

ADDENDUM TO THE CONCEPTUAL DRAINAGE STUDY UPDATE NO. 3

Kyle Canyon Gateway

APRIL 2022

PREPARED FOR:
Tri Pointe Homes
Las Vegas, Nevada

PREPARED BY:

Westwood

Kyle Canyon Gateway

Conceptual Drainage Study Update No. 3 Addendum

City of Las Vegas, NV

Prepared For:

Tri Pointe Homes Nevada, Inc.
4675 W. Teco Ave., Suite 115
Las Vegas, NV 89118

Prepared By:

Westwood Professional Services
5725 W. Badura Avenue, Suite 100
Las Vegas, NV 89118
Phone: (702) 284-5300
Fax: (702) 284-5339

Project Number: PAR2004.000
Date: April 2022

Lant Leavitt, P.E.
NV Professional Engineer No. 18287

Assisted by: Phil Koerschner

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL
DRAINAGE STUDY INFORMATION FORM

Name of Development: Addendum to the Kyle Canyon Gateway Conceptual Study Update No. 3 Date: 04/14/2022
 Location of Development: a) Descriptive (Cross Streets): North/South: Alpine Ridge Way
East/West: Kyle Canyon Rd
 b) Section: 1 Township: 19 S. Range: 59 E.
 c) APN: See attached sheet.

Name of Owner: Tri Pointe Homes
 Telephone No.: 702-614-1400 Fax No.: 702-873-6881 E-mail Address: Dan.Hale@PardeeHomes.com
 Address: 4675 West Teco Avenue, Suite 115 Las Vegas NV 89118

Contact Person – Name: Lant Leavitt, P.E. Telephone No.: (702) 284-5300
 *E-mail Address: lant.leavitt@westwoodps.com Fax No.: (702) 284-5399
 Firm: Westwood Professional Services
 Address: 5725 W. Badura Ave, #100 Las Vegas NV 89118

Type of Land Development/Land Disturbance Process:

☐ Rezoning	☐ Subdivision Map	☐ Clearing and grading Only
☐ Parcel Map	☐ Planned Unit Development	☒ Other (Please specify below)
☐ Large Parcel Map	☐ Building Permit	☐ Conceptual Drainage Analysis

- Total Owned Land Area: At Site: 87.7 ac +/- Being Developed/Disturbed: All
- Is a portion or all of the subject property located in a FEMA Flood Hazard Area? ☐ Yes** ☒ No
- Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ Yes** ☐ No
- Proposed type of development (Residential, Commercial, Etc.): Residential
- Approximate upstream land area which drains to the subject site: approx 2.6 sqmi
- Has the site drainage been evaluated in the past? ☒ Yes** ☐ No If yes, please identify documentation: Conceptual Drainage Study for Kyle Canyon Gateway, Conceptual Drainage Study Update Numbers 1 and 2 for Kyle Canyon Gateway
- If known, please briefly identify the proposed discharge point(s) of runoff from the site: East side of site toward existing US 95 culverts
- Briefly describe your proposed schedule for the subject project: ASAP



Engineer's Seal

Submit this form as part of the required drainage study to the local entity which has jurisdiction over The subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

***Newly Required Field**
****Review and concurrence of the Clark County Regional Flood Control District is required**

Local Entity File No.	Revision	Date

REFERENCE:

STANDARD FORM 1

Updated 05/01/2008

APN 126-01-601-014, 126-01-601-007, 126-01-701-006, 126-01-701-005, 126-01-701-004, 126-01-601-012, 126-01-601-013, 126-01-501-007, 126-01-501-006, 126-01-601-002, 126-01-601-010, 126-01-601-008, 126-01-601-009, 126-01-601-011, 126-01-701-001, 126-01-701-002, 126-01-701-009, 126-01-501-005

PAR2004.000

April 14, 2022

Albert Sung, P.E.
City of Las Vegas
495 S. Main Street
Las Vegas, NV 89101

Subject: Kyle Canyon Gateway Conceptual Drainage Study Update No. 3 Addendum

Mr. Sung:

This letter certifies that all items provided on electronic submittal CD matches 100% of the *Kyle Canyon Gateway Conceptual Drainage Study Update No. 3 Addendum* bound paper version.

Respectfully Submitted,
WESTWOOD PROFESSIONAL SERVICES



Phil Koerschner, E.I.
Graduate Engineer – Water Resources Department

PAR2004.000

April 14, 2022

City of Las Vegas
495 S. Main Street
1st Floor
Las Vegas, Nevada 89101

**Subject: Addendum to the Conceptual Drainage Study Update No. 3 for
Kyle Canyon Gateway (CLV# DS5414)**

This letter is submitted in response to the comments contained in the April 1, 2022 review memorandum, regarding the above referenced project. A copy of the Clark County Public Works – Development Review comment letter has been provided in Appendix A. The comments in the review memorandum have been individually addressed as follows:

Comments 1 – 5 shall be addressed for the Conceptual Drainage Study Update #3 approval:

- 1. Comment: Exhibit F - Proposed Condition and Exhibit G – Ultimate Condition:**
The Proposed Condition for Unit 3 (ON3C) has a 100-year flow of 47 cfs. The Ultimate Condition for Unit 3 (A2 and B2) has a combined flow of 22 cfs based upon the prorated flows. The Proposed Condition for Unit 4 (ON3A and ON3B) has a 100-year flow of 24 cfs. The Ultimate Condition for Unit 4 (C2a and C2b) has a combined flow of 10 cfs based upon the prorated flows. It is apparent that the proposed developments have a higher density than what was developed with the 2018 MPU. This discrepancy in the developed CN values needs to be addressed so that the facility along the Michelli Crest alignment is sized to convey the 100-year flow in the Ultimate Condition to the north and continues to meet the Intend of the 2018 MPU. Update the facility sizes of the “U” facilities on Exhibit G accordingly.

Response: The original study included pro-rated flows of 2018 MPU subbasins to determine ultimate condition flow rates for design. As stated in the review comment, proposed condition hydrology for the development area is showing a higher rate of runoff than the ultimate condition pro-rates. To address this, an ultimate condition HEC-1 model has been created, see Appendix C for hydrologic parameter calculations and HEC-1 model. The HEC-1 model includes subbasins for the proposed development area using the proposed condition HEC-1 parameters, but routes them according to the ultimate condition, meaning that Michelli Crest Way is a 100-yr cutoff and flows are routed north along this alignment to Moccasin Road.

Note that although the proposed development area and several adjacent downstream offsite subbasins are included in the HEC-1 model, the majority of the offsite area is still pro-rated from the 2018 MPU, and therefore ultimate condition flow rates should be taken from Exhibit G, rather than straight from the ultimate condition HEC-1 model. Exhibit G shows the combined HEC-1 and 2018 MPU pro-rated flows for the total flow rate at concentration points.

2. **Comment:** *The Conceptual Drainage Study Update #3 shall discuss the Updated Exhibits F & G and include the updated Ultimate KCG Units 2, 3, and 4 flow impacts to the Ultimate "U" facilities.*

Response: Exhibit F is updated as discussed in Comment Response #3. Exhibit G is updated as discussed in Comment Response #1. Impacts to individual units is as follows:

- **KCG East** – offsite storm drain in McKinster Road is reduced in size from 60-in RCP to 18-in RCP and may be able to be removed completely if interim and ultimate condition flow routing concerns can be addressed with individual unit TDS, see Comment Response #3.
- **Unit 1** – No change.
- **Unit 2** – Storm drain in Rocky Avenue between west edge of Unit 2 and Michelli Crest Way is proposed to be increased in size from 60-in RCP to 72-in RCP to accommodate offsite flows from both DIV-3 and DIV-4, see Comment Response #3. Ultimate condition flow rates are increased along Michelli Crest Way from the previous study, however that study sized the proposed storm drain facilities conservatively and no changes to ultimate condition facility sizes in Michelli Crest are proposed with this study. The individual technical study will analyze the facility hydraulics in greater detail and confirm the required facility size for the increased flow rate.
- **Unit 3** – No change.
- **Unit 4** – Storm drain previously proposed through basin ON3A is eliminated in favor of routing offsite flows from DIV-4 north in Alpine Ridge Way then east in Rocky Avenue to the 60-in RCP in KCG East. Proposed storm drain in McKinster Road is reduced in size and may be able to be eliminated completely, see Comment Response #3.

3. **Comment:** *Exhibit F – Proposed Condition: Update the Exhibit to include the KCG Unit 4 storm drain extension from the proposed Kyle Canyon Gateway East facility near Rocky Ave. and McKinster Rd. to the west side of the proposed Unit 4 improvements.*

Response: The original study proposed to have offsite flow impacting the west edge of Unit 4 near Ruston Road (DIV-4) conveyed east through the site and discharged into the undeveloped parcel to the east (OFF4B). To address the review comment, the DIV-4 flows are now proposed to be intercepted along the west edge of Unit 4 and conveyed north in Alpine Ridge Way, then east in Rocky Avenue to the KCG East 60-in RCP at McKinster Road. Sections representing the revised storm drain reaches are labeled on Exhibit F in Appendix B, and hydraulic analysis is included in Appendix D.

The storm drain previously proposed in McKinster Road is no longer needed to convey offsite flow from the west, however an 18-in RCP is still proposed here to convey interim condition flows from subbasin OFF4B. It is reasonable to assume that OFF4B can drain overland to McKinster Road in the future, and if the TDS for the individual unit can show that positive drainage can be maintained in the interim from OFF4B into McKinster Road, a storm drain may not be needed in this reach.

4. **Comment:** *The Conceptual Drainage Study Update #3 shall discuss the extension of the Proposed Storm Drain from the west side of Unit 4 to the 60" RCP proposed with Kyle Canyon Gateway East.*

Response: As discussed in Comment Response #3, the 60-in RCP in Rocky Avenue at McKinster Road is now proposed to be extended west up Rocky Avenue and then south in Alpine Ridge Way to collect offsite flows. This addresses Comment #3 and eliminates the proposed discharging of offsite flow through subbasin OFF4B in Exhibit F.

5. **Comment:** *Update the Phasing Plan for the Proposed Condition facilities necessary for each Unit as part of Exhibit F. The impacted area of Future Unit #4 needs to include both Concept and Future (Ultimate) facilities.*

Response: A phasing plan is provided with this addendum, see Appendix B. Note that this is the preferred phasing order for the developer, but that this phasing plan is subject to schedule constraints of individual phasing, sometimes due to circumstances outside the developers control.

6. **Comment:** *The Conceptual Study identifies changes to the adopted 2018 MPU. **The proposed changes do not require that the City and Clark County Regional Flood Control District (CCRFCDD) approve an Amendment to the Master Plan at this time.** If an Amendment to the Master Plan is deemed necessary, coordinate the requirements of the Master Plan Amendment with the City and Regional Flood prior to submittal. The Master Plan Amendment shall be approved prior to construction of these facilities to assure compliance with the intent of the Master Plan.*

Response: Noted.

7. **Comment:** *The conceptual study proposes Local facility extensions to the Clark County Regional Flood Control District (CCRFCDD) Master Planned facilities. The conceptual interim and conceptual ultimate facilities needed for this development needs to be included as a part of this study. Therefore, CCRFCDD concurrence is required prior to final approval of the technical drainage study.*

Response: Noted.

8. **Comment:** *The approval of this Conceptual Drainage Study is limited to the scope of the hydrologic aspects such as the conceptual local collection facilities needed to convey the interim flows and how the development will meet the intent of the MPU Basin routing identified in the 2018 MPU. Hydraulic analysis at the conceptual stage is preliminary and requires the future technical drainage study to support the final design of the proposed facilities. A detailed hydraulic analysis shall be included to verify the proposed facilities provide the capacity to capture and carry the design flows as stated in the study. A Phasing*

Plan shall be provided with each of the technical studies to identify what facilities are necessary for the development to move forward.

Response: Phasing plan included with this conceptual update addendum, see Appendix B.

9. **Comment:** *Development of Unit #3, west of the Michelli Crest alignment, does not change the intent of the MPU boundary. The flows intercepted and routed by the proposed Alpine Way drainage facility and the developed flows from Unit #3 will be conveyed to the Ruston Road & Michelli Crest intersection. The Ultimate Condition facility will convey the flows north as shown on Exhibit G.*

Response: Agreed. This conceptual update addendum maintains the intent of Michelli Crest Way being a 100-yr storm cutoff and routing ultimate condition flows north to Moccasin Road.

10. **Comment:** *Development of the portion of proposed Unit #4, west of the Michelli Crest alignment, does not change the intent of the MPU boundary. The flows intercepted and routed by the proposed Alpine Way drainage facility and the developed flows from the portion of Unit #4 will be conveyed to the Michelli Crest alignment. The Ultimate Condition facility will convey the flows north as shown on Exhibit G. Verify the required facility sizes going north of Ruston Rd.*

Response: Agreed. Required ultimate condition facility sizes in Michelli Crest Way north of Ruston Road are included with the conceptual study update addendum.

The following comments pertaining to the conceptual drainage study and are provided to assist with the future Technical Drainage Study:

11. **Comment:** *The Technical Drainage Studies for KCG Units 2, 3 and 4 shall include the Future Ultimate Storm Drain Facility within the Michelli Crest alignment, from Ruston Road north to Trails End Ave.*

Response: To be addressed with individual unit TDS.

12. **Comment:** *The concept Storm Drain in KCG Unit 4 identifies high velocity flows that need to be addressed with the Technical Drainage Study.*

Response: To be addressed with individual unit TDS.

13. **Comment:** *The TDS for each the Proposed Units shall include a Phasing Plan for the Proposed Condition facilities necessary for each Unit and clearly identify any interim facilities.*

Response: To be addressed with individual unit TDS.

14. **Comment:** *The TDS for each the Proposed Units shall include a Phasing Plan for the Ultimate Condition facilities necessary for each Unit to meet the intent of the MPU. The construction phasing sequence of the Ultimate facility within the Michelli Crest alignment from Ruston north to Rocky and from Rocky north to Trails End needs to be defined within the Phasing Plans to allow for the complete Ultimate Facility.*

Response: To be addressed with individual unit TDS.

15. **Comment:** *The TDS shall incorporate the Ultimate Condition Facilities into the proposed Unit Improvement Plans in addition to the required Interim (Proposed Condition) Facilities.*

Response: To be addressed with individual unit TDS.

16. **Comment:** *Flood Control understands that the 2D Model serves as the basis for the flow split percentages that are applied to the Diversions shown in the HEC-1 analysis.*

Response: Agree.

17. **Comment:** *The 2D Model has been extended upstream of the flow split from Basin OFF3. The flow split near the intersection of Kyle Canyon Road and Nicholson Street is about a 50/50 split based upon the 2D Model. Based upon the 2D Model information, this result seems reasonable for the Conceptual Study.*

Response: Agree.

18. **Comment:** *The extension of the drainage facilities within the Michelli Crest Way alignment north of Ruston to convey flows north toward the Moccasin MPU facility alignment shall be conveyed in a storm drain system within the Michelli Way improvements.*

Response: Agree.

19. **Comment:** *The TDS needs to verify that the existing culverts crossing US95 have the appropriate capacity to convey the flows based upon your presented flow rates. These culvert systems shall be evaluated to show the flows in the culverts and flow splits (if any). What are the impacts of possible flow splits along US 95.*

Response: To be addressed with individual unit TDS.

20. **Comment:** *A TDS Update for the previously approved Kyle Canyon Gateway Unit 1 is required in order to address the revision to remove the 20-foot drainage easement. The Update must also analyze an interim condition and provide interim flood-protection prior to the construction of the Ultimate Condition facility in Alpine Ridge Way.*

Response: To be addressed with individual unit TDS.

We believe the above responses and revisions provided in the revised appendix material have adequately satisfied the concerns in the subject review memorandum. If you have any questions or require additional information, please do not hesitate to contact our office at (702) 284-5300.

Respectfully Submitted,
WESTWOOD PROFESSIONAL SERVICES



Lant Leavitt, P.E.
Project Manager – Water Resources Services

CC: Dan Poll, P.E.
Mark Failla, P.E., CFM

List of Appendices

Appendix A **City of Las Vegas Comment Letter & Coordination**

Appendix B **Drainage Exhibits**

- Exhibit F – Proposed Condition Drainage Map
- Exhibit G – Ultimate Condition Drainage Map
- Kyle Canyon Gateway Unit Phasing Order Exhibit

Appendix C **Hydrologic Analyses**

- Curve Number and Lag Time Computations
- Ultimate Condition HEC-1 Model

Appendix D **Hydraulic Analyses**

- Proposed Condition Hydraulic Sections
- Ultimate Condition Hydraulic Sections

APPENDIX A

City of Las Vegas Comment Letter & Coordination

CITY OF LAS VEGAS		DATE:
INTER-OFFICE MEMORANDUM		April 1, 2022
TO: Land Development Services Department of Building & Safety		FROM: Oh-Sang Kwon, P.E. Flood Control, Project Manager Department of Public Works
SUBJECT:	Drainage Study for:	COPIES TO:
Conceptual Drainage Study – Kyle Canyon Gateway		Westwood PS
Cross Streets:	Alpine Ridge Way & Kyle Canyon Road	Tri Pointe Homes
File Number:	F:\Depot\DSMemos\DS5414F.doc	Bart Anderson, P.E., DevCo
Parcel Number:	Various, 12601601..., 12601501..., etc.	CCRFC
Zoning Action:	N/A	
FEMA Flood Zone	YES NO X	
Proposed Storm Drain	YES X NO	

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES	FEES PAID Payment Trn #
1 st Submittal	1/20/2021	2/2/2021	See Comments Below	\$400.00	4138484: \$400
2 nd Submittal	2/24/2021	3/4/2021	Conditionally Approved	\$400.00	4179382: \$400
3 rd Submittal	9/27/2021	10/19/2021	Conditionally Approved	\$100.00	4466210: \$100
4 th Submittal	10/19/2021	11/18/2021 & 12/9/2021	Not Approved	\$100.00	4501147: \$100
5 th Submittal	12/22/2021	12/29/2021	Conditionally Approved	\$400.00	4581759: \$400
6 th Submittal	3/8/2022	3/31/2022	Not Approved	\$100.00	4680518: \$100
TOTAL FEES (LDDRS):				\$1400.00	----

REMARKS: The Conceptual Drainage Study sets the parameters for the detailed Technical Drainage Study for the proposed Local Facilities and modifications to the MPU Basins and Facilities identified in the 2018 MPU in the Kyle Canyon area.

6th Submittal: Update #3 to expand analysis for Future Kyle Canyon Gateway (KCG) Unit 4 and minor adjustments to overall Flows.

4th & 5th Submittal: Update #2 and Addendum to expand the areas of analysis to include Kyle Canyon Gateway Unit 2 (Rocky Ave to the South, Trials End Ave to the North, and 340-feet to the east and west of Michelli Crest Way and adjust Interim Condition flow routing.

3rd Submittal: Update #1, Conceptual analysis of storm drain system in Alpine Ridge Way instead of drainage easement channel along Michelli Crest Way.

The Conceptual Drainage Study for the subject project has been reviewed and:

	is Conditionally Approved subject to conformance to all City standards and the following conditions:
X	must be resubmitted or supplemented including the following:
	is conditionally approved subject to Clark County Regional Flood Control District concurrence.
	is conditionally approved subject to Clark County Public Works Department concurrence.

Comments 1 – 5 shall be addressed for the Conceptual Drainage Study Update #3 approval:

1. **Exhibit F – Proposed Condition and Exhibit G – Ultimate Condition:** The Proposed Condition for Unit 3 (ON3C) has a 100-year flow of 47 cfs. The Ultimate Condition for Unit 3 (A2 and B2) has a combined flow of 22 cfs based upon the prorated flows. The Proposed Condition for Unit 4 (ON3A and ON3B) has a 100-year flow of 24 cfs. The Ultimate Condition for Unit 4 (C2a and C2b) has a combined flow of 10 cfs based upon the prorated flows. It is apparent that the proposed developments have a higher density than what was developed with the 2018 MPU. This discrepancy in the developed CN values needs to be addressed so that the facility along the Michelli Crest alignment is sized to convey the 100-year flow in the Ultimate Condition to the north and continues to meet the intent of the 2018 MPU. Update the facility sizes of the “U” facilities on Exhibit G accordingly.
2. The Conceptual Drainage Study Update #3 shall discuss the Updated Exhibits F & G and include the updated Ultimate KCG Units 2, 3, and 4 flow impacts to the Ultimate “U” facilities.
3. **Exhibit F – Proposed Condition:** Update the Exhibit to include the KCG Unit 4 storm drain extension from the proposed Kyle Canyon Gateway East facility near Rocky Ave. and McKinister Rd. to the west side of the proposed Unit 4 improvements.
4. The Conceptual Drainage Study Update #3 shall discuss the extension of the Proposed Storm Drain from the west side of Unit 4 to the 60” RCP proposed with Kyle Canyon Gateway East.
5. Update the Phasing Plan for the Proposed Condition facilities necessary for each Unit as part of Exhibit F. The impacted area of Future Unit #4 needs to include both Concept and Future (Ultimate) facilities.
6. The Conceptual Study identifies changes to the adopted 2018 MPU. ***The proposed changes do not require that the City and Clark County Regional Flood Control District (CCRFCD) approve an Amendment to the Master Plan at this time.*** If an Amendment to the Master Plan is deemed necessary, coordinate the requirements of the Master Plan Amendment with the City and Regional Flood prior to submittal. The Master Plan Amendment shall be approved prior to construction of these facilities to assure compliance with the intent of the Master Plan.
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8. The approval of this *Conceptual Drainage Study* is limited to the scope of the hydrologic aspects such as the conceptual local collection facilities needed to convey the interim flows and how the development will meet the intent of the MPU Basin routing identified in the 2018 MPU. Hydraulic analysis at the conceptual stage is preliminary and requires the future technical drainage study to support the final design of the proposed facilities. A detailed hydraulic analysis shall be included to verify the proposed facilities provide the capacity to capture and carry the design flows as stated in the study. A Phasing Plan shall be provided with each of the technical studies to identify what facilities are necessary for the development to move forward.
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19. The TDS needs to verify that the existing culverts crossing US95 have the appropriate capacity to convey the flows based upon your presented flow rates. These culvert systems shall be evaluated to show the flows in the culverts and flow splits (if any). What are the impacts of possible flow splits along US 95.
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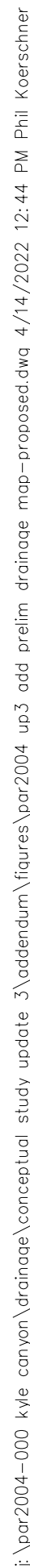
NOTE: Please be advised that all land surface area disturbances over 1 acre or any area adjacent to a water way must submit to the *Nevada Division of Environmental Protection* a "Notice of Intent" to discharge that certifies a stormwater pollution prevention plan has been developed and is maintained on site; for inclusion in the Stormwater General Permit No. NVR100000. A phased construction unit in a contiguous subdivision is considered under construction until all stripped or disturbed surface areas have been covered by paving, building construction or planting. For more information, including forms and applications see <http://ndep.nv.gov/bwpc/storm01.htm> or call (775) 687-9429.

END OF REMARKS
PBJ/OSK/JKS/PBJ

T/R/S: T19S/R59E/S1
AREA F-1

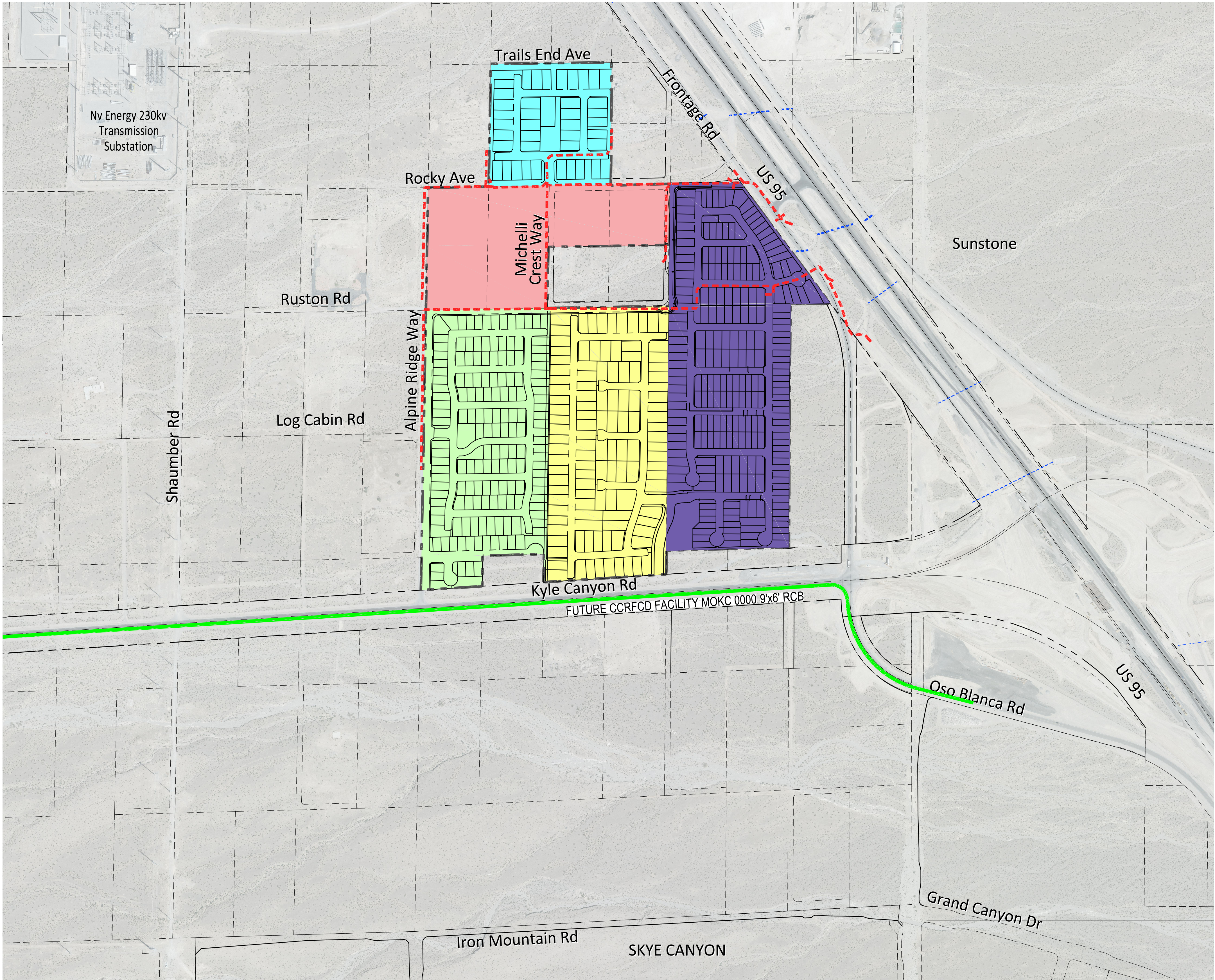
APPENDIX B

Drainage Exhibits



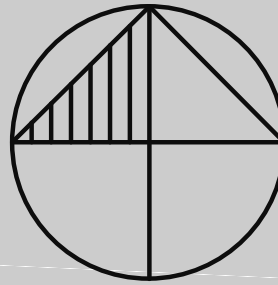
KYLE CANYON GATEWAY

City of Las Vegas, NV



KYLE CANYON GATEWAY PHASING ORDER

-  KYLE CANYON GATEWAY UNIT 1
GROSS ACREAGE: 22.90 AC
 -  KYLE CANYON GATEWAY EAST
GROSS ACREAGE: 31.06 AC
 -  KYLE CANYON GATEWAY UNIT 3
GROSS ACREAGE: 29.46 AC
 -  KYLE CANYON GATEWAY UNIT 2
GROSS ACREAGE: 9.08 AC
 -  KYLE CANYON GATEWAY UNIT 4
GROSS ACREAGE: 15.00 AC
- PROPOSED KYLE CANYON GATEWAY BOUNDARY
- EXISTING DRAINAGE FACILITY
- MPU CATEGORY B PROPOSED FACILITY
- PROPOSED DRAINAGE FACILITY



APPENDIX C

Hydrologic Analyses

Curve Number & Lag Time Computations

Kyle Canyon Gateway

Curve Number Calculations - Conservative B Soils

BASIN ID	Soil Survey	LAND USE INDEX NUMBER	SOIL MAP UNIT NUMBER	SUB REGION CN	SUB REGION AREA (AC)	BASIN AREA (AC)	PERCENT OF BASIN	CUMULATIVE PERCENT	AREA WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
OFF1	LAS VEGAS VALLEY	1	1107	77	685.25	685.25	100.0%	100.0%	77.00	77.00	77.0
OFF2	LAS VEGAS VALLEY	1	1107	77	59.61	59.61	100.0%	100.0%	77.00	77.00	77.0
OFF3	LAS VEGAS VALLEY	1	1107	77	1004.00	1004.00	100.0%	100.0%	77.00	77.00	77.0
OFF4A	LAS VEGAS VALLEY	1	1107	77	5.09	5.09	100.0%	100.0%	77.00	77.00	77.0
OFF4B	LAS VEGAS VALLEY	1	1107	77	5.26	5.26	100.0%	100.0%	77.00	77.00	77.0
OFF4C	LAS VEGAS VALLEY	1	1107	77	1.98	1.98	100.0%	100.0%	77.00	77.00	77.0
XON1	LAS VEGAS VALLEY	1	1107	77	15.72	15.72	100.0%	100.0%	77.00	77.00	77.0
XON2	LAS VEGAS VALLEY	1	1107	77	29.49	29.49	100.0%	100.0%	77.00	77.00	77.0
XON3	LAS VEGAS VALLEY	1	1107	77	54.38	54.38	100.0%	100.0%	77.00	77.00	77.0
XON4	LAS VEGAS VALLEY	1	1107	77	19.49	19.49	100.0%	100.0%	77.00	77.00	77.0
ON1A	LAS VEGAS VALLEY	6	1107	83	10.02	10.02	100.0%	100.0%	83.00	83.00	83.0
ON2A	LAS VEGAS VALLEY	6	1107	83	47.12	47.12	100.0%	100.0%	83.00	83.00	83.0
ON2B	LAS VEGAS VALLEY	6	1107	83	7.41	7.41	100.0%	100.0%	83.00	83.00	83.0
ON3A	LAS VEGAS VALLEY	6	1107	83	5.28	5.28	100.0%	100.0%	83.00	83.00	83.0
ON3B	LAS VEGAS VALLEY	6	1107	83	5.27	5.27	100.0%	100.0%	83.00	83.00	83.0
ON3C	LAS VEGAS VALLEY	6	1107	83	23.97	23.97	100.0%	100.0%	83.00	83.00	83.0
ON4B	LAS VEGAS VALLEY	6	1107	83	5.74	5.74	100.0%	100.0%	83.00	83.00	83.0
OFF4A	LAS VEGAS VALLEY	6	1107	83	5.09	5.09	100.0%	100.0%	83.00	83.00	83.0
OFF4B	LAS VEGAS VALLEY	6	1107	83	5.26	5.26	100.0%	100.0%	83.00	83.00	83.0
OFF4C	LAS VEGAS VALLEY	6	1107	83	1.32	1.98	66.7%	66.7%	55.33	55.33	
OFF4C	LAS VEGAS VALLEY	7	1107	89	0.66	1.98	33.3%	100.0%	29.67	85.00	85.0



HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

Project Name & Number: PAR2004 KYLE CANYON GATEWAY UP3

Description: EXISTING, PROPOSED, & ULTIMATE CONDITIONS

By: PK

Date: 4/13/2022

SUB-BASIN DATA					INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)				Tc	Tc Check Urbanized Basins		Flag		
DESIG:	DEV./EX. (D or E)	CN	K	AREA Ac	AREA Mi^2	INITIAL	SLOPE	Ti	TRAVEL	SLOPE	V1	V2	Tt	Tc	Tc	Flag	
						LENGTH Feet	%	Min	LENGTH Feet	%	VELOCITY FPS	VELOCITY FPS	Min	Calc.	Check	Hours	
			[1]		[2]			[3]			[4]	[5]	[6]	[7]	[8]	[9]	[10]

EXISTING CONDITION

OFF1																	
OFF2	E	77.0	0.626	46.23	0.0722	145	6.90	5.39	6850	2.03	2.11	4.19	29.22	34.62			0.346
OFF3																	
XON1	E	77.0	0.626	15.72	0.0246	180	4.44	6.96	995	3.22	2.65	5.27	4.70	11.66			0.117
XON2	E	77.0	0.626	29.49	0.0461	170	4.12	6.93	1870	3.26	2.67	5.31	7.42	14.35			0.144
XON3	E	77.0	0.626	54.38	0.0850	175	4.57	6.79	2260	2.96	2.55	5.06	9.06	15.86			0.159
XON4	E	77.0	0.626	19.49	0.0305	115	4.35	5.60	1950	3.28	2.68	5.33	7.65	13.25			0.132

PROPOSED CONDITION

OFF4A	E	77.0	0.626	5.09	0.0080	180	1.67	9.65	600	2.83	2.49	4.95	3.68	13.33			0.133
OFF4B	E	77.0	0.626	5.26	0.0082	70	3.57	4.67	630	3.49	2.77	5.49	3.41	8.07			0.100
OFF4C	E	77.0	0.626	1.98	0.0031	60	5.00	3.86	275	2.91	2.52	5.01	1.82	5.68			0.100
ON1A	D	83.0	0.706	10.02	0.0157	145	2.07	6.71	820	2.44	3.15	4.78	3.76	10.47	965	15.361	0.105
ON2A	D	83.0	0.706	47.12	0.0736	85	5.88	3.63	1620	2.84	3.40	5.16	6.07	9.69	1705	19.472	0.097
ON2B	D	83.0	0.706	5.25	0.0082	160	4.38	5.49	730	3.01	3.51	5.31	3.10	8.59	890	14.944	0.086
ON3A	D	83.0	0.706	5.28	0.0083	85	4.12	4.08	565	3.72	3.89	5.90	2.32	6.41	650	13.611	0.064
ON3B	D	83.0	0.706	5.27	0.0082	60	6.67	2.92	730	3.15	3.59	5.43	3.03	5.95	790	14.389	0.060
ON3C	D	83.0	0.706	23.97	0.0375	150	4.00	5.48	670	2.30	3.06	4.64	3.33	8.81	820	14.556	0.088
ON4B	D	83.0	0.706	5.74	0.0090	65	3.08	3.94	710	3.80	3.94	5.97	2.70	6.64	775	14.306	0.066

ULTIMATE CONDITION																		
OFF4A	D	83.0	0.706	5.09	0.0080	100	1.00	7.10	750	2.40	3.13	4.74	3.54	10.64	850	14.722	0.106	
OFF4B	D	83.0	0.706	5.26	0.0082	100	1.00	7.10	1000	2.10	2.93	4.43	4.73	11.83	1100	16.111	0.118	
OFF4C	D	85.0	0.732	1.98	0.0031	100	1.00	6.62	275	2.91	3.45	5.22	1.33	7.95	375	12.083	0.080	
[1]	K = 0.0132 (CN) - 0.39										[5]	For Existing Conditions: V2 = 29.4 * (S/100)^0.5						
[2]	A = Area/640										[6]	For Developed Conditions: V2 = 30.6 * (S/100)^0.5						
[3]	Ti = (1.8 (1.1-K) L^0.5)/S^0.33										[7]	Tt = L/(60*V)						
[4]	For Existing Conditions: V1 = 14.8 * (S/100)^0.5										[8]	Tc = Ti + Tt						
	For Developed Conditions: V1 = 20.2 * (S/100)^0.5											Total L = Initial L + Travel L						
REFERENCE :																		
STANDARD FORM 4																		

Ultimate Condition HEC-1 Model

*FREE

*DIAGRAM

ID WESTWOOD PROFESSIONAL SERVICES
 ID KYLE CANYON GATEWAY
 ID CONCEPTUAL STUDY HYDROLOGY - UPDATE 3 ADDENDUM
 ID ULTIMATE DRAINAGE CONDITION

ID RETURN PERIOD ----- 100-YR
 ID DISTRIBUTION ----- 6-HOUR SDN3
 ID PROJECT NO. ----- PAR2004.000
 ID FILENAME ----- ULTIMATE COND.H1
 ID DATE ----- APRIL 2022
 ID MODELED BY ----- PK

ID SIX HOUR DEPTH-AREA REDUCTION FACTORS
 ID DRAINAGE AREA (MI^2) DARF
 ID 0.0-0.49 1.00
 ID 0.5-0.99 0.98
 ID 1.0-1.99 0.97
 ID 2.0-3.99 0.93
 ID 4.0-5.99 0.91
 ID 6.0-7.99 0.90

ID
 IT 5 0 0 2000
 IO 5 0 0
 IN 5 0 0
 JR PREC 1.00 0.98 0.97 0.93 0.91 0.90

*

KK ON1A
 BA0.0157
 PC 0 0.020 0.057 0.070 0.087 0.108 0.124 0.130 0.130 0.130
 PC 0.130 0.130 0.130 0.133 0.140 0.142 0.148 0.158 0.172 0.181
 PC 0.190 0.197 0.199 0.200 0.201 0.204 0.214 0.229 0.241 0.249
 PC 0.251 0.256 0.270 0.278 0.281 0.283 0.295 0.322 0.352 0.409
 PC 0.499 0.590 0.710 0.744 0.781 0.812 0.819 0.835 0.851 0.856
 PC 0.860 0.868 0.876 0.888 0.910 0.926 0.937 0.950 0.970 0.976
 PC 0.982 0.985 0.987 0.989 0.990 0.993 0.993 0.994 0.995 0.998
 PC 0.998 0.999 1
 PB 2.80
 LS 0 83.0
 UD 0.105

*

KK ON3C
 BA0.0375
 PB 2.80
 LS 0 83.0
 UD 0.088

*

KK ON3A
 BA0.0083
 PB 2.80
 LS 0 83.0
 UD 0.064

*

KK ON3B
 BA0.0082
 PB 2.80
 LS 0 83.0
 UD 0.060

*

KK U3B
 KM Does not include MPU NW51-C-E contribution
 HC 3

*

KK OFF4A
 BA0.0080
 PB 2.80
 LS 0 83.0
 UD 0.106

*

KK ON4B
 BA0.0090
 PB 2.80
 LS 0 83.0
 UD 0.066

*

KK OFF4B
 BA0.0082
 PB 2.80
 LS 0 83.0
 UD 0.118

*

KK OFF4C
 BA0.0031
 PB 2.80
 LS 0 85.0
 UD 0.080

*

KK CP3

KM Does not include MPU NW50-C-E contribution
HC 3
*
KK ON2A
BA0.0736
PB 2.80
LS 0 83.0
UD 0.097
*
KK ON2B
BA0.0082
PB 2.80
LS 0 83.0
UD 0.086
*
ZZ

Ultimate Cond

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
*   JUN 1998
*   VERSION 4.1
*
* RUN DATE 13APR22 TIME 18:34:24
*
*****
    
```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****
    
```

```

X X XXXXXX XXXX X
X X X X X XX
X X X X X
XXXXXX XXXX X XXXX X
X X X X X
X X X X X
X X XXXXXX XXXX XXX
    
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.

THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION

NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

*** FREE ***

```

*DIAGRAM
1 ID WESTWOOD PROFESSIONAL SERVICES
2 ID KYLE CANYON GATEWAY
3 ID CONCEPTUAL STUDY HYDROLOGY - UPDATE 3 ADDENDUM
4 ID ULTIMATE DRAINAGE CONDITION
5 ID
6 ID RETURN PERIOD ----- 100-YR
7 ID DISTRIBUTION ----- 6-HOUR SDN3
8 ID PROJECT NO. ----- PAR2004.000
9 ID FILENAME ----- ULTIMATE COND.H1
10 ID DATE ----- APRIL 2022
11 ID MODELED BY ----- PK
12 ID
13 ID SIX HOUR DEPTH-AREA REDUCTION FACTORS
14 ID DRAINAGE AREA (MI^2) DARF
15 ID 0.0-0.49 1.00
16 ID 0.5-0.99 0.98
17 ID 1.0-1.99 0.97
18 ID 2.0-3.99 0.93
19 ID 4.0-5.99 0.91
20 ID 6.0-7.99 0.90
21 ID
22 IT 5 0 0 2000
23 IO 5 0 0
24 IN 5 0 0
25 JR PREC 1.00 0.98 0.97 0.93 0.91 0.90
*
26 KK ON1A
27 BA 0.0157
28 PC 0 0.020 0.057 0.070 0.087 0.108 0.124 0.130 0.130 0.130
29 PC 0.130 0.130 0.130 0.133 0.140 0.142 0.148 0.158 0.172 0.181
30 PC 0.190 0.197 0.199 0.200 0.201 0.204 0.214 0.229 0.241 0.249
31 PC 0.251 0.256 0.270 0.278 0.281 0.283 0.295 0.322 0.352 0.409
32 PC 0.499 0.590 0.710 0.744 0.781 0.812 0.819 0.835 0.851 0.856
33 PC 0.860 0.868 0.876 0.888 0.910 0.926 0.937 0.950 0.970 0.976
34 PC 0.982 0.985 0.987 0.989 0.990 0.993 0.993 0.994 0.995 0.998
35 PC 0.998 0.999 1
36 PB 2.80
37 LS 0 83.0
38 UD 0.105
*
39 KK ON3C
40 BA 0.0375
41 PB 2.80
42 LS 0 83.0
43 UD 0.088
*
    
```

1 HEC-1 INPUT Page 1 PAGE 2

Ultimate Cond

LINE	ID	1	2	3	4	5	6	7	8	9	10
44	KK	ON3A									
45	BA	0.0083									
46	PB	2.80									
47	LS	0	83.0								
48	UD	0.064									
	*										
49	KK	ON3B									
50	BA	0.0082									
51	PB	2.80									
52	LS	0	83.0								
53	UD	0.060									
	*										
54	KK	U3B									
55	KM	Does not include MPU NW51-C-E contribution									
56	HC	3									
	*										
57	KK	OFF4A									
58	BA	0.0080									
59	PB	2.80									
60	LS	0	83.0								
61	UD	0.106									
	*										
62	KK	ON4B									
63	BA	0.0090									
64	PB	2.80									
65	LS	0	83.0								
66	UD	0.066									
	*										
67	KK	OFF4B									
68	BA	0.0082									
69	PB	2.80									
70	LS	0	83.0								
71	UD	0.118									
	*										
72	KK	OFF4C									
73	BA	0.0031									
74	PB	2.80									
75	LS	0	85.0								
76	UD	0.080									
	*										
77	KK	CP3									
78	KM	Does not include MPU NW50-C-E contribution									
79	HC	3									
	*										

HEC-1 INPUT

PAGE 3

LINE	ID	1	2	3	4	5	6	7	8	9	10
80	KK	ON2A									
81	BA	0.0736									
82	PB	2.80									
83	LS	0	83.0								
84	UD	0.097									
	*										
85	KK	ON2B									
86	BA	0.0082									
87	PB	2.80									
88	LS	0	83.0								
89	UD	0.086									
	*										
90	ZZ										

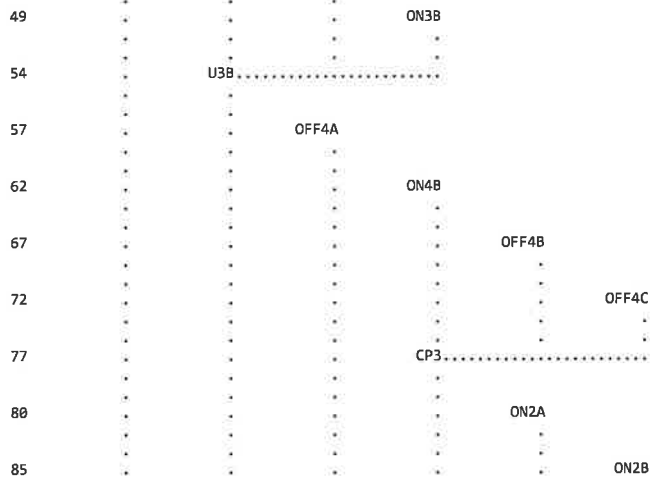
SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
 NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

```

26  ON1A
    *
    *
39  * ON3C
    *
    *
44  * ON3A
    *
  
```


Ultimate Cond



(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

1*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* JUN 1998 *
* VERSION 4.1 *
* RUN DATE 13APR22 TIME 18:34:24 *
*****
  
```

```

*****
* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 756-1104 *
*****
  
```

```

WESTWOOD PROFESSIONAL SERVICES
KYLE CANYON GATEWAY
CONCEPTUAL STUDY HYDROLOGY - UPDATE 3 ADDENDUM
ULTIMATE DRAINAGE CONDITION

RETURN PERIOD ----- 100-YR
DISTRIBUTION ----- 6-HOUR SDN3
PROJECT NO. ----- PAR2004.000
FILENAME ----- ULTIMATE COND.H1
DATE ----- APRIL 2022
MODELED BY ----- PK
  
```

```

SIX HOUR DEPTH-AREA REDUCTION FACTORS
DRAINAGE AREA (MI^2)   DARF
0.0-0.49              1.00
0.5-0.99              0.98
1.0-1.99              0.97
2.0-3.99              0.93
4.0-5.99              0.91
6.0-7.99              0.90
  
```

```

23 IO      OUTPUT CONTROL VARIABLES
          IPRNT      5  PRINT CONTROL
          IPLOT      0  PLOT CONTROL
          QSCAL      0.  HYDROGRAPH PLOT SCALE

IT         HYDROGRAPH TIME DATA
          NMIN      5  MINUTES IN COMPUTATION INTERVAL
          IDATE      1  0  STARTING DATE
          ITIME     0000  STARTING TIME
          NQ        2000  NUMBER OF HYDROGRAPH ORDINATES
          NDDATE     7  0  ENDING DATE
          NDTIME     2235  ENDING TIME
          ICENT      19  CENTURY MARK

          COMPUTATION INTERVAL .08 HOURS
          TOTAL TIME BASE 166.58 HOURS

ENGLISH UNITS
DRAINAGE AREA      SQUARE MILES
PRECIPITATION DEPTH  INCHES
LENGTH, ELEVATION  FEET
FLOW               CUBIC FEET PER SECOND
STORAGE VOLUME     ACRE-FeET
SURFACE AREA       ACRES
TEMPERATURE        DEGREES FAHRENHEIT
  
```

Ultimate Cond

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
1.00 .98 .97 .93 .91 .90

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION					
				RATIO 1 1.00	RATIO 2 .98	RATIO 3 .97	RATIO 4 .93	RATIO 5 .91	RATIO 6 .90
HYDROGRAPH AT +	ON1A	.02	1 FLOW TIME	18. 3.58	18. 3.58	17. 3.58	16. 3.58	16. 3.58	15. 3.58
HYDROGRAPH AT +	ON3C	.04	1 FLOW TIME	47. 3.50	45. 3.50	45. 3.50	41. 3.50	40. 3.50	39. 3.50
HYDROGRAPH AT +	ON3A	.01	1 FLOW TIME	12. 3.50	11. 3.50	11. 3.50	10. 3.50	10. 3.50	10. 3.50
HYDROGRAPH AT +	ON3B	.01	1 FLOW TIME	12. 3.50	11. 3.50	11. 3.50	10. 3.50	10. 3.50	10. 3.50
3 COMBINED AT +	U3B	.05	1 FLOW TIME	70. 3.50	68. 3.50	67. 3.50	62. 3.50	60. 3.50	59. 3.50
HYDROGRAPH AT +	OFF4A	.01	1 FLOW TIME	9. 3.58	9. 3.58	9. 3.58	8. 3.58	8. 3.58	8. 3.58
HYDROGRAPH AT +	ON4B	.01	1 FLOW TIME	12. 3.50	12. 3.50	12. 3.50	11. 3.50	11. 3.50	10. 3.50
HYDROGRAPH AT +	OFF4B	.01	1 FLOW TIME	10. 3.58	9. 3.58	9. 3.58	8. 3.58	8. 3.58	8. 3.58
HYDROGRAPH AT +	OFF4C	.00	1 FLOW TIME	4. 3.50	4. 3.50	4. 3.50	4. 3.50	4. 3.50	4. 3.50
3 COMBINED AT +	CP3	.02	1 FLOW TIME	26. 3.50	25. 3.50	24. 3.50	23. 3.50	22. 3.50	22. 3.50
HYDROGRAPH AT +	ON2A	.07	1 FLOW TIME	88. 3.50	85. 3.50	84. 3.50	78. 3.50	75. 3.50	74. 3.50
HYDROGRAPH AT +	ON2B	.01	1 FLOW TIME	10. 3.50	10. 3.50	10. 3.50	9. 3.50	9. 3.50	9. 3.50

*** NORMAL END OF HEC-1 ***

APPENDIX D

Hydraulic Analyses

Proposed Condition Hydraulic Sections

Worksheet for Section 10

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.86 %
Diameter	5.00 ft
Discharge	287.00 cfs
Results	
Normal Depth	2.94 ft
Flow Area	12.0 ft ²
Wetted Perimeter	8.74 ft
Hydraulic Radius	1.37 ft
Top Width	4.92 ft
Critical Depth	4.62 ft
Percent Full	58.8 %
Critical Slope	1.05 %
Velocity	23.89 ft/s
Velocity Head	8.87 ft
Specific Energy	11.81 ft
Froude Number	2.697
Maximum Discharge	473.77 cfs
Discharge Full	440.42 cfs
Slope Full	1.21 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	58.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.94 ft
Critical Depth	4.62 ft
Channel Slope	2.86 %
Critical Slope	1.05 %

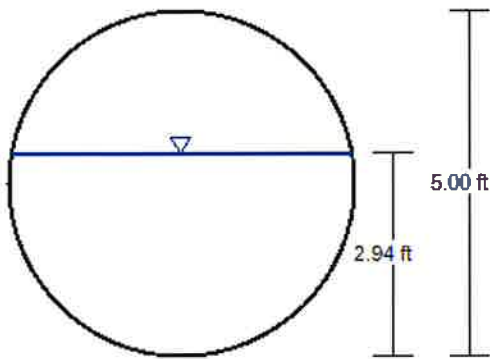
Cross Section for Section 10

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	2.86 %
Normal Depth	2.94 ft
Diameter	5.00 ft
Discharge	287.00 cfs



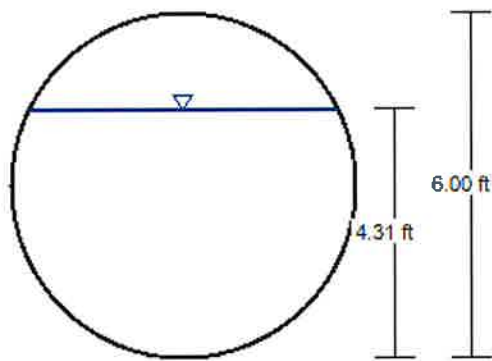
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H: 1

Worksheet for Section 12

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Diameter	6.00 ft
Discharge	531.00 cfs
Results	
Normal Depth	4.31 ft
Flow Area	21.7 ft ²
Wetted Perimeter	12.13 ft
Hydraulic Radius	1.79 ft
Top Width	5.40 ft
Critical Depth	5.74 ft
Percent Full	71.8 %
Critical Slope	1.37 %
Velocity	24.43 ft/s
Velocity Head	9.28 ft
Specific Energy	13.58 ft
Froude Number	2.146
Maximum Discharge	660.15 cfs
Discharge Full	613.69 cfs
Slope Full	1.57 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	71.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.31 ft
Critical Depth	5.74 ft
Channel Slope	2.10 %
Critical Slope	1.37 %

Cross Section for Section 12

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Normal Depth	4.31 ft
Diameter	6.00 ft
Discharge	531.00 cfs



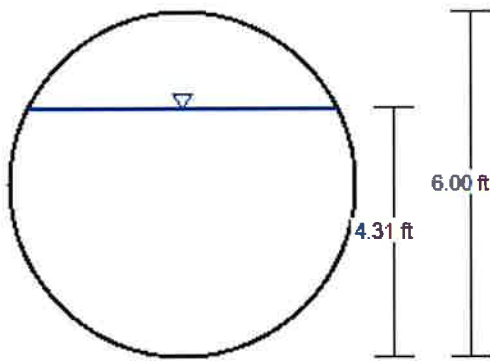
V: 1
H: 1

Worksheet for Section 13

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Diameter	6.00 ft
Discharge	531.00 cfs
Results	
Normal Depth	4.31 ft
Flow Area	21.7 ft ²
Wetted Perimeter	12.13 ft
Hydraulic Radius	1.79 ft
Top Width	5.40 ft
Critical Depth	5.74 ft
Percent Full	71.8 %
Critical Slope	1.37 %
Velocity	24.43 ft/s
Velocity Head	9.28 ft
Specific Energy	13.58 ft
Froude Number	2.146
Maximum Discharge	660.15 cfs
Discharge Full	613.69 cfs
Slope Full	1.57 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	71.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.31 ft
Critical Depth	5.74 ft
Channel Slope	2.10 %
Critical Slope	1.37 %

Cross Section for Section 13

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Normal Depth	4.31 ft
Diameter	6.00 ft
Discharge	531.00 cfs



V: 1
H: 1

Worksheet for Section 14

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	1.33 %
Diameter	1.50 ft
Discharge	10.00 cfs
Results	
Normal Depth	1.04 ft
Flow Area	1.3 ft ²
Wetted Perimeter	2.95 ft
Hydraulic Radius	0.44 ft
Top Width	1.38 ft
Critical Depth	1.22 ft
Percent Full	69.2 %
Critical Slope	0.92 %
Velocity	7.66 ft/s
Velocity Head	0.91 ft
Specific Energy	1.95 ft
Froude Number	1.390
Maximum Discharge	13.03 cfs
Discharge Full	12.11 cfs
Slope Full	0.91 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	69.2 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.04 ft
Critical Depth	1.22 ft
Channel Slope	1.33 %
Critical Slope	0.92 %

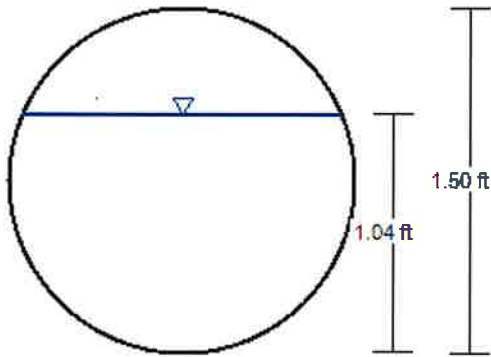
Cross Section for Section 14

Project Description

Friction Method	Manning
	Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	1.33 %
Normal Depth	1.04 ft
Diameter	1.50 ft
Discharge	10.00 cfs



V: 1
H: 1

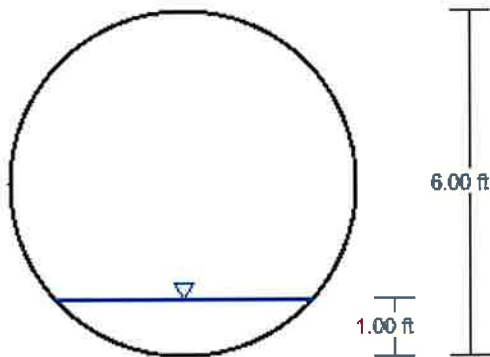
Ultimate Condition Hydraulic Sections

Worksheet for Section U3A

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Diameter	6.00 ft
Discharge	37.00 cfs
Results	
Normal Depth	1.00 ft
Flow Area	3.1 ft ²
Wetted Perimeter	5.04 ft
Hydraulic Radius	0.61 ft
Top Width	4.47 ft
Critical Depth	1.61 ft
Percent Full	16.7 %
Critical Slope	0.31 %
Velocity	11.96 ft/s
Velocity Head	2.22 ft
Specific Energy	3.22 ft
Froude Number	2.534
Maximum Discharge	660.15 cfs
Discharge Full	613.69 cfs
Slope Full	0.01 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	16.7 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.00 ft
Critical Depth	1.61 ft
Channel Slope	2.10 %
Critical Slope	0.31 %

Cross Section for Section U3A

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	2.10 %
Normal Depth	1.00 ft
Diameter	6.00 ft
Discharge	37.00 cfs



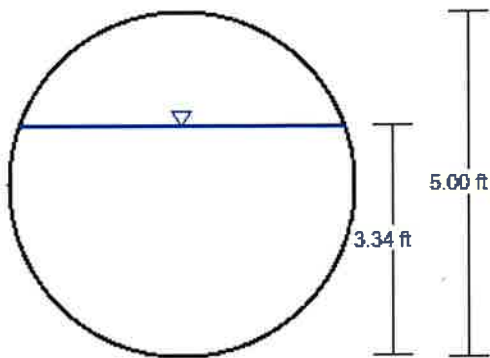
V: 1
H: 1

Worksheet for Section U3B

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.64 %
Diameter	5.00 ft
Discharge	164.00 cfs
Results	
Normal Depth	3.34 ft
Flow Area	14.0 ft ²
Wetted Perimeter	9.57 ft
Hydraulic Radius	1.46 ft
Top Width	4.71 ft
Critical Depth	3.67 ft
Percent Full	66.9 %
Critical Slope	0.50 %
Velocity	11.75 ft/s
Velocity Head	2.15 ft
Specific Energy	5.49 ft
Froude Number	1.204
Maximum Discharge	224.12 cfs
Discharge Full	208.34 cfs
Slope Full	0.40 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	66.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.34 ft
Critical Depth	3.67 ft
Channel Slope	0.64 %
Critical Slope	0.50 %

Cross Section for Section U3B

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.64 %
Normal Depth	3.34 ft
Diameter	5.00 ft
Discharge	164.00 cfs



V: 1
H: 1

Worksheet for Section U3

Project Description

Friction Method	Manning
	Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.50 %
Diameter	6.00 ft
Discharge	201.00 cfs

Results

Normal Depth	3.60 ft
Flow Area	17.7 ft ²
Wetted Perimeter	10.63 ft
Hydraulic Radius	1.67 ft
Top Width	5.88 ft
Critical Depth	3.88 ft
Percent Full	60.0 %
Critical Slope	0.40 %
Velocity	11.36 ft/s
Velocity Head	2.00 ft
Specific Energy	5.60 ft
Froude Number	1.154
Maximum Discharge	322.12 cfs
Discharge Full	299.45 cfs
Slope Full	0.23 %
Flow Type	Supercritical

GVF Input Data

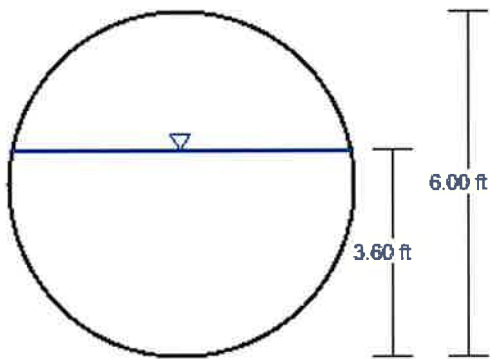
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	60.0 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.60 ft
Critical Depth	3.88 ft
Channel Slope	0.50 %
Critical Slope	0.40 %

Cross Section for Section U3

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.50 %
Normal Depth	3.60 ft
Diameter	6.00 ft
Discharge	201.00 cfs



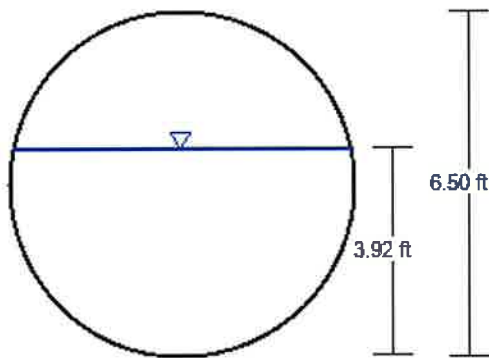
V: 1
H: 1

Worksheet for Section U4

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.50 %
Diameter	6.50 ft
Discharge	251.30 cfs
Results	
Normal Depth	3.92 ft
Flow Area	20.9 ft ²
Wetted Perimeter	11.57 ft
Hydraulic Radius	1.81 ft
Top Width	6.36 ft
Critical Depth	4.25 ft
Percent Full	60.4 %
Critical Slope	0.40 %
Velocity	12.00 ft/s
Velocity Head	2.24 ft
Specific Energy	6.16 ft
Froude Number	1.166
Maximum Discharge	398.76 cfs
Discharge Full	370.70 cfs
Slope Full	0.23 %
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	60.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.92 ft
Critical Depth	4.25 ft
Channel Slope	0.50 %
Critical Slope	0.40 %

Cross Section for Section U4

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.50 %
Normal Depth	3.92 ft
Diameter	6.50 ft
Discharge	251.30 cfs



V: 1
H: 1

Worksheet for Section U5

Project Description

Friction Method	Manning
	Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.80 %
Diameter	6.50 ft
Discharge	295.80 cfs

Results

Normal Depth	3.74 ft
Flow Area	19.8 ft ²
Wetted Perimeter	11.20 ft
Hydraulic Radius	1.77 ft
Top Width	6.42 ft
Critical Depth	4.62 ft
Percent Full	57.6 %
Critical Slope	0.44 %
Velocity	14.94 ft/s
Velocity Head	3.47 ft
Specific Energy	7.21 ft
Froude Number	1.501
Maximum Discharge	504.40 cfs
Discharge Full	468.90 cfs
Slope Full	0.32 %
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	57.6 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.74 ft
Critical Depth	4.62 ft
Channel Slope	0.80 %
Critical Slope	0.44 %

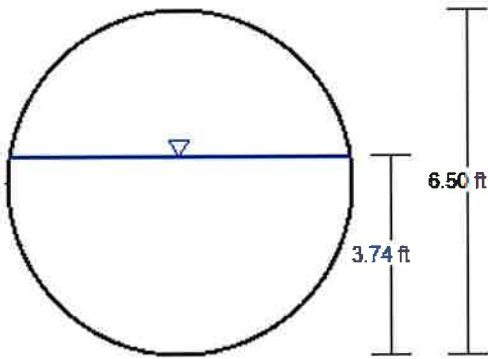
Cross Section for Section U5

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.80 %
Normal Depth	3.74 ft
Diameter	6.50 ft
Discharge	295.80 cfs



V: 1
H: 1