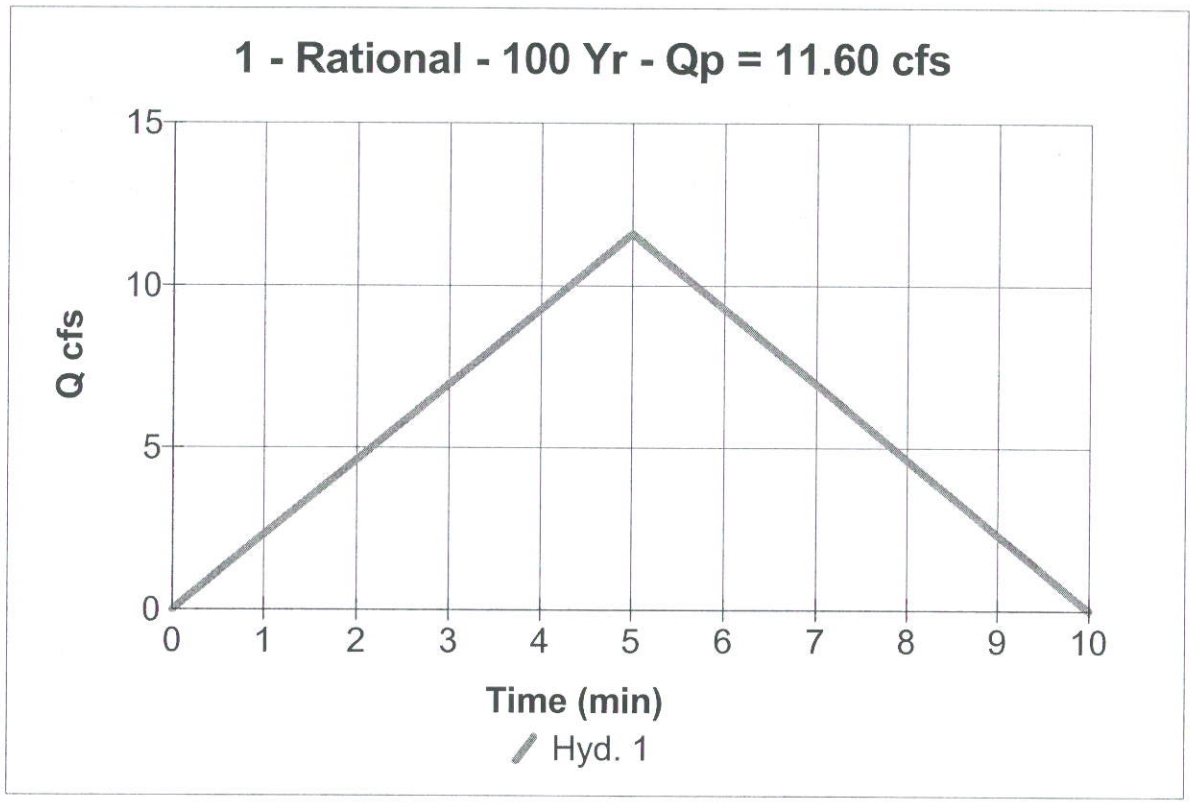
Hydrograph Plot

Hyd. No. 1

PRO BASIN B

Hydrograph type	= Rational	Peak discharge	= 11.60 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 2.0 ac	Runoff coeff.	= 0.86
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 3,479 cuft



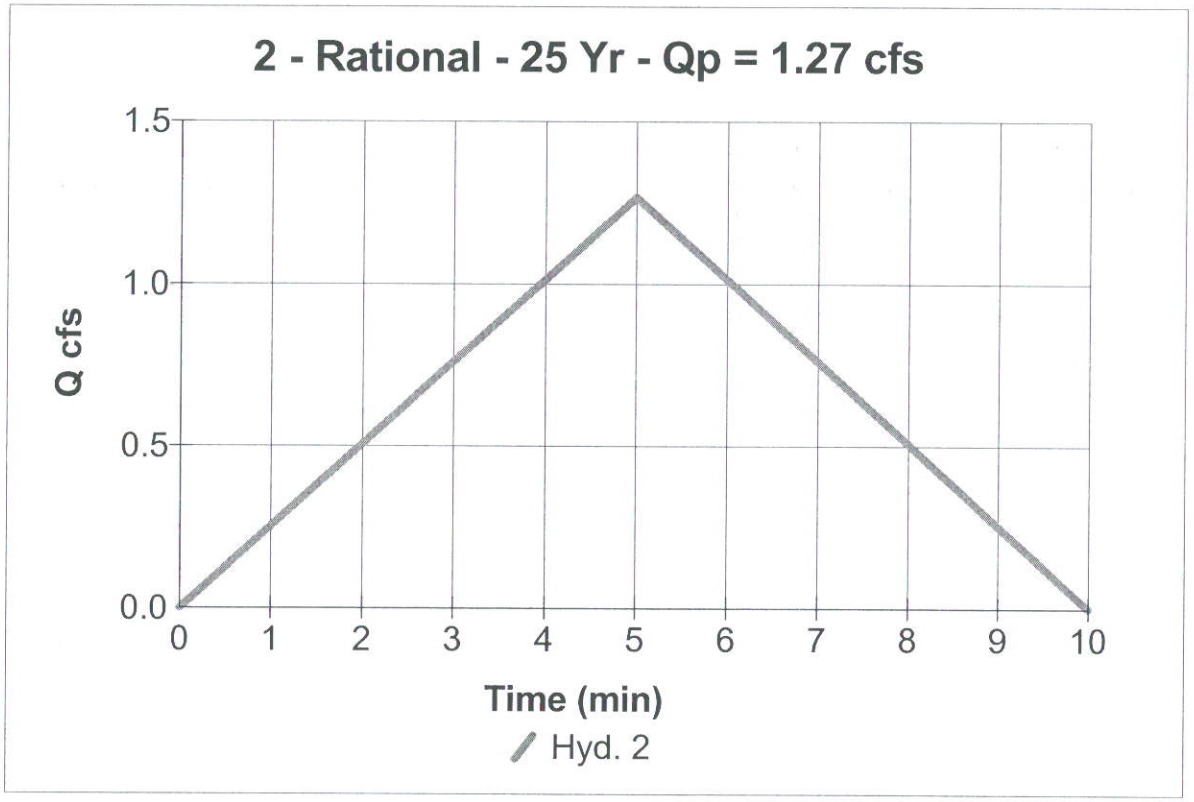
Hydrograph Plot

Hyd. No. 2

PRO BASIN C

Hydrograph type	= Rational	Peak discharge	= 1.27 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.3 ac	Runoff coeff.	= 0.75
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 380 cuft



Hydrograph Plot

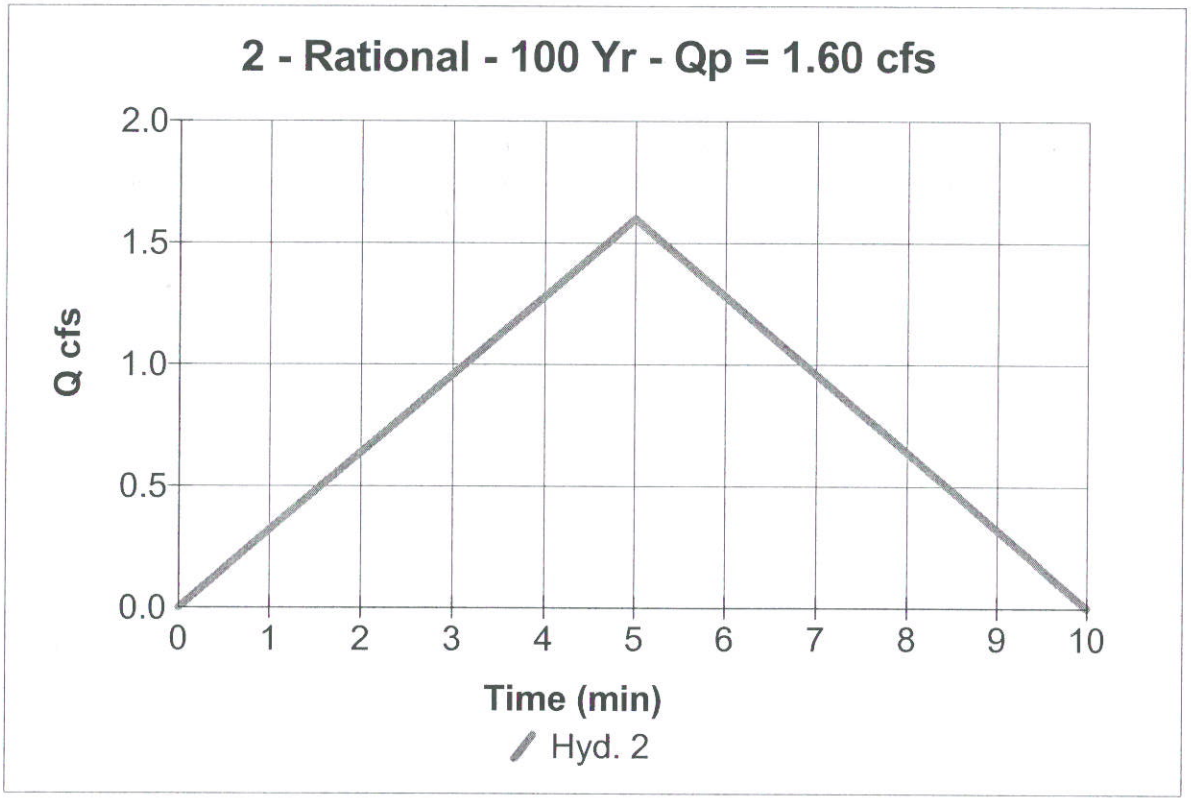
Hydraflow Hydrographs by Intelisolve

Hyd. No. 2

PRO BASIN C

Hydrograph type	= Rational	Peak discharge	= 1.60 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.3 ac	Runoff coeff.	= 0.75
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 480 cuft



Hydrograph Plot

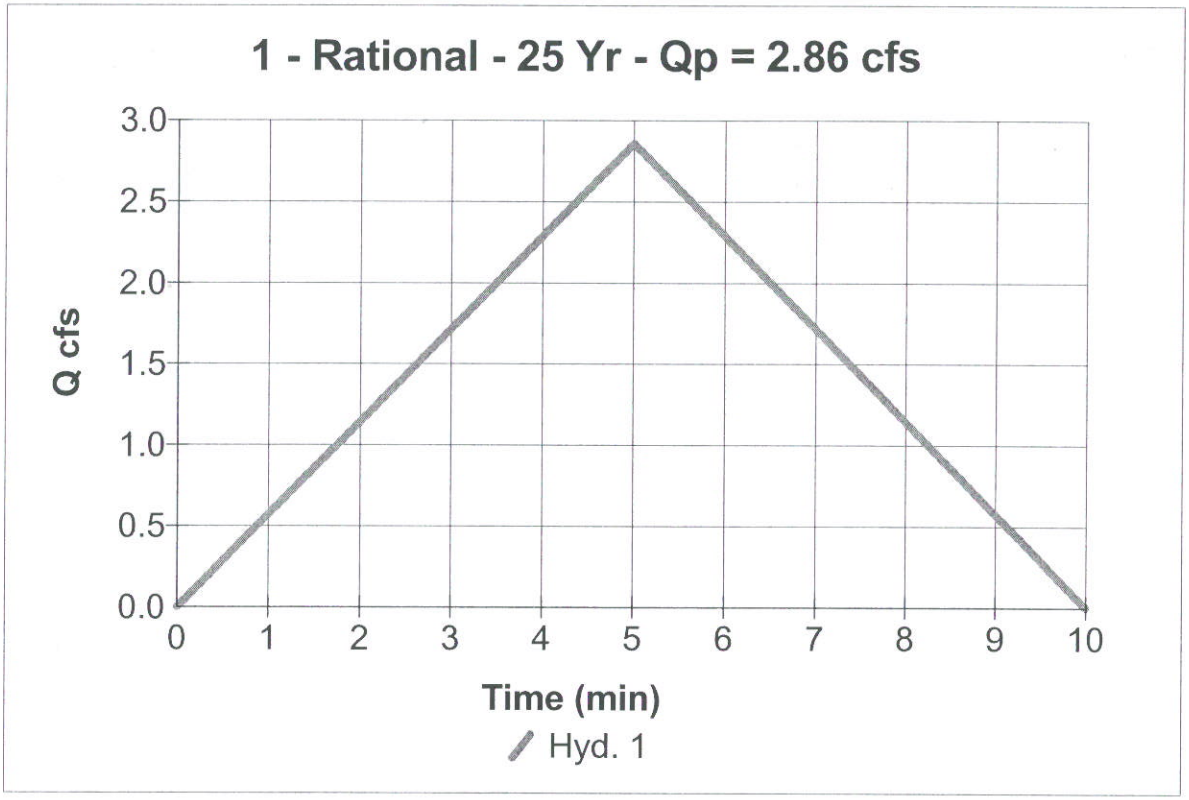
Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

PRO BASIN D

Hydrograph type	= Rational	Peak discharge	= 2.86 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.89
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 858 cuft



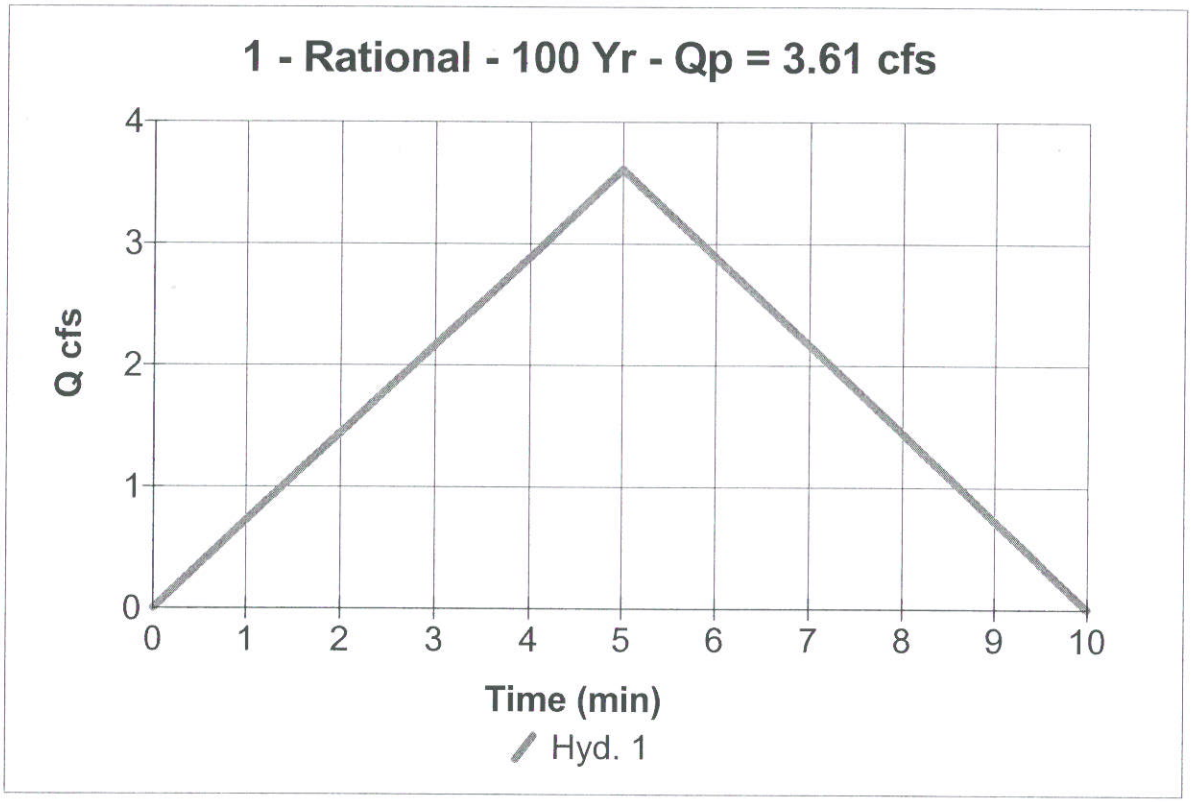
Hydrograph Plot

Hyd. No. 1

PRO BASIN D

Hydrograph type	= Rational	Peak discharge	= 3.61 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.89
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,084 cuft



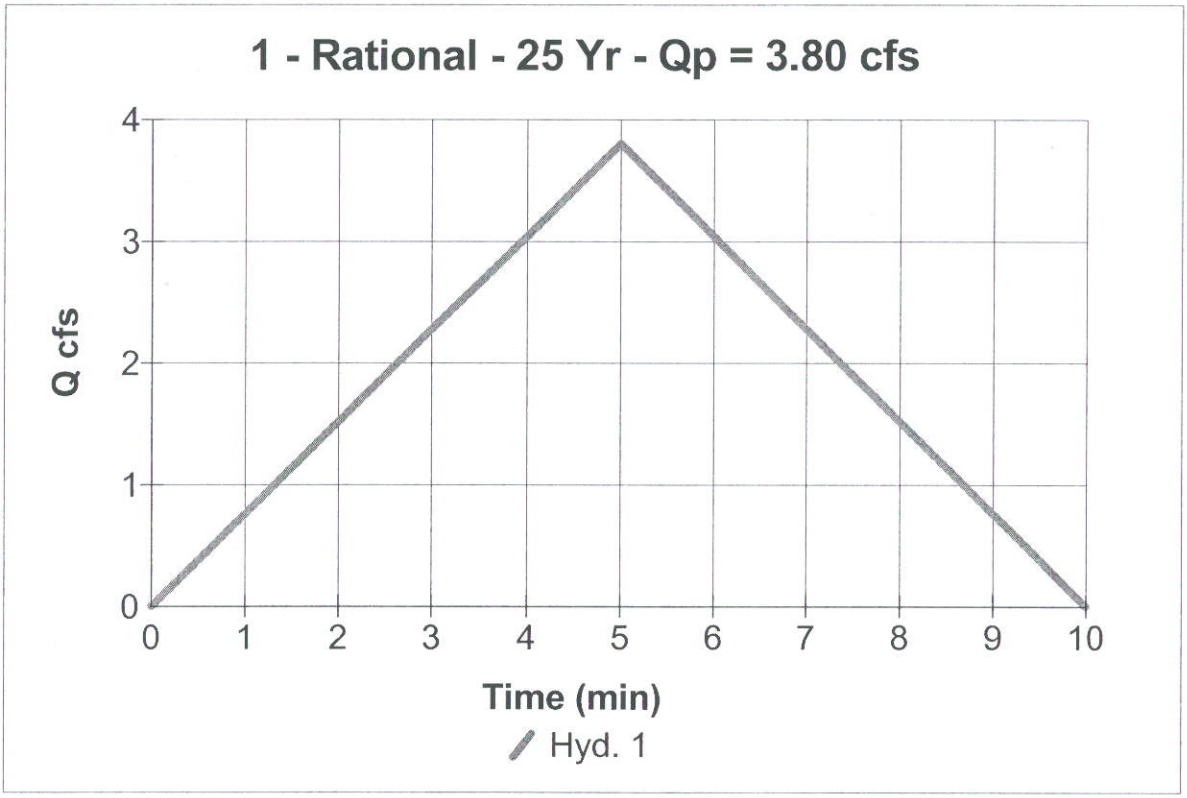
Hydrograph Plot

Hyd. No. 1

PRO BASIN E

Hydrograph type	= Rational	Peak discharge	= 3.80 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.97
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,141 cuft



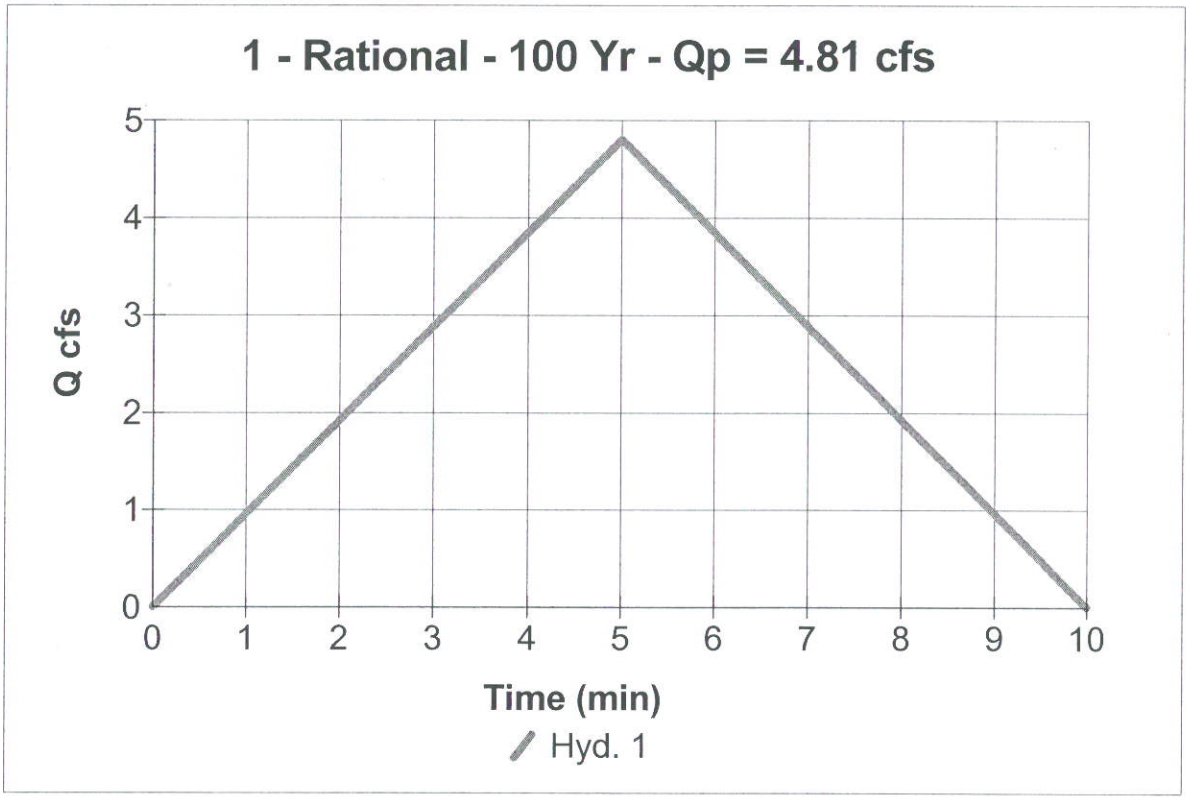
Hydrograph Plot

Hyd. No. 1

PRO BASIN E

Hydrograph type	= Rational	Peak discharge	= 4.81 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.7 ac	Runoff coeff.	= 0.97
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 1,442 cuft



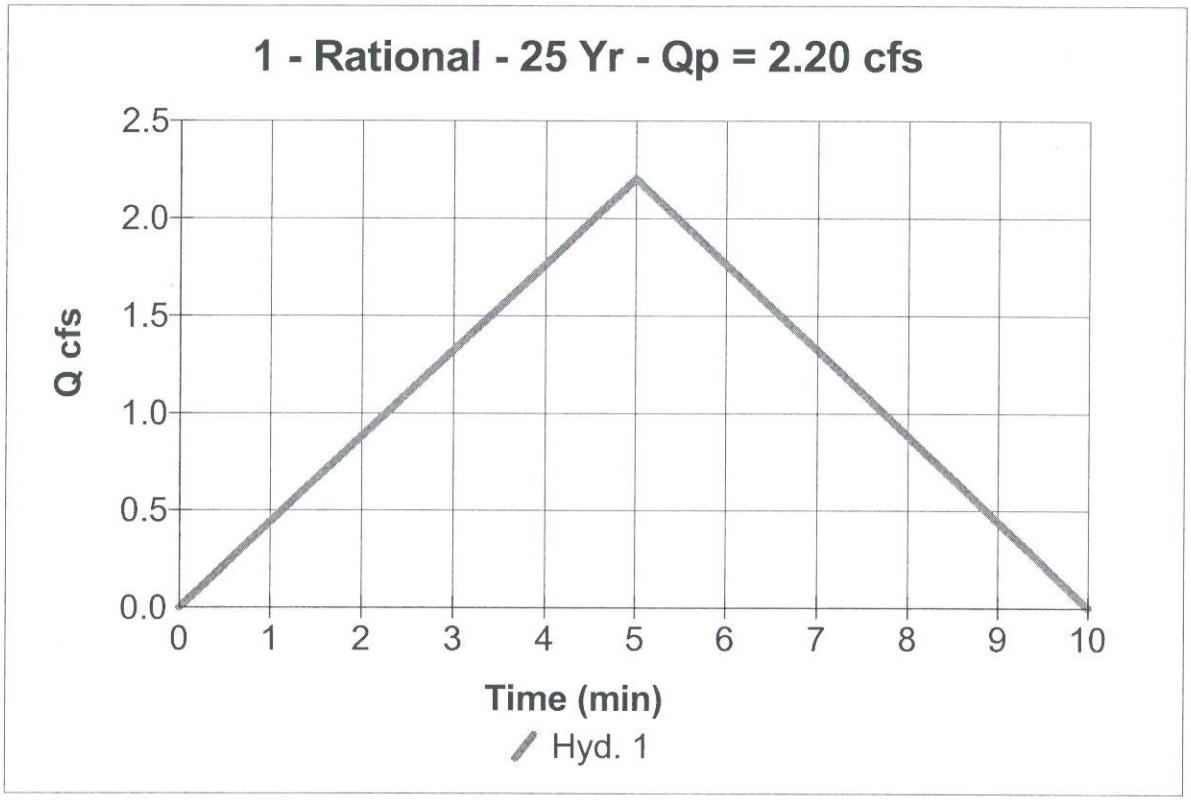
Hydrograph Plot

Hyd. No. 1

PRO BASIN F

Hydrograph type	= Rational	Peak discharge	= 2.20 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.71
Intensity	= 5.446 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 661 cuft



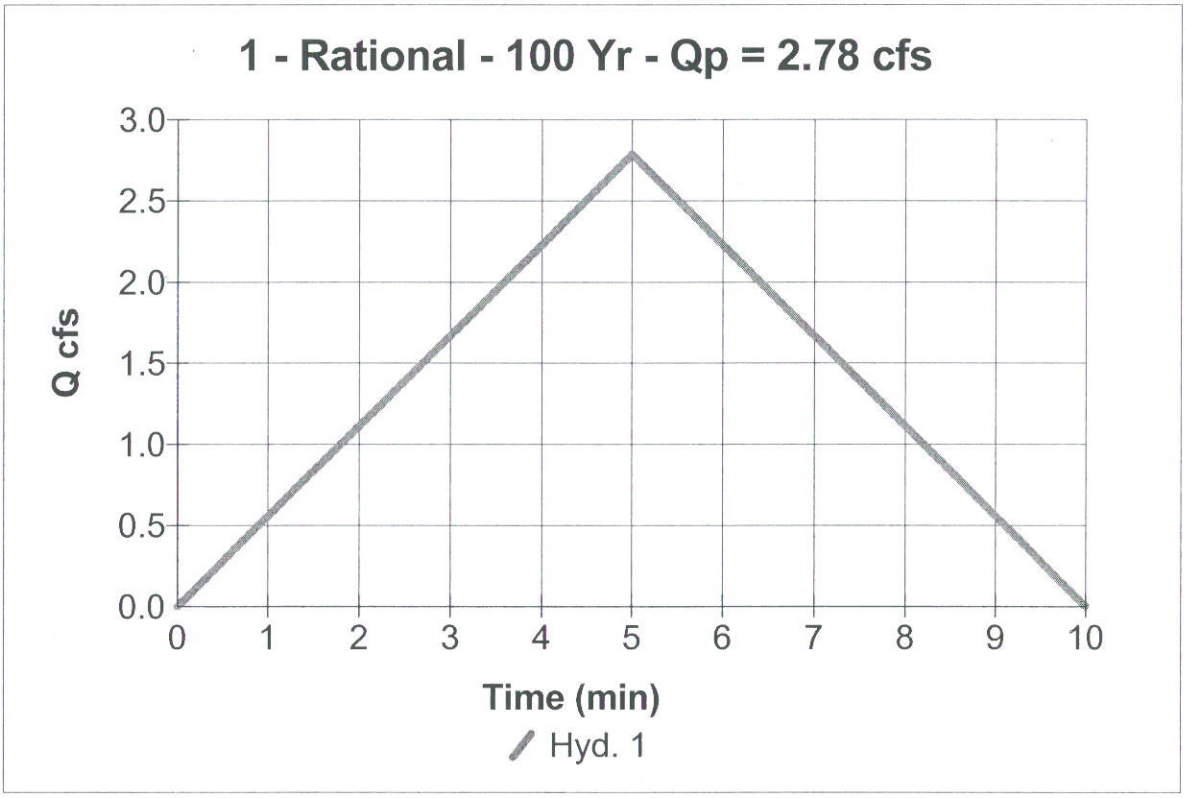
Hydrograph Plot

Hyd. No. 1

PRO BASIN F

Hydrograph type	= Rational	Peak discharge	= 2.78 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 0.6 ac	Runoff coeff.	= 0.71
Intensity	= 6.880 in/hr	Time of conc. (Tc)	= 5 min
IDF Curve	= 08KEYTONE.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 835 cuft



APPENDIX B-

Exhibit A- Existing Drainage Plan
Exhibit B- Proposed Drainage Plan

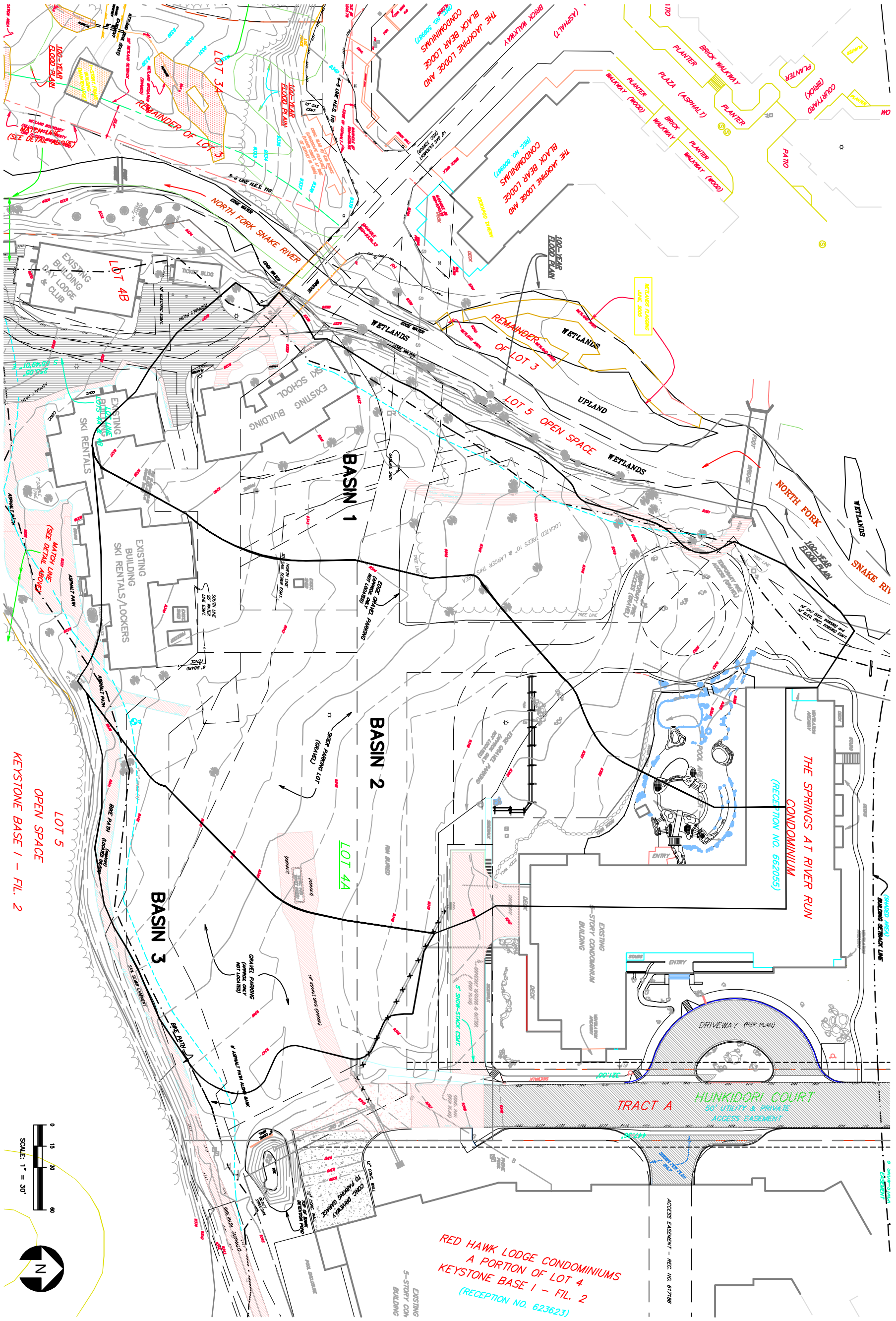


EXHIBIT A

Client: Oz Architecture
Proj. Loc.: Keystone, Colorado

ONE RIVER RUN
KEYSTONE RESORT

APPENDIX B
EXISTING DRAINAGE PLAN

MARK	DATE	DESCRIPTION	BY

DD
NOT APPROVED FOR CONSTRUCTION

Project No.: 02797-08001
Designed By:
Drawn By: CAM
Checked By: CDD

TETRA TECH
www.tetratech.com
410 South French Street P.O. Box 1659
Breckenridge, Colorado 80424
PHONE: (970) 453-6394 FAX: (970) 453-4579

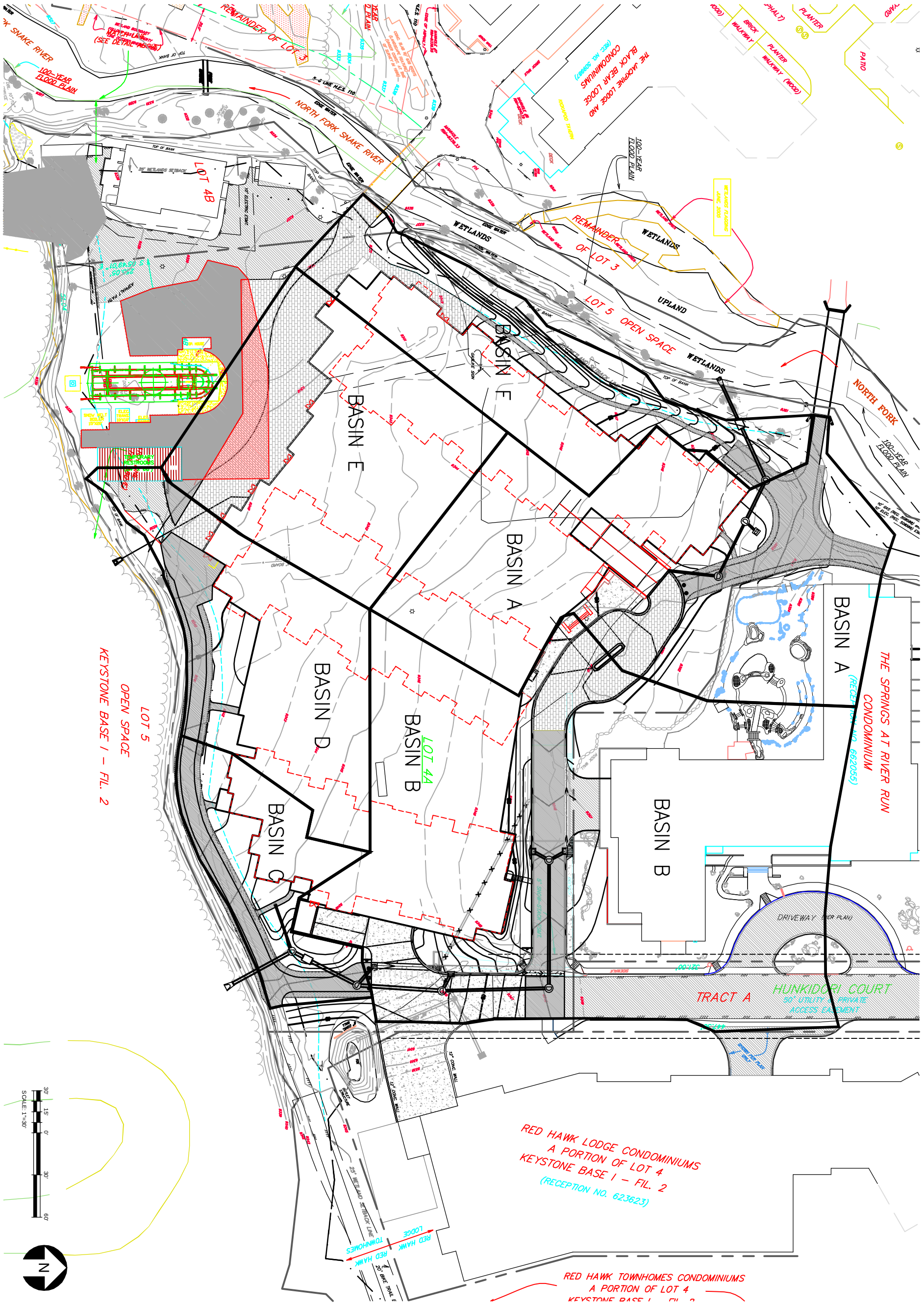


EXHIBIT B

Project No.:	02797-08001
Designed By:	CMS
Drawn By:	CMS
Checked By:	CDD

Client: Oz Architecture
Proj. Loc.: Keystone, Colorado

ONE RIVER RUN
KEYSTONE RESORT

APPENDIX B
PROPOSED DRAINAGE PLAN

MARK	DATE	DESCRIPTION	BY

DD
NOT APPROVED FOR CONSTRUCTION

TETRA TECH
www.tetratech.com
410 South French Street P.O. Box 1659
Breckenridge, Colorado 80424
PHONE: (970) 453-6394 FAX: (970) 453-4579

APPENDIX C- Letter from Wright Water Engineers

WWE
Wright Water Engineers, Inc.
2490 West 26th Ave., Suite 100A
Denver, Colorado 80211
(303) 480-1700 TEL
(303) 480-1020 FAX
www.wrightwater.com
e-mail:aearles@wrightwater.com

May 31, 2006

Via fax: 970-668-4225

Mr. Ric Pocius, P.E.
Summit County Engineering Department
P.O. Box 5660
37CR1005
Frisco, CO 80443

Re: Summary of May 24, 2006, meeting on Marriott Grand Residences in River Run at Keystone Resort

Dear Ric:

Wright Water Engineers, Inc. (WWE) has prepared this letter to summarize our understanding following our meeting on Wednesday, May 24th, 2006, regarding water quality and drainage for the Marriott Grand Residences in River Run at Keystone Resort. Wright Water Engineers, Inc. (WWE) attended this meeting with you and Alpine Engineering Inc. (AEI) to discuss requirements for water quality and detention for the proposed project. It is our understanding that the following general strategy for water quality and drainage for the project site will be acceptable to Summit County:

1. Runoff from impervious ground surfaces such as drives and walkways will be collected in a storm sewer system and directed to storm water quality treatment devices (stormceptors) on the site prior to discharge to the North Fork of the Snake River. These devices will provide gravitational separation of solids and floatables, thereby providing water quality treatment prior to discharge. Maintenance of these devices will be very important in order to assure that they provide the water quality functions for which they are designed. These devices will be included in the maintenance plan for the project, and we understand that frequent monitoring to determine the necessary maintenance frequency will be very important during initial operation.

2. Runoff from aprons to the subsurface parking area and melt water within the parking area will receive treatment via oil and grit separators. As with the stormceptors, maintenance of these devices will be important and will be addressed in the maintenance plan for the project.

3. Runoff from roof drains will be directed to landscaped areas rather than onto other impervious surfaces, thereby reducing directly connected impervious area on the site. This runoff will be collected in underdrains beneath the landscaped areas and will be conveyed to the North Fork of the Snake River.

4. Because of the very short time of concentration of the project site and its close proximity to the North Fork of the Snake River (relative to the much longer time of concentration

associated with flood flows in the North Fork of the Snake River), large-scale underground storage for peak attenuation will not be required for the project site.

WWE believes that the strategy described above is consistent with the overall water quality protection strategy that has been implemented for other development projects in the River Run area. We sincerely appreciated the opportunity to meet with you and AEI to discuss this strategy. If you have any questions or require clarifications related to the summary provided above, please do not hesitate to contact us.

Very truly yours,

WRIGHT WATER ENGINEERS, INC.

By _____
T. Andrew Earles, Ph.D., P.E.
Water and Civil Engineer

cc: Don Leinweber, P.E., Alpine Engineering (Via email: dleinweber@comcast.net)
Becky Stone, Oz Architecture (Via email: bstone@ozarch.com)